9.1 Introduction

9.1.1 This chapter of the Environmental Statement (ES) provides an assessment of the potential impacts to local air quality resulting from the proposed hotel, residential and mixed commercial development at Twickenham railway station (hereafter referred to as the 'proposed development').

9.1.2 This chapter describes the assessment methodology; the baseline conditions at the proposed development site and its surroundings; the likely significant environmental impacts of the proposed development, including the mitigation measures required to prevent, reduce or offset any significant adverse impacts; the likely residual effects after these measures have been employed; and the likely impact of the proposed development in combination with the potential impacts to local air quality associated with other developments in the surrounding area (as described within *Chapter 2: EIA Methodology* this ES).

9.1.3 In particular, this chapter assesses the potential impacts of atmospheric releases from:

- On-site demolition/construction plant and equipment;
- Dust generation during demolition and construction;
- Additional road traffic attributed to the demolition/construction and operational stages of the proposed development; and
- Heating and power plant associated with the completed development.

9.2 Planning Policy Context

National Legislation

9.2.1 The principal air quality legislation within the United Kingdom is the Air Quality Standards Regulations 2007 (SI 2007/64) (Ref. 9-1), which came into force on 15 February 2007 and brings together the Government's requirements to transpose the separate EU Daughter Directives into national legislation through a single consolidated statutory instrument.

9.2.2 In addition, the Environment Act 1995 (Ref. 9-2) requires the Government to produce a national Air Quality Strategy (AQS) containing standards, objectives, and measures for improving ambient air quality and to keep the policies identified below under review.

9.2.3 The Environment Act (Ref. 9-2) also requires that Local Authorities undertake a tiered appraisal of air quality within their borough to establish compliance or non-compliance with the targets established in the Air Quality Strategy. Where the objectives are likely to be exceeded, the Local Authority must designate an Air Quality Management Area (AQMA) and establish an Action Plan for the region, which outlines measures to achieve the objectives.

9.2.4 The AQS for England, Scotland, Wales and Northern Ireland, July 2007 (Ref. 9-3) provides the over-arching strategic framework for air quality management in the UK and contains national air quality standards and objectives established by the Government to protect human health. These objectives apply to outdoor locations where people are regularly present and do not apply to occupational, indoor, or in-vehicle exposure.

9.2.5 The air quality objectives (AQO) applicable to Local Air Quality Management are set out in the Air Quality Regulations 2000 (Ref. 9-4) and the Air Quality (Amendment) Regulations 2002 (Ref. 9-5). The Air Quality Standards Regulations 2007 (Ref. 9-1) include additional objectives for arsenic, cadmium, nickel and particulate matter ($PM_{2.5}$). However, the AQS (Re. 9-3) does not contain an obligation to currently review and assess concentrations of these species locally.

9.2.6 Current assessment criteria applicable to the protection of human health and Local Air Quality Management based on the recent AQS (Ref. 9-3) and the 2007 Air Quality Standards Regulations (Ref.9-1) are presented in Table 9-1.

Table 9-1 Air Quality Objectives

Pollutant	Air Quality Objective		Date to be Achieved by
	Concentration	Measured as	
Benzene	16.25 µg/m^3 5.00 µg/m^3	Annual mean	31.12.2003 31.12.2010
1,3-butadiene	2.25 µg/m^3	Annual mean	31.12.2003
Carbon monoxide	10 mg/m^3	Max daily 8-hr mean	31.12.2003
Lead	0.5 µg/m^3 0.25 µg/m^3	Annual mean	31.12.2004 31.12.2008
Nitrogen dioxide	200 µg/m^3 40 µg/m^3	1-hr mean <18/yr Annual mean	31.12.2005
Particles (PM_{10})	200 µg/m^3 40 µg/m^3 20 µg/m^3	24-hr mean <35/yr Annual mean Annual mean	31.12.2004 31.12.2004 31.12.2010
Sulphur dioxide	350 µg/m^3 125 µg/m^3 266 µg/m^3	1-hr mean <24/yr 24-hr mean <3/yr ¼-hr mean <35/yr	31.12.2004 31.12.2004 31.12.2005

National Planning Policy

9.2.7 Planning Policy Statement 23 (PPS23) '*Planning and Pollution Control*' (Ref. 9-6) takes into account the national AQS and the system of Local Air Quality Management (LAQM), stating that, as in other Government Guidance, air quality considerations can be a material planning consideration: "*Any air quality consideration that relates to land use and its development is capable of being a material planning consideration*".

9.2.8 It also acknowledges that: *"It is not the case that all planning for developments inside or adjacent to AQMAs should be refused if the developments would result in a deterioration of local air quality. Such an approach could sterilise development particularly where authorities have designated their entire areas as AQMAs. Authorities should work together to ensure development has a beneficial impact on the environment, for example by exploring the possibility of securing mitigation measure that would allow the proposal to proceed"*.

9.2.9 Additional planning policies relevant to air quality management includes Planning Policy Guidance Note 13 National Planning Policy '*Transport*' (PPG13) (Ref. 9-7), which states that local air quality is a key consideration in the integration between planning and transport. PPG13 also advises that well designed traffic measures contribute to reductions in local air pollution. Another relevant planning policy is the recently published Policy Guidance Note LAQM.PG(09) (Ref.9-8), which represents all aspects of policy, including air quality reviews and assessments, air quality action planning, transport planning, and land use planning.

Regional Planning Policy

The London Plan: Spatial Development Strategy for London Borough of Richmond upon Thames

9.2.10 The revised London Plan (Consolidated with Alterations since 2004) (Ref. 9-9) is the statutory strategic planning framework for London. Policy 4.A.19 describes the strategy for 'Improving Air Quality' and emphasises the need to achieve reductions in pollutant emissions and public exposure to pollution though a number of measures, including ensuring that air quality is taken into account at the planning stage along with other material considerations.

The Draft Replacement London Plan

9.2.11 A draft replacement Spatial Development Strategy for Greater London was published in October 2009 (Ref. 9-10). The draft replacement London Plan sets out an integrated economic, environmental, transport and social framework for the development of London for the next 20-25 years. Draft policies of relevance to air quality within the context of this development have been considered.

South London Sub-Regional Development Framework

9.2.12 In May 2006, the Mayor published five Sub-Regional Development Frameworks (SRDF) for London. Policy 4C of the South London SRDF (Ref. 9-11) recognises the relationship between road traffic and air quality and emphasises the need to integrate air quality plans with other relevant strategies.

Air Quality Strategy for London

9.2.13 The Greater London Authority produced the Air Quality Strategy for London in 2001. This strategy contains proposals and policies for implementing the national strategy's policies and for achieving AQS objectives in London. It focuses on the main pollutants of concern in London: nitrogen dioxide (NO_2) and particulate matter (PM_{10}). As mentioned above, since the main source of emissions in London is road traffic, the main focus of the London AQS is on reducing traffic related emissions, primarily through the promotion of cleaner vehicles and technologies and reduced vehicle usage within the capital.

Local Planning Policy

9.2.14 The London Borough of Richmond-upon-Thames gave the following Scoping Opinion (Ref 9-12):

- *The site is within an Air Quality Management Area (AQMA), therefore any development should not further reduce air quality in the area and should safeguard the health of the current and potential community.*
- *The potential for the generation of dust (and therefore particulates) is noted but details of how these issues will be considered and the actions that will be taken in the event that the required level of air quality improvements cannot be achieved should be noted in the ES. It is important to make clear at the earliest stage of the development that details provided should outline all measures (such as site management activities and the use of low–emission plant) that will be undertaken over the course of the development to reduce the environmental impacts of the development. Reference should be made to all relevant guidance and legislation and should include potential for inclusion of measures to comply with new EU limit values as they are likely to be finalised prior to the implementation of the development.*

- *The Environmental Statement should provide details of the potential mitigation measures that will be required to safeguard the health and amenity of residents and workers in the area, pre-, post- and during the development.*
- *Any mitigation measures or consideration of particulates should also include the impacts of CHP and biomass on air quality if these technologies are proposed. Biomass boilers are generally not encouraged in AQMAs.*
- *The impact of railway emissions must be assessed in relation to future owners/occupiers of the new flats.*

9.2.15 The London Borough of Richmond-upon-Thames Air Quality Action Plan Progress Report 2008 (Ref 9-13) confirmed that the air pollutants of most concern at the site are nitrogen dioxide (NO_2) and particulate (PM_{10}).

9.3 Assessment Methodology and Significance Criteria

9.3.1 This section presents the methodology used to assess the ambient air quality at the site, the impacts on the proposed receptors within the proposed development and the probable impacts resulting from the construction of the proposed development and the proposed development in service.

9.3.2 The ambient or baseline air quality at the site has been assessed from a review of the results of air quality monitoring within the vicinity of the site in recent years and a period of air quality monitoring at four locations within the site.

9.3.3 Receptors sensitive to air pollution at the site will include:

- Future site users in the proposed development – likely to be affected by the ambient air quality at the site.
- Existing site users (including passengers and users of the station) and, particularly, the nearest residential receptors - likely to be affected by the air quality from the proposed development in service or during construction.

9.3.4 Significance criteria specific to the air quality assessment are given in Table 9-2 below.

Table 9-2 Air Quality Assessment Significance Criteria

Air Quality Significance Criteria	Annual Mean $N0_2$ and PM_{10} Air Quality Objectives Plus Construction Dust
Major adverse	Where location presently exceeds AQO and proposed development will result in an increase in concentrations of NO_2 and/or PM_{10} of greater than 5 % Or: Where location presently does not exceed AQO and proposed development will result in exceedence of AQO Or: Where the proposed construction of the development will result in dust concentrations exceeding 2 mg/m^3 as a daily average concentration at the site boundary with residences.
Minor adverse	Where location presently exceeds AQO and proposed development will result in an increase in concentrations of NO_2 and/or PM_{10} of <5 % Or: Where location presently does not exceed AQO and proposed development will not result in exceedence of AQO Or: Where the proposed construction of the development will result in dust concentrations of <2 mg/m^3 as a daily average concentration at the site boundary with residences.
No/negligible impact	Proposed development results in no change at location where the AQO is presently exceeded or less than 1 % or 1$\mu g/m^3$ change (whichever is the greater).
Minor beneficial	Where location presently exceeds AQO and proposed development will result in a decrease in concentrations of NO_2 and/or PM_{10} but will not result in the location no longer exceeding the AQO Or: Where location presently does not exceed AQO and proposed development will not result in a reduction in concentrations of <5 % or <5 $\mu g/m^3$ (whichever is the greater).
Major beneficial	Where location presently exceeds AQO and proposed development will result in a decrease in concentrations of NO_2 and/or PM_{10} such that the location no longer exceeds the AQO Or: Where location presently does not exceed AQO and proposed development will not result in a reduction in concentrations of >5 % or >5 $\mu g/m^3$ (whichever is the greater).
Notes	Where air quality impacts meet multiple criterion, the higher significance class will be applied.

Study Species

9.3.5 The air pollutants of concern include:

- **Particulate:** Usually measured as PM_{10} (particulates with a size below 10 µm). Commonly attributed to emissions from diesel engines, but can be from any source of fine dust or smoke. Particulates may be re-suspended and entrained in any airflow. Concentrations are weather dependant, being higher on dry windy days and minimal during rainfall.
- **Sulphur dioxide (SO_2):** Associated with the combustion of coal. There is some (albeit reducing) sulphur content in both petrol and diesel fuels. A proportion of SO_2 is derived from vehicle emissions and a tiny amount from smell agents in the combustion of natural gas. SO_2 is known as a "transboundary pollutant" as emissions may impact on countries distant from the source (notably emissions from coal power stations). The concentration in air is affected by the weather. Rainfall washes out SO_2 to form dilute sulphuric acid (a contribution to acid rain).
- **Oxides of nitrogen (NO_x):** Mainly a product of high temperature combustion resulting in oxidation of nitrogen in fuel and air. The emission is mainly in the form of nitrous oxide (NO), which oxidises to nitrogen dioxide (NO_2) in the atmosphere. Principal sources are vehicle engines, gas fired appliances and gas turbine (jet) engines. NO_2 levels may vary regionally and are not necessarily directly associated with proximity to the nearest source of NO. NO_2 is the principal input to the photo-chemical reaction producing ozone (O_3).
- **Ozone (O_3):** Important in filtering UV radiation in the upper atmosphere, low level O_3 concentrations can produce adverse respiratory symptoms and O_3 is considered a pollutant at ground level. Ozone is produced by a photo-chemical reaction with NO_2 and O_2, degrading in sunlight to NO and O_3. Concentrations of Ozone are not associated with proximity to a source, but rather a regional effect of high oxides of nitrogen pollution. A transboundary pollutant, concentrations vary with meteorological conditions.
- **Carbon monoxide (CO):** Produced by the incomplete combustion of carbon fuels. Concentrations closely related to proximity of source. The principal source is petrol engines, very little is produced by diesels as diesel combustion has an air-rich air/fuel ratio. Petrol engine emissions are reduced by around 90 % by catalytic converters and modern engine management systems. A toxic air pollutant, eventually oxidising to CO_2.
- **Carbon dioxide (CO_2):** Product of combustion of carbon fuels in a normal atmosphere and principal "greenhouse" gas. Increased atmospheric concentrations have been linked to changes in climate. CO_2 is not toxic, but is asphyxiant at high concentrations. Natural background concentration is around 0.03 %. Concentrations greater than 2 % can cause respiratory distress.
- **Non-methane hydrocarbons (NMHC):** NMHC are hydrocarbons in air, excluding the natural background methane. Sources are evaporation from fuel tanks, crankcase breather emissions and products of incomplete combustion.
- **Benzene:** Benzene is an aromatic hydrocarbon likely to be released to air from evaporating fuels or as a product of incomplete combustion. Benzene is toxic, readily absorbed and a suspected carcinogen.

- **1,3 butadiene:** This is a common polycyclic aromatic hydrocarbon (PAH) and is a product of many types of combustion, although the principal source is industrial processes. Motor vehicles contribute around 7 % of air pollution from PAHs. 1,3 butadiene is an indicator of the likely presence of other PAHs.
- **Lead (Pb):** The principal source of lead as an air pollutant used to be exhaust emissions from engines using petrol with a lead anti-knock additive. All commercially available petrol is now unleaded. Lead is a neurotoxin.

9.4 Ambient Air Quality – Baseline Conditions

9.4.1 The most appropriate method of establishing the ambient air quality baseline is by air quality monitoring at and in the vicinity of the site.

9.4.2 Air quality is regularly monitored at locations throughout the UK. These locations may be adjacent to major highways, in central urban or rural locations for indications of background, in industrial areas or close to other significant air pollution sources such as airports. The monitoring stations are principally fixed units measuring a range of pollutants. Some monitoring units are re-locatable and may be moved around from time to time. Substances monitored include CO, benzene, NO_2, SO_2, O_3 and particulates with a size not exceeding 10 µm (PM_{10}). In addition, NO_2 diffusion tubes may be deployed at several locations between the main monitoring stations.

9.4.3 There are several local authority (London Borough of Richmond Upon Thames) NO_2 diffusion tube monitoring locations within the vicinity of the Twickenham Rail Station site, some with a similarity of exposure to the areas of the site closest to highways. The nearest monitoring stations are listed in Table 9-3 below.

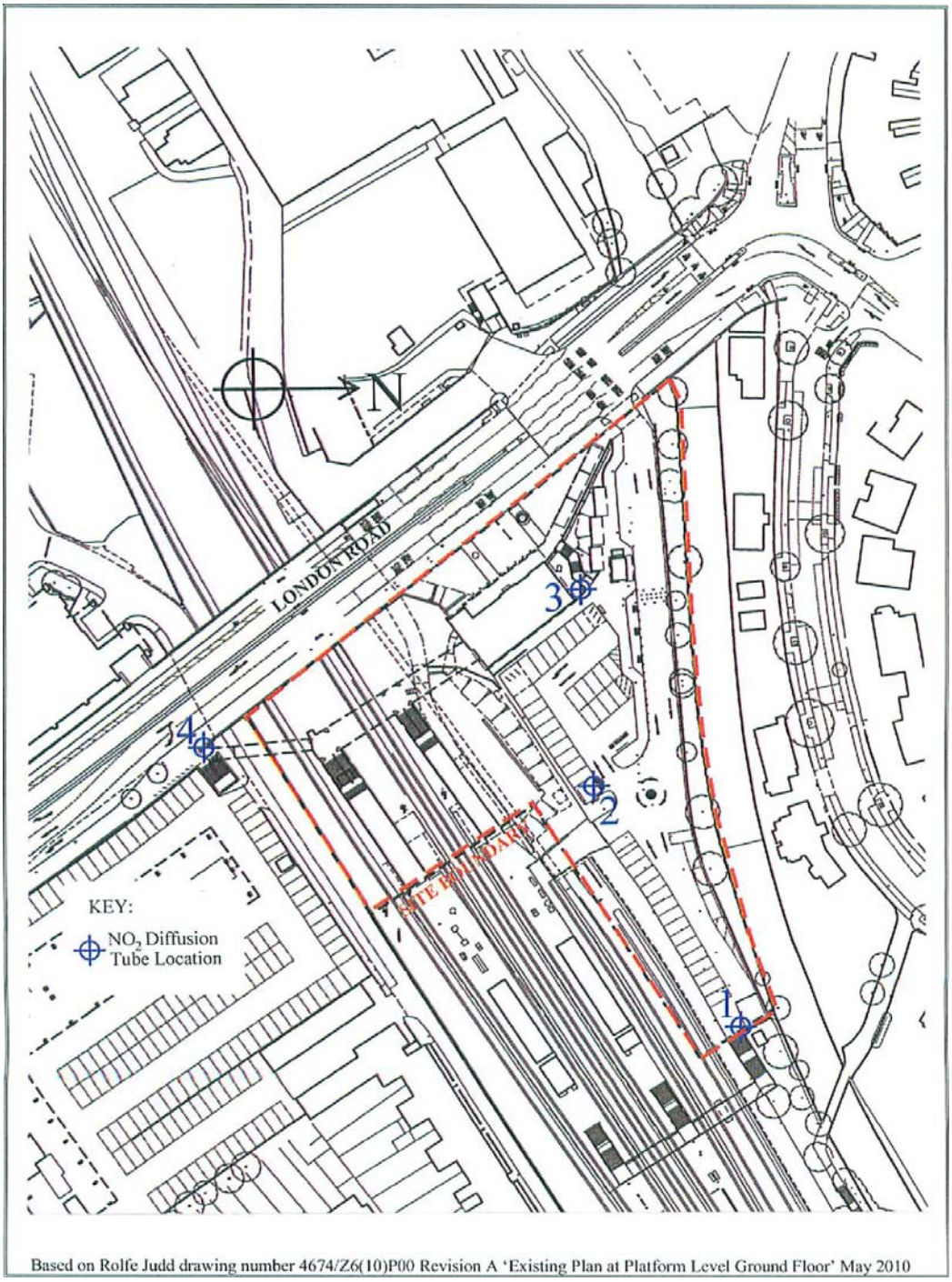
Table 9-3 Nearest Local Authority Monitoring Locations

Local Authority Site ID	Site Name
13	Whitton Road, Whitton (opposite Rugby Ground)
14	Cross Deep, Twickenham (near Poulett Gardens)
15	Richmond Road, Twickenham (opposite Marble Hill Park)
16	St Margarets Road, St Margarets (near Bridge Road)
31	A316
32	Kings Street, Twickenham
33	Heath Road, Twickenham
RUT01	Civic Centre, York Street, Twickenham

9.4.4 The NO_2 diffusion tube monitoring results for recent years are summarised in Table 9-4. As part of this assessment, four NO_2 diffusion tubes were exposed around the site between 27th May 2010 and 24th June 2010. See Figure 9-1 for diffusion tube locations.

9.4.5 The results from the analysis of the four exposed NO_2 diffusion tubes are given in *Appendix D - ES Volume III* and summarised in Table 9-5.

Figure 9-1 Diffusion Tube Locations



Note: Drawing Not to Scale

Table 9-4 Results of NO2 Diffusion Tube Monitoring for Monitoring Stations within the Vicinity of Twickenham Railway Station

Concentration Annual average NO_2 ($\mu g/m^3$)	Site ID	Year			
		2007	2008	2009	2010 (to date)*
	13	**48.0**	**54.0**	**50.0**	**53.1**
	14	**54.0**	**53.0**	**54.0**	**55.1**
	15	**48.0**	**57.0**	**55.0**	**52.2**
	16	**47.0**	**50.0**	**49.0**	**45.9**
	31	**67.0**	**62.0**	**60.0**	**55.0**
	32	**112.0**	**106.0**	**110.0**	**103.9**
	33	**62.0**	**56.0**	**63.0**	**63.9**
	RUT01	**58.0**	**64.0**	**62.0**	**54.0**

Values in **bold** indicate exceedence of the AQO; * Results are an average of NO2 diffusion tube data collected from January to June 2010 and are *not* bias adjusted.

Table 9-5 Results of NO2 Diffusion Tube Monitoring at the Site

Site Monitoring Location	Start Date	End Date	NO_2 Concentration		
			On Tube	In Air	
			(μg)	($\mu g/m^3$)	(ppb)
1	27/05/2010	24/06/2010	1.26	25.30	13.31
2	27/05/2010	24/06/2010	1.58	31.63	16.63
3	27/05/2010	24/06/2010	1.80	36.14	19.01
4	27/05/2010	24/06/2010	1.59	31.97	16.82

9.4.6 An appropriate method of interpreting a short period of monitoring is by extrapolating the result to the equivalent average of a comparable 12 months by annualising the results and applying any appropriate bias factor.

9.4.7 The results from the month of NO_2 diffusion tube monitoring at the site may be annualised by comparison with monitoring for the same period from a nearby monitoring station with a full 12 months of results from which an annual average has been established. There are no continuous monitoring stations particularly close to the site and the nearest surrounding continuous monitoring stations are two in the London Borough of Richmond Upon Thames and two in London Borough of Hounslow. Results from these four nearby continuous monitoring stations have been used to derive an annualisation factor. See Table 9-6.

Table 9-6 Deriving an Annualisation Factor

Monitoring Station		Average NO_2 for 27/05/2010 to 24/06/2010 ($\mu g/m^3$)	Average NO_2 for 25/06/2009 to 24/06/2010 ($\mu g/m^3$)	Apparent annualisation factor for site monitoring period
R/1	Richmond Castelnau	31.5	39.0	1.24
TD0	National Phys Lab	15.7	23.3	1.46
HS9	Hounslow Heston Rd	48.3	47.9	0.99
HS6	Hounslow Feltham	38.4	47.0	1.22

9.4.8 In this case, there are significant differences in the apparent annualisation factors between the monitoring stations. However, an average of the apparent annualisation factors derived above would appear appropriate. This would give an annualisation factor of 1.23.

9.4.9 A bias factor should be applied to the diffusion tube results and this is normally derived from a comparison of the continuous monitoring results and the diffusion tube from the same location over the same time period. The London Borough of Richmond Upon Thames has advised that the bias factor they are using currently is the 2009 adjustment factor of 1, and therefore the bias factor used in this assessment will also be 1.

9.4.10 The results from the NO_2 diffusion tube monitoring at the site have been annualised and have had the bias factor applied. See Table 9-7 below.

Table 9-7 Annualisation of and Application of the Bias Factor to the NO2 Diffusion Tube Results At The Site

Site Monitoring Location	Average NO_2 Concentration ($\mu g/m^3$)	
	As measured (uncorrected)	Annualised and adjusted for bias factor
1	25.30	31.12
2	31.63	38.90
3	36.14	**44.45**
4	31.97	39.32

Values in **bold** indicate exceedence of the AQO

9.4.11 Whilst annual average NO_2 is considered the AQO most likely to be exceeded, the next parameter of concern is likely to be particulate (PM_{10}). PM_{10} is monitored at two of the nearest continuous monitoring stations and the comparison between the NO_2 and PM_{10} results for 2009 are summarised in Table 9-8.

Table 9-8 Results of NO_2 and PM_{10} Monitoring for the Nearest Continuous Monitoring Stations

Monitoring Station		Annual Average NO_2 Concentration for 2009 ($\mu g/m^3$)	Annual Average PM_{10} Concentration for 2009 ($\mu g/m^3$)
R/1	Richmond Castelnau	**42**	21
HS9	Hounslow Heston Road	**53**	24

Values in **bold** indicate exceedence of the AQO

9.4.12 From the above, assuming a similar ratio of NO_2 to PM_{10}, the average annual PM_{10} concentration at the site would be anticipated to be around 21 $\mu g/m^3$ at monitoring station 3 and around 14 $\mu g/m^3$ at the rear of the site (monitoring stations 1 and 2).

Interpretation of the results

9.4.13 The results of the monitoring (as corrected) show that the front (west) of the site, which is closest to the London Road highway has NO_2 concentrations close to or exceeding the AQO for annual average NO_2 concentrations (as would be anticipated at this location within the AQMA). However, the locations within the site more distant from the highway, although close to the railway, enjoy better air quality.

9.5 Site Preparation and Construction Impacts and Mitigation Measures

9.5.1 The proposed demolition, site clearance, construction and finishing methods for the proposed development are not known and will largely be the choice of the contractor engaged to construct the proposed development. However, assumptions have been made to enable an assessment of the air quality impacts.

9.5.2 It is assumed that the construction of the proposed development will require the demolition of existing structures, the removal of existing surfacing, site clearance, loading waste into trucks for removal and/or stockpiling demolition waste for crushing, screening and recycling on site. The construction will require importing materials on to the site in HGVs, the operation of diesel powered plant, excavations in soil, working from stockpiles, augering piles, casting concrete foundations, erecting steelwork (including welding), placing surfacing, plus all manner of finishing works. There will be numerous opportunities for the generation of dust and fume during the aforementioned activities.

9.5.3 The principal risk will be dust generated during the work. This is not feasibly predictable at this stage as it is a function of the friability and moisture content of the material being handled, the degree of disturbance and the availability of entraining air currents. Demolition and construction dust is best controlled by an initial risk assessment, vigilance during the works, particularly on dry windy days when surfaces have been dry for some time (typically between April and October), and having available/applying dust suppression measures (water spraying, etc) where necessary. Suitable measures are given in the London Councils Best Practice Guidance '*The Control of Dust and Emissions from Construction and Demolition*' November 2006 (Ref 9-14). The principal risks and appropriate mitigation measures are summarised in Table 9-9.

Table 9-9 Mitigation measures for air quality impacts during demolition and construction

Risk Factor	Mitigation Measures
Dust and fume impacts on nearest residents and station users	Erect solid barriers around site. Use water as dust suppressant. Construction traffic to switch off engines when not in use. Vehicle movements on site to be on hard surfacing. Loads entering or leaving site to be covered. Enclose and cover stockpiles. All non-road diesel plant to use ultra low sulphur fuel and to be low emission types or retrofitted with emission controls. Occasionally monitor dust at site boundaries on dry windy days between April and October.
General impacts on local air quality	Clean and wheel-wash vehicles as necessary. Minimise idling plant and vehicles. As far as is practicable, minimise construction related traffic.
Specific impacts on the railway and railway passengers	Building constructed over the railway to be enclosed in sheeting during construction where possible. Protective sheeting in the form of a fan scaffold over the areas below/adjacent to construction activity to project over platforms to catch dust and small debris.

9.5.4 It is not known whether there are any asbestos containing materials within structures to be demolished as part of the proposed development. Dust from asbestos containing materials must be avoided by identification and removal (preferably intact) of any asbestos containing items prior to demolition. Items should be wetted as necessary to reduce dusting, bagged and disposed of as asbestos waste in advance of the main demolition work. Any asbestos containing materials identified within the building structures to be removed in accordance with the Control of Asbestos Regulations 2006 (Ref. 9-15) prior to the commencement of the main demolition and construction works.

9.5.5 The construction work will have impacts on air quality in the locality, in addition to dust. Nearly all the construction materials and plant required for the development will be brought to site by HGV. 50 % of the plant used on site is likely to be powered by diesel engines.

9.5.6 The impact of the construction related traffic at the nearest residential receptors (2, 2A, 2B and 4 Cole Park) may be estimated using the Design Manual for Roads and Bridges model. The model inputs are summarised in Table 9-10.

Table 9-10 Summary of Model Inputs

CASE	Distance to Receptor	AADF	% HGV and BUS	Traffic Speed (km/hr)
2011	50 m	16810	7.7 %	25
2011 + construction	50 m	16950	8.2 %	25
	45 m	140	71.4 %	5

AADF = Annual Average Daily (traffic) Flow

9.5.7 Running the DMRB air quality model for a 2011 traffic flow and the 2011 traffic flow with the addition of peak construction related traffic (estimated as a maximum of 50 HGV + 20 LDV visits per day) predicted an increase in concentrations of NO_2 and PM_{10} of 2.0 % and 0.6 % respectively at the nearest residential receptors. These increases would be considered as minor adverse impacts unlikely to have any apparent effect on the nearest residents as they are well within presently occurring variations due to diurnal and meteorological influences, and the construction related effects will be limited to the construction period.

Mitigation Options

9.5.8 Recycling demolition waste on site would reduce the traffic flows and associated air quality impact. The recycling processes must pay specific attention to dust creation and apply appropriate dust suppression techniques.

9.5.9 The use of electrical plant may reduce the diesel plant emissions of PM10 and N0x, although electrical plant has higher associated carbon emission levels. Emission control on non-vehicular powered plant is not as strict as required for road vehicles, however, emission control apparatus is available for retrofitting to diesel plant exhausts.

9.5.10 It would be advantageous, from the air quality point of view, to deliver construction materials and take away demolition waste by rail. However, this is not considered feasible due to the absence of suitable sidings and unloading facilities at the site, and the associated increased train movements.

9.6 Operational Impacts and Mitigation Measures

9.6.1 It is predicted in the Traffic Assessment for the scheme that vehicle movements will not increase as the scheme is proposed to be car-free. Users of the proposed development are assumed to arrive and depart from the site by foot, public transport or taxis. However, it is assumed that there will be a small amount of service or supply traffic.

9.6.2 The proposed plant equipment to supply the space heating and hotwater requirements are a gas fired CHP with communal gas back-up boiler. The choice of systems is considered appropriate for the sites location within an AQMA, and is anticipated to have a negligible impact on NO_2 through the use of routine controls on plant equipment.

9.6.3 Odour from commercial users, principally from kitchen extraction systems, will be mitigated through the use of routine controls on the extraction systems. This may be addressed by the suitable positioning of the outlets from the ventilation systems or by the provision of precipitators and scrubbers to clean the discharge to an acceptable level.

9.6.4 Tall buildings may cause local wind turbulence at street level, which can entrain dust and cause localised air quality impacts. This risk is normally addressed at the building design stage.

9.7 Residual Impacts and Conclusions

9.7.1 The principal concern will be whether the air quality at the site is likely to exceed the current AQOs and whether the proposed development will result in an increased number of receptors exposed. See air quality assessment summary matrix in Table 9-11 below:

Table 9-11 Air Quality Assessment Summary

Criteria		Conclusion
AQOs likely to be exceeded?	At present	Yes – front part of the site
	Post-development	Yes – front part of the site
Increase in number of receptors exposed?		Yes – additional proposed residents and site users
Air quality impacts from proposed development in service?		Minor adverse / negligible
Remedial measures indicated?		Possible advantage in venting buildings from the rear

9.7.2 Residential units falling within the area towards the front of the site where current AQOs are predicted to be exceeded, should be provided with controlled ventilations systems incorporating filtration on the inlet to reduce the concentration of nitrogen dioxide within the living spaces.

9.7.3 The proposed development is designed to minimise the generation of additional traffic when in service and, subject to the selection of a suitable heating system (CHP Plant as detailed within the Energy Strategy), there is anticipated to be a negligible impact on air quality from the proposed development in service.

9.7.4 The principal impact on air quality during the demolition and construction stages of the development will be from dust. Dust is best controlled by initial risk assessment applied to the chosen demolition and construction methods, vigilance during demolition and construction, and having available/applying dust suppression measures (water spraying, etc) where necessary. Other impacts on air quality during the construction phase will be from construction traffic and diesel powered plant running on site. Although the extent of the construction related traffic and the type of plant to be used is not known, an initial assessment suggests that, subject to the adoption of the recommended mitigation measures, the impacts on air quality from the construction traffic and plant at the nearest residential receptors will be minor adverse/ negligible.

9.7.5 A summary of residual impacts is given in Table 9-12.

Table 9-12 Summary of Residual Impacts

Description	Nature of Impact	Geographic scale; Timeframe	Significance
Ambient air quality	Proposed site users exposed to air quality exceeding current AQOs	Local; Long term	Minor adverse, negligible with mitigation
Demolition, site clearance and construction impacts on air quality	Dust and construction traffic/plant emissions impacts on residential receptors	Local; Limited to demolition and construction period	Minor adverse, negligible with mitigation
Operational impacts on air quality	No significant impact predicted for car-free scheme	Local; Long term	Negligible

9.8 Cumulative Impact Assessment

9.8.1 Through discussions with Regal House Contractor, it is presently thought that the Regal House redevelopment will be completed in early 2012 (anticipated to be approximately February 2012). Initial site works for the podium at of the Twickenham Station development are anticipated for Spring 2011.

9.8.2 It is therefore anticipated that the initial phase of the proposed development will coincide with the redevelopment of Regal House extension to the south of the site. If the demolition/construction phases likely to generate dust or give rise to elevated noise and vibration levels of both schemes were to coincide, cumulative air quality and noise and vibration impacts would be likely.

9.8.3 It is also understood that the Royal Mail Depot to the west of the site may be subject to redevelopment at some time in the future. No information is presently available regarding this proposed redevelopment and it is thought unlikely to coincide with the proposed redevelopment at the site.

9.8.4 It is not unusual for construction to take place on more than one site and the principle contractor will be required to undertake regular liaison meetings and reviews with neighbouring sites to plan works to minimise unnecessary disruption and implement appropriate mitigation measures to both sites.

9.8.5 There is not enough information presently available about the proposed Regal House or Royal Mail Depot redevelopments to carry out a quantitative cumulative impact assessment. Providing similar mitigation as proposed for Twickenham Station is applied to the Regal House redevelopment and/or the Royal Mail Depot redevelopment, the cumulative impacts are considered likely to be minor to moderate adverse.

9.8.6 As described in *Chapter 6: Site Preparation and Construction*, a Demolition and Construction Method Statement will be produced and an Environmental Management Plan (EMP) implemented to minimise the effects of construction and operational activities. A Construction Logistics Plan (CLP) will also be implemented to minimise the potential impacts of construction traffic.

9.9 References

Ref. 9-1: Air Quality Standards Regulations 2007 (SI 2007/64)

Ref. 9-2: The Environment Act 1995

Ref. 9-3: The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, July 2007

Ref. 9-4: Local Air Quality Management set out in the Air Quality Regulations 2000

Ref. 9-5: Air Quality (Amendment) Regulations 2002

Ref. 9-6: Planning Policy Statement 23 (PPS23) '*Planning and Pollution Control*'

Ref. 9-7: Planning Policy Guidance Note 13 National Planning Policy '*Transport*' (PPG13)

Ref. 9-8: Policy Guidance Note LAQM.PG (09)

Ref. 9-9: The revised London Plan (Consolidated with Alterations since 2004)

Ref. 9-10: Spatial Development Strategy for Greater London was published in October 2009

Ref. 9-11: Sub-Regional Development Frameworks (SRDF) for London. Policy 4C of the South London SRDF

Ref. 9-12: The London Borough of Richmond upon Thames scoping opinion

Ref. 9-13: The London Borough of Richmond-upon-Thames Air Quality Action Plan Progress Report 2008

Ref. 9-14: London Councils Best Practice Guidance '*The control of dust and emissions from construction and demolition*' November 2006

Ref. 9-15: Control of Asbestos Regulations 2006

10.1 Introduction

10.1.1 This chapter of the Environmental Statement (ES) describes the assessment of potential noise and vibration impacts associated with the proposed hotel, residential and mixed commercial development at Twickenham railway station (hereafter referred to as the 'proposed development'), during the demolition and construction and completed development stages. In addition, noise associated with the operational development has been assessed. In particular, it considers potential impacts on identified receptors, in terms of:

- Predicted noise levels from demolition and construction;
- Noise from building services plant of the completed development; and
- Any increases to road traffic attributed to the development.

10.1.2 This chapter also provides an assessment of the suitability of the site for the proposed uses, in terms of existing noise and vibration, and of the need to provide an adequate internal noise environment. This chapter has been produced by Environmental Assessment Services Limited (EAS).

Noise and Vibration Terminology

10.1.3 For the purposes of this ES Chapter, the following terminology and abbreviations will be used:

- $dB_{(A)}$ - The unit of noise measurement that expresses the loudness in terms of decibels (dB) based on a weighting factor for humans sensitivity to sound (A);
- Hz - Hertz; - The unit of frequency in cycles per second;
- $L_{(A)10}$, $L_{(A)50}$, $L_{(A)90}$ - A-weighted sound pressure level exceeded for 10, 50 or 90 % of the measured time;
- $L_{(A)eq}$ - Equivalent continuous A-weighted sound pressure level over a given period of time;
- $L_{(A)max}$ - Equivalent maximum continuous A-weighted sound pressure level over a given period of time;
- $L_{(A)min}$ - Equivalent minimum continuous A-weighted sound pressure level over a given period of time; and
- VDV - Vibration Dose Values in metres per second$^{1.75}$ ($m/s^{1.75}$).

10.2 Planning and Policy Context

National Planning Guidance

10.2.1 Department of Environment Planning Policy Guidance Note 24 (PPG24) '*Planning and Noise*', 1994 (Ref. 10-1) provides guidance on the development of residential areas near to existing, or new noise sources. It also defines noise exposure categories (NECs) for day and night-time to assess whether or not it is appropriate to grant permission for the development of residential properties for a given noise climate. The categories relate to different noise bands depending on the source of noise (i.e. road, rail, air, or mixed noise sources).

10.2.2 In addition to introducing NECs, PPG24 (Ref 10-1) outlines the considerations to be taken into account, while determining planning applications both for noise sensitive development and for those activities that generate noise, and advises on the use of conditions to minimise the impact.

Regional Planning Policy

The London Plan

10.2.3 The London Plan '*Spatial Development Strategy for Greater London*' (Ref. 10-2) was published in February 2008. With specific reference to noise, the following policy applies. Policy 4A.20 states:

"The Mayor will and boroughs should reduce noise by:

- *Minimising the existing and potential adverse impacts of noise on, from, within, or in the vicinity of, development proposals separating new noise sensitive development from major noise sources wherever practicable;*
- *Supporting new technologies and improved practices to reduce noise at source, especially in road, rail and air transport;*
- *Reducing the impact of traffic noise through highway management and transport policies (See Chapter 3C);*
- *Containing noise from late night entertainment and other 24-hour activities, and where appropriate promoting well-managed designated locations (see Chapter 3D);*
- *Identifying areas of relative tranquillity, which it is intended should be protected or enhanced; and*
- *The Mayor will work with strategic partners to ensure that the transport, spatial and design policies of this plan support the objectives, policies and proposals set out in the London Ambient Noise Strategy* (Ref 10-3)*".*

The Consultation Draft Replacement London Plan, October 2009

10.2.4 The Consultation Draft Replacement London Plan '*Spatial Development Strategy for Greater London*' (Ref. 10-4) was published in October 2009. The replacement plan is currently open for consultation, and a formal publication of the replacement plan is expected towards the end of 2011.

10.2.5 While the consultation process is going on, the London Plan 2008 (Ref 10-2) will have legal status until the replacement plan is formally published.

10.2.6 With regards to noise and vibration issues, the replacement plan has included some re-wording of the policies set out in the London Plan 2008 (Ref 10-2), however there have been no significant changes in policy.

'Sounder City' The Mayor's Ambient Noise Strategy

10.2.7 The London Ambient Noise Strategy '*Sounder City*', 2004 (Ref. 10-3) aims to minimise the adverse impacts of noise on people living, working in and visiting London by using the best available practices and technologies within a sustainable development framework.

10.2.8 The Strategy aims to work towards more compact city development, whilst minimising noise. This will require careful consideration of the adverse impact of noise on, from, within or in the vicinity of development proposals. The Mayor seeks exemplary standards of acoustic design, including better sound insulation for new and existing homes.

Local Planning Policy

10.2.9 The London Borough of Richmond upon Thames policy and requirements were summarised in the London Borough of Richmond Upon Thames Scoping Opinion report, 2010 (Ref: 10-5):

- *"One of the Council's key concerns is the potential for increases in background noise levels and vibration during demolition, construction and post development. This would not only result from the processes involved in developing the area but also from the additional residents in the area. The commitment to undertake a baseline noise survey is supported by the Council but this must be continually updated. This will allow the continual assessment of the impact of the development on existing residents and the River Crane NICS, in particular bat and bird life.*
- *The Council is particularly concerned with the potential impact of rail noise and vibration on future residents of the development and would expect any assessment of noise associated with the development to include appropriate consideration of this and how it might be addressed as well as noise impacts from discrete sources.*
- *Monitoring should not be just for the sake of monitoring, so where potential impacts are identified practicable solutions to mitigate these impacts should be considered and implemented.*
- *In addition to this it should be noted that the Council will seek the level of noise transmission between units to exceed part E of the building regulations. The impact of railway noise must be assessed in relation to future owners/occupiers of any new residential units.*
- *To assist in good management of construction noise, vibration, dust and other emissions, the Council suggest that a construction method statement is developed. Guidance on control measures for dust and other emissions is given in 'The Control of dust and emissions from construction and demolition: Best Practice Guidelines', Greater London Authority, November 2006. A low vibration method of piling must be employed with visual alarms set at vibration levels detailed with the new BS 5288* (Ref 10-6) *guidance. If the piling is due to be carried out for some time, the amount of hours per day may be restricted. The E.S needs to clarify piling methods and times. The types of piling most suitable will be hydraulic piling methods, auger piling methods and diaphragm walling*."

10.3 Assessment Methodology and Significance Criteria

10.3.1 The noise part of the assessment has been carried out generally in accordance with PPG24 '*Planning and Noise*' (Ref 10-1) with reference to British Standard BS 4142:1997 (Ref: 10-7). Vibration monitoring results have been compared with guidance given in BS 7385 (Ref 10-8), BS 6472 (Ref 10-9), BS 5228 (Ref 10-6) and other references.

10.3.2 The assessment of the ambient condition by the selection of suitable noise monitoring stations (to which access would be available both day and night), the selection of a suitable location to install the vibration monitor, operation of the monitors for suitable monitoring periods, general observations of factors affecting noise and vibration around the site, and a review of the results of the monitoring. *Appendix E-1 of ES Volume III* shows the existing site layout and noise and vibration monitoring locations.

10.3.3 For the noise monitoring, suitable locations with reasonably free-field conditions (generally more than 3 m from any façade) and a line of sight to principal noise sources were required. In this case, the principal noise sources were the adjacent railway and traffic on London Road. Twickenham Rugby Stadium is a short distance from the site. The railway station and vicinity become extremely busy when there are major events at the stadium. Additional monitoring was carried out when there was a major event at the stadium.

10.3.4 The noise monitoring was carried out using a CEL (Casella) Type 490 Precision Sound Level Meter and CEL-110/1 field calibrator (calibrated to national standards on 16 March 2009 – see certificate in *Appendix E-2 of ES Volume III*). The SLM was field calibrated before and after each monitoring session. The SLM was mounted 1.5 m above ground level on a tripod during the measurements. The monitoring was carried out between 27 May and 17 June 2010. Noise monitoring was carried out during several periods covering both daytime and night-time. Night-time is defined in PPG24 (Ref 10-1) as the period between 23:00 hours and 07:00 hours.

10.3.5 Ambient vibration monitoring requires a secure location within the site, a similar distance from the most likely source of vibration as the nearest part of the proposed development and preferably on a hard structural base. The monitor can then be left to record continuously over a sufficient period to cover a reasonable cycle of vibration exposures, including peak hour and night-time. In this case, a suitable monitoring location was provided reasonably close to the railway lines (centre of vibration). The vibration monitoring was carried out on 16 and 17 June 2010.

10.3.6 The first part of the assessment involved the consideration of the impacts of the ambient noise and vibration on the post-development site users. The second part of the assessment considered the probable noise and vibration impact at the nearest sensitive receptors from the demolition and construction work necessary to produce the proposed development. The third part of the assessment considers the probable noise and vibration impacts of the proposed development in service on the nearest sensitive receptors.

10.3.7 The noise outputs from the demolition and construction phases are derived from BS 5228 (Ref 10-6) and other sources.

10.3.8 Receptors sensitive to noise and vibration at the site will include:

- Future site users in the proposed development – likely to be affected by the ambient noise and vibration at the site (the PPG24 (Ref 10-1) case).
- Existing site users (including passengers and users of the station) and, particularly, the nearest residential receptors - likely to be affected by the noise and vibration from the proposed development in service or during construction.

10.3.9 The significance criteria for environmental effects are given in Table 10-1 below:

Table 10-1 Noise Impact Significance Based on BS 4142 (Ref 10-7), PPG24 (Ref 10-1), World Health Organisation '*Guidelines for Community Noise*', 2003 (Ref 10-10), BS 7385 (Ref 10-8), BS 6472 (Ref 10-9) and BS 5228 (Ref 10-6)

Significance	Definition
Major	Greater than a 10.0 $dB_{(A)}$ change in sound level or sound produced ≥ 10.0 $dB_{(A)}$ above baseline levels or recognised noise guideline values
Moderate	Greater than a 5.0 $dB_{(A)}$ and less than a 9.9 $dB_{(A)}$ change in sound level or sound produced between 5 $dB_{(A)}$ and less than a 9.9 $dB_{(A)}$ above baseline levels or recognised noise guideline values
Minor	Greater than a 3 $dB_{(A)}$ and less than a 4.9 $dB_{(A)}$ change in sound level or sound produced between 3 $dB_{(A)}$ and less than a 4.9 $dB_{(A)}$ above baseline levels or recognised noise guideline values
Negligible	Greater than a 0.1 $dB_{(A)}$ and less than a 2.9 $dB_{(A)}$ change in sound level or sound produced between 0.1 $dB_{(A)}$ and less than a 2.9 $dB_{(A)}$ above baseline levels or recognised noise guideline values
No Impact	> 5.0 $dB_{(A)}$ below baseline levels or recognised noise guideline levels

10.3.10 The significance criteria defined in *Chapter 2: EIA Methodology* includes 'extreme' impacts. It is specified that "*These effects represent key factors in the decision-making process. They are generally, but not exclusively associated with sites and features of national importance and resources/features which are unique and which, if lost, cannot be replaced or relocated*." Due to the localised nature of potential noise impacts and the existing urban setting of the development site, it is considered the use of 'extreme' is not appropriate for the noise impacts of this development.

10.4 Baseline conditions

Noise

10.4.1 The ambient (or baseline) noise environment has been assessed by noise monitoring at various periods in the noise cycle at various points around the site.

10.4.2 By observation at the site, it was immediately apparent that the principal noise sources were traffic on London Road and trains passing through the station. During the major event at Twickenham Stadium (the Guinness Rugby Cup Final on 29 May 2010), the major noise source at the site was the noise from the crush of the crowd trying to leave the area via the railway station after the match, and the efforts of the police and railway staff trying to assist them.

10.4.3 The results of the noise monitoring are summarised in Tables 10-2 (daytime results) and 10-3 (night-time results). Examples of the SLM output, including 1/3 octave frequency distributions, are given in *Appendix E-3 of ES Volume III.*

Table 10-2 Summary of the Results of Daytime Monitoring

Monitoring Location 1.					
PERIOD	11.06 – 11:26 hrs 27 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	54.5	44.5	48.0	55.0	88.0
WEATHER	Light westerly wind, overcast				
PRINCIPAL NOISE SOURCES	Passing railway trains, occasional vehicles moving in the car park				

Monitoring Location 2.					
PERIOD	11:26 – 11:46 hrs 27 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	54.6	46.0	50.0	55.5	83.7
WEATHER	Light westerly wind, overcast				
PRINCIPAL NOISE SOURCES	Passing railway trains, distant traffic on London Road, occasional vehicles moving in the car park				

Monitoring Location 3.					
PERIOD	11:47 – 12:04 hrs 27 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	57.3	49.5	55.5	59.5	74.1
WEATHER	Light westerly wind, overcast				
PRINCIPAL NOISE SOURCES	Traffic on London Road, passing railway trains, occasional vehicles moving in the car park				

Monitoring Location 4.					
PERIOD	12:06 – 12:21 hrs 27 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	70.0	61.5	68.5	72.5	85.3
WEATHER	Light westerly wind, overcast				
PRINCIPAL NOISE SOURCES	Traffic on London Road. Voices of passers-by				

Monitoring Location 1.					
PERIOD	07:46 – 08:01 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	59.0	42.5	51.0	63.5	74.9
WEATHER	Moderate southeast wind, sunny with increasing cloud				
PRINCIPAL NOISE SOURCES	Passing railway trains, vehicles moving in the car park				

Monitoring Location 2.					
PERIOD	08:01 – 08:16 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	58.4	50.5	55.0	61.5	73.7
WEATHER	Moderate southeast wind, sunny with increasing cloud				
PRINCIPAL NOISE SOURCES	Passing railway trains, distant traffic on London Road, vehicles moving in the car park				

Monitoring Location 3.					
PERIOD	08:17 – 08:32 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	60.4	53.5	57.0	62.5	82.2
WEATHER	Moderate southeast wind, sunny with increasing cloud				
PRINCIPAL NOISE SOURCES	Traffic on London Road, vehicles in car park, people locking-up bicycles, workers moving drilling rig				

Monitoring Location 4.					
PERIOD	08:34 – 08:49 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	68.5	61.0	66.5	72.0	81.5
WEATHER	Moderate southeast wind, sunny with increasing cloud				
TRAFFIC COUNT	1380 vehicles/hr of which 3.5% bus or HGV				
PRINCIPAL NOISE SOURCES	Traffic on London Road, voices of passers-by				

Monitoring Location 5.					
PERIOD	08:51 – 09:06hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	62.4	50.0	54.0	63.0	88.3
WEATHER	Moderate southeast wind, sunny with increasing cloud				
PRINCIPAL NOISE SOURCES	Distant traffic, passing trains, occasional passing cars				

Monitoring Location 6.					
PERIOD	13:01 – 13:21 hrs 17 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	63.5	52.0	56.0	65.5	83.4
WEATHER	Moderate southeast wind, sunny with increasing cloud				
PRINCIPAL NOISE SOURCES	Traffic on London Road, vehicles in car park, people locking-up bicycles, workers moving drilling rig				

Table 10-3 Summary of the Results of Night-time Monitoring

Monitoring Location 1.					
PERIOD	05:50 – 06:05 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	49.9	44.5	47.5	52.5	69.8
WEATHER	Calm and sunny				
PRINCIPAL NOISE SOURCES	Passing trains, distant (light) traffic on London Road, birdsong				

Monitoring Location 2.					
PERIOD	06:06 – 06:21 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	57.8	47.0	50.0	61.0	75.1
WEATHER	Calm and sunny				
PRINCIPAL NOISE SOURCES	Trains, cars entering car park, distant traffic				

Monitoring Location 3.					
PERIOD	06:22 – 06.37 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	58.5	50.5	56.5	62.0	70.9
WEATHER	Calm and sunny				
PRINCIPAL NOISE SOURCES	Traffic and trains				

Monitoring Location 4.					
PERIOD	06:40 – 06:59 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	68.9	60.0	67.5	72.0	83.4
WEATHER	Light south-easterly wind, sunny				
TRAFFIC COUNT	1140 vehicles/hr of which 5.5% bus & HGV				
PRINCIPAL NOISE SOURCES	Busy traffic on London Road, passers-by en-route to station, etc				

Monitoring Location 1.					
PERIOD	23:02 – 23:17 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	60.5	43.5	49.0	64.5	77.4
WEATHER	Clear with light westerly wind				
PRINCIPAL NOISE SOURCES	Trains, distant traffic, aeroplanes en-route to Heathrow				

Monitoring Location 2.					
PERIOD	23:18 – 23:33 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	58.8	44.5	50.0	59.0	78.4
WEATHER	Clear with light westerly wind				
PRINCIPAL NOISE SOURCES	Trains, distant traffic on London Road				

Monitoring Location 3.					
PERIOD	23:34 – 23:49 hrs 15 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	56.4	45.0	51.0	56.5	86.6
WEATHER	Clear with light westerly wind				
PRINCIPAL NOISE SOURCES	Traffic on London Road, trains				

Monitoring Location 4.					
PERIOD	23:52 – 00:07 hrs 15/16 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	65.0	46.5	60.0	69.5	78.9
WEATHER	Clear with light westerly wind				
PRINCIPAL NOISE SOURCES	Traffic on London Road, taxis running engines at kerbside				

Monitoring Location 5.					
PERIOD	00:09 – 00:24 hrs 16 June 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	51.3	42.5	47.0	54.5	72.0
WEATHER	Clear with light westerly wind				
PRINCIPAL NOISE SOURCES	Distant traffic, occasional trains				

10.4.4 In addition to the above, noise monitoring was carried out at the Guinness Premiership Rugby Final (Saracens v Leicester) on 29 May 2010. This event involved an estimated 81,600 spectators. The stadium capacity is 82,000. This was considered a reasonably worst-case event.

10.4.5 The maximum impact at the station was considered to be after the match when the crowds streamed towards the station and there was massive queuing for trains. The arrivals before the event were more staggered and generally quieter.

10.4.6 The car park was closed and was used to assemble passengers for the London-bound trains. The main station entrance was reserved for passengers for the out-of-London trains. London Road was closed to traffic and the whole area was controlled by temporary pedestrian barriers.

10.4.7 Principal event noise sources were crowd noise, including inebriated singing/shouting etc., the scraping of the steel barriers on the ground, plus a continuous stream of loud-hailer instructions from station staff to control the queuing crowd. Police prevented access to monitoring stations 1 and 2 and the noise monitoring was subject to continual interference from over-excited individuals in the crowd. However, four monitoring sessions were successfully completed and the results are summarised in Table 10-4 below:

Table 10-4 Summary of the Results of the Monitoring During Event on 29 May 2010

Monitoring Location 3.					
PERIOD	19:00 – 19:15 hrs 29 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	62.1	55.0	59.5	65.5	80.6
WEATHER	Light WSW wind, overcast, occasional drizzle				
PRINCIPAL NOISE SOURCES	Noise from crowd leaving Twickenham Stadium and streaming into the railway station, scraping of barriers, loud-hailer use by station staff				

Monitoring Location 3a.					
PERIOD	19:15 – 19:30 hrs 29 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	74.3	61.0	66.5	79.0	91.6
WEATHER	Light WSW wind, overcast, occasional drizzle				
PRINCIPAL NOISE SOURCES	Noise from crowd leaving Twickenham Stadium and streaming into the railway station, scraping of barriers, continuous loud-hailer use by station staff				

Monitoring Location 4.					
PERIOD	19:34 – 19:49 hrs 29 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	66.8	61.5	64.5	69.0	83.7
WEATHER	Light WSW wind, overcast, occasional drizzle				
PRINCIPAL NOISE SOURCES	Noise from crowd leaving Twickenham Stadium and streaming past the railway station on London Road (closed to vehicles)				

Monitoring Location 3a.					
PERIOD	20:02 – 20:17 hrs 29 May 2010				
NOISE LEVELS $dB_{(A)}$	$L_{(A)eq}$	$L_{(A)90}$	$L_{(A)50}$	$L_{(A)10}$	$L_{(A)max}$
	66.1	64.0	65.0	67.5	74.7
WEATHER	Light WSW wind, overcast, occasional drizzle				
PRINCIPAL NOISE SOURCES	Crowd leaving Twickenham Stadium and streaming into the railway station, now reducing, scraping of police barriers, loud-hailer use by station staff				

Vibration

10.4.8 The vibration monitor was left to run continuously from 11:59 hours on 16 June 2010 until 12:01 hours on 17 June 2010. On completion, the data was downloaded and reviewed in case further monitoring was required. The initial data set was found to be good and is provided in *Appendix E-4 of ES Volume III.*

10.4.9 A further brief monitoring session was also carried out on 17 June 2010 to provide additional data to assist the calculation of the Vibration Dose Values (VDVs).

10.4.10 The significant vibrations (exceeding a peak particle velocity (ppv) of 0.15 mm/s with a frequency of < 100 Hz) were noted. A total of 78 significant vibrations were recorded during the monitoring, of which ten occurred during the night-time (23:00 – 07:00 hours). The maximum vertical peak particle velocity recorded was 0.254 mm/s at a frequency of 14 Hz at 23:49 hours on 16 June 2010.

10.4.11 The significant vibration frequencies were between 10 and 20 Hz, with the majority around 15 Hz. The significant vibration events coincided with the passage of trains through the station.

10.4.12 The five largest vibrations recorded during the monitoring were all recorded on 16 June 2010 and are summarised in Table 10-5 below.

Table 10-5 Largest Significant Vibrations

Date	Time (hours)	Peak (vertical) particle velocity (mm/s)	Peak (long/trans) particle velocity (mm/s)	Frequency (Hz)
16 June 2010	12:26	0.222	0.111	15
	13:28	0.206	0.111	16
	14:56	0.206	0.127	16
	16:16	0.238	0.143	16
	23:49	0.254	0.111	14

10.4.13 From the additional vibration record of 17 June 2010 it is possible to estimate the overall daytime and night-time human exposure doses (VDVs) by using the Instantel software to calculate the VDVs for individual vibration events and calculating the overall exposure using the formula: VDV = $(\Sigma_{i=1\text{-}N}\ VDV_i^4)^{0.25}$. The VDVs were calculated for vibration in the vertical plane for the daytime exposures (07:00 – 23:00 hours) and in the horizontal/transverse plane for the night-time exposures (as the vibration is assumed to be acting on a recumbent body).

10.5 Interpretation of the Results

Noise

10.5.1 From the results of the monitoring, it is possible to derive a reasonable estimate of the $L_{(A)eq,16hr}$ for the daytime and $L_{(A)eq,8hr}$ for the night-time for each of the monitoring locations around the site.

10.5.2 From the $L_{(A)eq,t}$ values, the Noise Exposure Categories for the monitoring locations may be obtained from Table 1 in Annex 1 of PPG24 (Ref 10-1) which has been reproduced at Table 10-6 below:

Table 10-6 Recommended Noise Exposure Categories for New Dwellings Near Existing Noise Sources

Noise Levels Corresponding to the Noise Exposure Categories for New Dwellings $L_{(A)Eq,T}$, dB				
Noise Source	**Noise Exposure Category**			
	A	***B***	**C**	**D**
Mixed Sources				
07:00-23:00 hrs	<55	55 – 63	63 – 72	>72
23:00-07:00 hrs	<45	45 – 57	57 – 66	>66

10.5.3 From the results of the monitoring and the subsequent analysis, the noise exposure categories (NECs) for the different monitoring locations across the site would appear to be as given in Table 10-7.

Table 10-7 NECs for the Monitoring Locations Across the Site

Monitoring Location No.	$L_{(A)eq,16hr}$ (daytime)	$L_{(A)eq,8hr}$ (night-time)	Noise Exposure Category	
			Daytime	Night-time
1	58.1	59.6	B	C
2	58.2	57.7	B	C
3	59.2	57.9	B	C
4	69.2	68.0	C	D*
5	60.0	51.0	B	B
6	65.3	-	C	-

* Due solely to effect of the start of the peak traffic period shortly before 07:00 hours

10.5.4 From Table 10-7, it is apparent that the façade of the proposed development with a line of sight to London Road and the railway will require some form of acoustic ventilation as an alternative to opening windows.

10.5.5 NEC B is defined in PPG24 '*Planning and Noise*' (Ref 10-1) as "*Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection against noise*".

10.5.6 NEC C is defined as "*Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise*".

10.5.7 The monitoring at the Guinness Premiership event showed that, whilst there is no perceptible noise impact from the stadium itself, the crowds using the station have a significant noise impact in the two hours after an event. However, the impact was not so severe as to change the Noise Exposure Category for the site. No special attenuation measures will be required to cover events. The biggest impact was from the loud-hailer used by station staff to direct people to the appropriate trains.

Vibration

10.5.8 The only practicable secure location for the vibration monitor for the 24-hour continuous monitoring was some 75 m from the centre of the source of vibration. However, the closest part of the proposed development will be some 30 m from the centre of the source of the vibration. Vibration, like noise, is attenuated by distance, thus the vibration from the trains at the proposed redevelopment closest to the railway will be greater than that measured during the 24 hour monitoring. A factor to take this into account has been derived from Golitsin's Equation:

$$A_2 = A_1 (r_1/r_2)^{0.5} .e^{-\gamma (r_2 - r_1)}$$

Where A_1 = amplitude of vibration at distance r_1
A_2 = amplitude of vibration at distance r_2
γ = attenuation coefficient

In this case, from measurements taken at the site:

A_1 (maximum) @ r_1 = 0.254 mm/s @ 75m
A_2 (maximum) @ r_2 = 0.619 mm/s @ 10m

The calculations give the attenuation coefficient γ as -0.00179

10.5.9 This indicates that the vertical vibrations measured at the vibration monitor should be multiplied by a factor of 1.46 for the part of the proposed development closest to the railway. Transverse/longitudinal vibrations tend to attenuate less with distance in soils compared with vertical vibrations. This would give the maximum vertical peak particle velocity of 0.371 mm/s for the site.

10.5.10 The threshold of human perception for vibration is generally considered to approximate to 0.3 mm/s peak particle velocity and the threshold for any significant (cosmetic) impact on a modern building is probably >10 mm/s.

10.5.11 It is apparent from the results that vibration from the railway (and other sources) will occasionally be perceptible within the site, particularly when freight trains are passing through the station. There should be no significant vibration impact on building structures or finishes and no requirement to incorporate any specialist anti-vibration mountings or dampers in the design.

10.5.12 From the vibration record of 16 - 17 June 2010 (adjusted for distance as described) it is possible to estimate the overall daytime and night-time human exposure doses (VDVs) by using the Instantel software to calculate the VDVs for individual vibration events and then calculate the overall exposure using the formula: $VDV = (\Sigma_{i=1-N} VDV_i^4)^{0.25}$. The VDVs were calculated for vibration in the vertical plane for the daytime exposures (07:00 – 23:00 hours) and in the horizontal/transverse plane for the night-time exposures (as the night-time vibration is assumed to be acting on a recumbent body).

10.5.13 The resulting daytime and night-time human exposure vibration dose values (VDVs) calculated from the monitoring are summarised and compared with the standards given in BS 6472 (Ref 10-9) in Table 10-8 below:

Table 10-8 Summary of VDVs and Comparison with Standards

Period	VDV values in $m/s^{1.75}$ calculated from the vibration monitoring results at the site	VDV values in $m/s^{1.75}$ from BS 6472: 2008 for residential buildings		
		Low probability of adverse comment	Adverse comment possible	Adverse comment probable
16-hour day	0.15	0.2 – 0.4	0.4 – 0.8	0.8 – 1.6
8-hour night	0.04	0.13	0.26	0.51

10.5.14 The vibration dose values (VDVs) calculated from the event continuous waveforms, using the Instantel software and applied to the 24 hour monitoring results (adjusted for distance) - see Table 10-8 above, did not exceed any relevant threshold given in the British Standard BS 6472 (Ref 10-9) for residential buildings.

10.6 Site Preparation and Construction Impacts and Mitigation Measures

10.6.1 The proposed demolition, site clearance, construction and finishing methods for the proposed development are not known and will largely be the choice of the contractor engaged to construct the proposed development. However, assumptions have been made regarding the construction methods, periods of operation and the type of mechanical plant to be used to enable an estimate of the likely noise and vibration impacts.

Site Clearance and Demolition

10.6.2 The site clearance and demolition work required for the proposed development will most likely involve the use of an excavator mounted hydraulic breaker, a tracked loader and a lorry fitted with grab for removal of the demolition waste. Alternatively, the broken hardcover and building waste may be crushed on site for re-use within the proposed development.

10.6.3 The nearest receptors of concern will be the nearest residences to the site. These, and their distance from the site boundary, are listed in Table 10-9 below:

Table 10-9 Receptors of Concern

Nearest Residential Receptor	Distance (M)	Acoustic Barrier?
2 Cole Park	65	No
2A, 2B and 4 Cole Park	45	No
6 Cole Park	61	No
16 Mary's Terrace	**87**	**Yes (low) –** existing station boundary wall

10.6.4 The relevant items of site clearance plant and their probable noise impacts are listed in Table 10-10 below:

Table 10-10 Demolition and Site Clearance

Plant type	SPL L_{wa} (dB)	Distance (m)	% on time	Impact at nearest receptor ($dB_{(A)}$)
Excavator mounted hydraulic breaker	119	50	60	74
Tracked loader	108	50	50	60
Lorry with grab	102	50	10	54
Various manual and hand tool activities	90	50	100	51
Crusher	105	70	20	54
Powerscreen	105	70	20	54
TOTAL				75

Construction

10.6.5 Construction of the proposed development is likely to involve:

- breaking out existing foundations
- excavating foundation bases and service trenches
- installing piles
- casting foundation bases
- erecting steelwork
- placing pre-cast concrete components
- fixing facing materials and fenestration
- interior fitting-out (no external impact) and external finishing work.

10.6.6 Piled foundations will probably be necessary for the proposed development and the method/type of piling will be critical. It assumed that piles driven by drop, diesel or air hammer will not be permitted on vibration and noise impact criteria. Bored piles will require the boring of holes by auger from a diesel driven rig.

10.6.7 The different construction phases will have different impacts and the noise impacts for the three principal phases are summarised in Tables 10-11, 10-12 and 10-13 below:

Table 10-11 Foundations, Piling and Services

Plant type	SPL L_{wa} (dB)	Distance (m)	% on time	Impact at nearest receptor ($dB_{(A)}$)
Excavator mounted hydraulic breaker	119	50	60	74
Tracked excavator	108	50	50	60
Lorry	102	50	10	54
Piling rig (bored piles)	113	90	50	64
Tracked crane	109	90	50	64
Truckmixer discharge	112	50	10	65
Concrete pump	106	50	50	60
Air compressor	106	50	100	67
Vibrating pokers	100	50	100	72
Various manual and hand tool activities	90	50	100	51
TOTAL				78

Table 10-12 Building Superstructure

Plant type	SPL L_{wa} (dB)	Distance (m)	% on time	Impact at nearest receptor ($dB_{(A)}$)
Concrete pump	106	50	50	60
Air compressor	106	50	100	67
Vibrating pokers	100	50	100	72
Tracked crane	109	90	50	64
General building work	90	50	100	51
Lorry (deliveries)	102	50	10	54
Various manual and hand tool activities	90	50	100	51
TOTAL				74

Table 10-13 Fitting out Interiors & External Finishing Works

Plant type	SPL L_{wa} (dB)	Distance (m)	% on time	Impact at nearest receptor ($dB_{(A)}$)
Surfacing/landscaping	90	50	100	51
Tracked loader	108	50	50	60
Lorry (deliveries)	102	50	10	54
TOTAL				61

Interpretation of estimated demolition/site clearance/construction noise

10.6.8 Daytime background ($L_{(A)90}$) noise levels at the nearest residential receptors are between 45 and 50 $dB_{(A)}$. It is immediately apparent that the predicted construction phase noise levels are significantly above background and could potentially have a major impact on receptors. The noise impacts should be (as far as is practicable) kept below $L_{(A)90}$ + 5 $dB_{(A)}$ or, at least below 55 $dB_{(A)}$ $L_{(A)eq}$ at the nearest residential receptors.

10.6.9 Some on the construction over and in the vicinity of the railway will have to be carried out during Network Rail possessions. This will inevitably require night-time working. Night-time background ($L_{(A)90}$) noise levels at the nearest residential receptors are in the range 42 – 45 $dB_{(A)}$ and the impact at the receptors could be more significant that for the daytime case. The work close to/over the railway will be further away from the Cole Park receptors, but will be close to the Mary's Terrace receptors. It is envisaged that some of the work over/close to the railway line will require mobile cranes to be deployed on the highway at Mary's Terrace and this will place a noise source closer to the receptors.

Mitigation Measures

10.6.10 The following noise and vibration mitigation measures may be employed on-site to achieve the appropriate noise levels:

- Surround the site with an impermeable hoarding (typically a solid plywood barrier with reinforcing timbers) to a height of at least 2 m during the demolition, site clearance and construction phase. This will not provide significant mitigation for operations above ground floor height, however, most of the significant noise sources will be ground level.
- Work on the upper floors should, as far as is practicable, be carried out inside an enclosure – this can be a plastic sheet shroud around the scaffolding (also required for dust control) and working inside the part completed building envelope.
- Confine the activities to normal business hours. However, some of the work, notably the construction of the lower part of the building bridging the railway will have to be carried out during railway possessions – typically at night and/or at weekends. There may also be out of hours working in order to deliver materials to areas that can be worked in during normal working hours between the tracks – Refer to construction chapter for details.
- Use only quiet types of plant.

- All plant that can practicably be fitted with silencers, should be fitted with silencers.
- Monitor noise at the site boundary with the nearest residential receptors for brief periods during operations likely to be the most noisy and when complaints are most likely.
- Where construction operations with a significant vibration impact are proposed, a pre-condition survey of the closest buildings should be carried out and vibration should be monitored during the critical operations.
- Potential residential receptors should be notified in advance of works requiring a Network Rail possession. This would also apply to the Mary's Terrace receptors when it is proposed to locate mobile cranes on or adjacent to the highway at this location.

10.7 Operational Impacts and Mitigation Measures

10.7.1 According to the Traffic Assessment for the proposed development, the scheme will be traffic-neutral as it is designed to be a car-free scheme (apart from some disabled parking). Subject to any external chillers or other air handling plant being suitably quiet (see comment below), the development in service should have a negligible adverse impact on ambient noise and vibration levels. No mitigation measures are indicated.

10.7.2 The ambient noise and vibration may have some potentially significant adverse impact on future site users and it will be necessary to ensure that noise levels in habitable rooms can be kept below 30 $dB_{(A)}$ $L_{(A)eq}$. The following mitigation measures are recommended:

- Windows on the facades with a line of sight to London road should be acoustic double-glazing (or secondary glazing) providing 40 dB of attenuation at traffic noise frequencies or night-time train noise $L_{(A)MAX}$, whichever is the greater. Acoustic ventilation with a similar attenuation should also be provided for habitable rooms on these facades to provide an alternative to opening windows for ventilation. See Table 10-14. Design of acoustic glazing for windows and balconies will be in accordance with BS 8233: 1999 *Sound Insulation and Noise Reduction in Buildings.*
- Other facades may require a lesser attenuation of 30 dB at railway and highway traffic noise frequencies. Standard thermal double-glazing will provide suitable attenuation in this case. To provide an alternative to opening windows, over or under window ventilation with a suitable level of acoustic attenuation is available from a number of manufacturers.
- Buildings over, say, two to three storeys in height may amplify ground level vibrations with increasing height. This will be avoided by design of the structure to dampen rather than amplify vibration with height.
- There is a specific concern regarding the impact of the noise of passing trains on the underside of the building spanning the tracks. Noise measurements taken on the existing footbridge into the station gave a peak noise level of 83.4 dB(A) during the passage of a fast train. This may be increased by reflections from the proposed development structure and it is recommended that the track spanning section should have a resistance to airborne sound transmission of at least 60.0 dB(A). As the structural section is likely to be a fairly thick reinforced concrete slab, it should be practicable to achieve the desired attenuation**.**

- Noise from mechanical services will be minimised by design to the appropriate LBRuT acoustic design criteria.
- Sound insulation of party walls, floors and ceilings between commercial and residential spaces will have to meet the LBRuT design standards of Building Regulations Approved Document E + 5 – 10 db (D'ntw +Ctr).
- There can be specific problems relating to tannoys or public address systems impacting on adjacent residential receptors. This is to be investigated to ensure that the operation of the tannoys/public address system at Twickenham Station complies with the London Underground guidance *Manual of Good Practice for Public Address Systems – Noise Management.*

Table 10-14 Sound Insulation to Typical Windows

Description	**Weighted Sound Reduction Index (Rw dB)**
All types of window in a façade when partially open.	10 – 15
Thermal insulation (6 mm glass – 12 mm air gap – 6 mm glass)	33 – 35
Secondary glazed windows (6 mm glass – 100 mm air gap – 6 mm glass)	35 – 40
Up-rated secondary glazed (200 mm air gap) or acoustic double glazed with thicker glass	40 +

10.8 Residual Impacts

10.8.1 It is concluded that the residual noise and vibration impacts from the proposed development in service will be minor adverse / negligible. See summary of residual impacts in Table 10-15.

10.8.2 The critical period for noise and vibration impacts will be during the demolition, site clearance and construction phase and it will be necessary to adopt the mitigation measures described in 10.6.9 above to minimise adverse impacts on the nearest residential receptors. Part of the mitigation for the demolition and construction impacts will be the short-term nature of these impacts.

10.8.3 It is concluded that the residual noise and vibration impacts on the proposed development from ambient conditions should not be significantly adverse, subject to the adoption of the mitigation measures recommended above.

Table 10-15 Summary of Residual Impacts

Description	Nature of Impact	Geographic Scale; Timeframe	Significance
Ambient Noise	Proposed development generally falls within NEC B and C. Mitigation measures include glazing and acoustic ventilation.	Local; Life of the development	Minor adverse, negligible with mitigation
Ambient vibration.	Occasional perceptible vibration from fast/heavy trains.	Local; Life of the development	Negligible
Demolition, site clearance & construction noise	Noise at nearest residential receptors. Mitigation works recommended include: Enclosing site in impermeable hoarding; Substitution of noisy plant / activities where possible; The use of "super-silenced" power generation plant at night; Application of generic Best Practice working methods; Application for Section 61 agreement between principal contractor and Local Authority.	Local; Demolition and construction period only	Potentially major adverse for brief periods, mainly minor adverse, Reduced to minor adverse and negligible with mitigation
Demolition, site clearance & construction vibration	Vibration at nearest residential receptors should be avoided by choice of construction methods.	Local; Demolition and construction period only	Minor adverse to Negligible
Operational noise	No significant impact predicted for car-free scheme. Adherence to requirements of Approved Document E of the Building Regulations 2000.	Local; Life of the development	Negligible
Operational vibration	None predicted.	Local; Life of the development	Negligible

10.9 Cumulative Impact Assessment

10.9.1 The proposed development at Twickenham Station is anticipated to coincide with the proposed redevelopment of Regal House immediately to the west of the site. This is most likely to exacerbate impacts at receptors in Mary's Terrace. The height of Regal House may add to the significance of impacts from the redevelopment. Current programmes for the proposed development and the redevelopment of Regal House suggest that the redevelopment of Regal House will overlap with the first stage of the proposed development.

10.9.2 It is recommended that joint noise monitoring should be carried out at Mary's Terrace during the period of overlap between the construction of the two projects.

10.9.3 There should be no significant cumulative noise and vibration impacts from both the proposed development and the proposed Regal House redevelopment when completed and in service.

10.9.4 It is also understood that the Royal Mail Depot to the west of the site may be subject to redevelopment at some time in the future. No information is presently available regarding this proposed redevelopment and it is thought unlikely to coincide with the proposed redevelopment at the site.

10.9.5 The choice of demolition/site clearance/construction methods and plant may impact on the noise environment during construction. It is recommended that joint noise monitoring should be carried out during the period of overlap between the construction of the two projects.

10.9.6 Any unanticipated significant increase in the traffic flows may impact on the ambient noise and vibration levels at the site, however we have no reason to anticipate increased traffic flows at this stage.

10.9.7 No other cumulative impacts are anticipated.

10.0 References

Ref. 10-1 Planning Policy Guidance Note 24 (PPG24) '*Planning and Noise'* Department of Environment, 1994

Ref. 10-2 The London Plan, 2008

Ref. 10-3 The London Ambient Noise Strategy '*Sounder City*', 2004

Ref. 10-4 The Consultation Draft Replacement London Plan '*Spatial Development Strategy for Greater London*', 2009

Ref. 10-5 The London Borough of Richmond upon Thames Scoping Opinion Report

Ref. 10-6 British Standard BS 5228, 2009

Ref. 10-7 British Standard BS 4142, 1997

Ref. 10-8 British Standard BS 7385, 1990

Ref. 10-9 British Standard BS 6472, 2008

Ref 10-10 World Health Organisation '*Guideline for Community Noise*', 2003

11.1 Introduction

11.1.1 This Chapter of the Environmental Statement (ES) assesses the potential impacts of the proposed development on soil and ground conditions. In particular, it considers the likely significant impacts of ground contamination on human health, and the quality of surface waters and groundwater.

11.1.2 This chapter describes the legislative and planning policy context, the methods used to assess the potential impacts, the baseline conditions currently existing at the Site and surrounds, the potential direct and indirect impacts of the proposed Development both during construction and operation and the mitigation measures required to prevent, reduce or offset the impacts. The residual impacts are then described.

11.1.3 The chapter was written by Waterman Energy, Environment & Design Ltd (Waterman) and largely draws on information collated from a Phase 1 Ground Contamination Desk Study Report, a Geotechnical Report and a Generic Quantitative Environmental Risk Assessment, which includes investigations undertaken on and adjacent to the Site.

11.1.4 The Phase 1 Ground Contamination Desk Study Report was undertaken by Capita Symonds in October 2007 and the Geotechnical Report was produced by RSK Group in August 2010. The results and conclusions of both reports were included within the subsequent Generic Quantitative Environmental Risk Assessment undertaken by Waterman in August 2010. The reports were completed in order to develop a Preliminary Conceptual Ground Model for assessing the potential sources of contamination on the Site and the likely pathways by which contamination could affect the identified receptors. The Phase 1 Ground Contamination Desk Study Report is included as *Appendix F-1*, the Geotechnical Report as *Appendix F-2* and the Generic Quantitative Environmental Risk Assessment as *Appendix F-3* of *ES Volume III*.

11.1.5 Waterman is liaising with the Environment Agency with respect to building within 8m of the River Crane, surface water drainage and foundation design for the proposed development.

11.2 Legislative and Planning Policy Context

National Legislation

11.2.1 Land contamination is regulated under several regimes, including environmental protection, environmental permitting, waste management, planning and development control, and health and safety legislation.

Environmental Protection Act 1990

11.2.2 Specific UK legislation on contaminated land is principally contained in Part IIA of the Environmental Protection Act (EPA), 1990 (Ref. 11-1). This legislation endorses the principle of a 'suitable for use' approach to contaminated land, where remedial action is only required if there are unacceptable risks to health or the environment, taking into account the use of the land and its environmental setting.

Contaminated Land (England) Regulations, 2006

11.2.3 The Contaminated Land (England) Regulations, 2006 (Ref. 11-2) and accompanying statutory guidance (DEFRA Circular 01/2006) (Ref. 11-3) provide amendments to and supersede the original Regulations and Guidance issued in 2000. The amendments largely address the incorporation within the legislation of land that is contaminated by virtue of radioactivity. The Guidance describes a risk assessment methodology in terms of 'significant pollutants' and 'significant pollutant linkages' within a source-pathway-receptor conceptual model. The model comprises:

- The principal pollutant hazards (sources) associated with the site;
- The principal receptor(s) at risk from the identified hazards (for example, people, environmental assets, surface water and/or groundwater); and
- The existence, or absence, of plausible pathways which may exist between the identified hazards and receptor(s).

11.2.4 For land to be determined as 'contaminated' in a regulatory sense, and therefore requiring remediation (or a change to less sensitive use), all three elements (source-pathway-receptor) of a significant pollutant linkage must be present. The legislation places a responsibility on the Local Planning Authority (LPA) to determine whether the land in its area is contaminated by consideration of whether:

- Significant harm is being caused;
- There is a possibility of significant harm being caused; or
- Pollution of controlled waters is being, or is likely to be, caused.

And in regard of radioactivity:

- Harm is being caused; or
- There is a significant possibility of such harm being caused.

11.2.5 LPAs rely heavily on the advice of the Environment Agency (EA) in relation to environmental matters for example in their approach to the analysis of pollution of 'Controlled Waters'.

Water Resources Act, 1991

11.2.6 The Water Resources Act (Ref. 11-4) seeks to protect the quality of groundwater and surface water, collectively defined as 'Controlled Waters'. The Act is of specific relevance to soil contamination in those cases where the nature, extent and mobility of contamination present a risk of pollution of Controlled Waters. In such cases, the land owner is committing an offence if the pollution of Controlled Waters is not prevented once the site has been identified as being a source of contamination.

Building Regulations

11.2.7 The Building Regulations 2000 and specifically, Approved Document C, Site Preparation and Resistance to Contaminants and Moisture, 2004 Edition (Ref. 11-5), outlines an approach for the assessment of contamination and preparation of sites prior to redevelopment.

National Planning Policy and Guidance

Planning Policy Statement 23: Planning and Pollution Control, 2004

11.2.8 In addition to the contaminated land regime, contamination is managed via the planning regime, through Planning Policy Statement (PPS) 23: Planning and Pollution Control (Ref. 11-6). PPS23 aims to ensure the sustainable use of land, encouraging the re-use of previously utilised land. Consequently, opportunities should be taken, wherever possible, to assist and encourage the remediation of contaminated land programmed for re-use and that any necessary polluting activities should be sited, planned and subject to planning conditions, such that their adverse impacts are minimised to within acceptable limits.

11.2.9 PPS23 recognises that whilst planning and pollution control systems are separate, they are complementary. Both are designed to protect the environment from potential harm caused by developments and operations, but with different objectives. PPS23 recognises that development can provide an opportunity to deal with risks associated with historical contamination. Annex 2 to the PPS provides specific guidance on the development of land affected by contamination.

11.2.10 PPS23 states that remediation will normally be secured through the planning system, rather than through Part IIA, because redevelopment provides both the opportunity and resources to carry out remediation. It remains the responsibility of the landowner/developer to identify land affected by contamination and to ensure that remediation is undertaken to secure a safe development.

Regional Planning Policy

The London Plan: Spatial Development Strategy for Greater London, 2008

11.2.11 Key policies of the London Plan (Ref. 11-7) relating to contaminated land are set out in policy 4A.33 (Bringing contaminated land into beneficial use). This policy states that such land affected by contamination should be recycled into new uses and may require measures to prevent contamination being activated or spread when building takes place.

11.2.12 The policy is set out as follows:

"*The Mayor will work with strategic partners to identify best practice mechanisms to enhance remediation of contaminated sites and bring the land into beneficial use*".

Draft Replacement London Plan (2009)

11.2.13 Key policies of the Draft Replacement London Plan (Ref. 11-8) relating to contaminated land are set out in policy 5.21. This policy states that brownfield and contaminated sites should be used for development. It goes on to say that development is an opportunity to reduce the potential health risk, environmental harm and stem the spread of contamination. Furthermore land affected by contamination may require measures to prevent contamination being spread or activated.

11.2.14 The policy is set out as follows:

"*The Mayor supports the remediation of contaminated sites and will work with strategic partners 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.*"

Local Planning Policy

The London *Borough of Richmond Upon Thames Adopted Unitary Development Plan, 2005*

11.2.15 The London Borough of Richmond Upon Thames (LBRUT) Adopted Unitary Development Plan (UDP) (Ref. 11-9) contains a policy specific to contaminated land. Environmental Policy ENV5 states:

"The Council will seek to identify contaminated land….and will take necessary measures to ensure that the contamination is treated appropriately in order to protect public health and the natural environment and bring sites into beneficial use. Before considering applications for the development of sites which are possibly contaminated, the Council will require developers to undertake an assessment of the types and concentrations of the contaminants present and provide a statement of the method and scope of the assessment and remedial measures proposed."

11.2.16 Paragraph 5.50 acknowledges that the extent of contamination in the Borough is at present unknown but land used for industrial purposes has been relatively insignificant and the amount of contamination is therefore likely to be limited.

The London Borough of Richmond Upon Thames Supplementary Planning Guidance on redevelopment of potentially contaminated sites, 2003

11.2.17 The London Borough of Richmond Upon Thames Supplementary Planning Guidance on redevelopment of potentially contaminated sites (Ref. 11-10) sets out the following:

"the approach the Council expects developers to take in relation to contaminated land issues for ensuring compliance with the requirements of the Town and Country Planning Act 1990 and Planning Policy Guidance Note (PPG) 23: Planning and Pollution Control, 1994 to bring the land into a 'suitable-for-use' state as well as to address possible future liabilities under Part IIA of the Environmental Protection Act 1990".

11.2.18 It should be noted that PPG 23 referred to has been superseded by PPS 23 (as described in the National Planning Policy section above).

11.3 Assessment Methodology and Significance Criteria

Assessment Methodology

11.3.1 The assessment methodology used is described in the sections below.

Collection of Baseline Data and Information Sources

11.3.2 The baseline conditions of the Site, in respect of the potential for contamination, were established through:

- a site walkover undertaken by Waterman in August 2010;
- geological and groundwater vulnerability maps for the area;
- BGS borehole logs for the Site;
- Landmark data for the Site;
- previous desk study for the Site undertaken by Capita Symonds;
- Geotechnical Report for the Site undertaken by RSK Group; and
- Generic Quantitative Environmental Risk Assessment undertaken by Waterman.

11.3.3 The reports reviewed are as follows:

- Phase 1 Ground Contamination Desk Study Report, Capita Symonds (ref. Version 1.0, October 2007);
- Geotechnical Report for Twickenham Railway Station (ref. 241458-01(00)), dated August 2010; and
- Generic Quantitative Environmental Risk Assessment - Interpretive Environmental Report on Ground Investigation at Twickenham Railway Station, Waterman Energy, Environment & Design Ltd (ref. EED11251-100/R/1.1.1/GB), dated August 2010.
- Type 2 Asbestos Survey, Osborne on behalf of Network Rail, 2009 (*Appendix F-4* of *ES Volume III*).

Assessment approach

11.3.4 The assessment presented in this Environmental Statement (ES) was undertaken in accordance with current good practice guidance on the assessment of contaminated land, including relevant British Standards, and the DEFRA Contaminated Land Reports (CLR) series. CLR 11 'Model Procedures for the Management of Contaminated Land' (Ref. 11-10) advocates the use of a tiered approach to the assessment of contaminated land, whereby initial conceptual models are formulated and where necessary further refined through successive phases of site investigation, risk assessment and where appropriate remediation.

11.3.5 A Phase 1 Ground Contamination Desk Study Report (Preliminary Risk Assessment) was carried out for the Site by Capita Symonds. This study included a site walkover, review of historical maps and plans and review of British Geological Survey (BGS) and Environment Agency maps. This information was used to develop a preliminary contaminated land conceptual model for the Site.

11.3.6 A Generic Quantitative Environmental Risk Assessment was prepared for the Site by Waterman. This was based on the results of the Phase 1 report and subsequent ground investigation and further refines the conceptual model.

Significance Criteria

11.3.7 Contaminated land legislation and guidance focuses on the site-specific assessment of potential pollutant linkages. There is no specific methodology or guidance for the assessment of impacts on ground conditions for the purposes of EIA. Significance criteria were therefore developed based on professional judgement and relevant experience, using the standard criteria adopted by Maddox & Associates for ESs. The criteria are based on the potential magnitude and duration of the effect, the sensitivity of the receiving environment and the likelihood of the effect occurring. An explanation of the significance criteria used in this Chapter is provided in Table 11-1.

11.3.8 For the purposes of ground conditions assessment, the 'risk' presented by the Site is determined using a source-pathway-receptor model, in line with regulatory requirements and best practice.

11.3.9 The risks associated with the mobilisation of contamination and potential environmental impacts during construction were qualitatively assessed.

Table 11-1 Significance Criteria

Criteria	Description
Major Adverse	High risk site classification - acute or severe chronic effects to human health and/or animal/ plant populations predicted. Effect on a potable groundwater or surface water resource of regional importance e.g. major aquifer, public water reservoir or inner protection zone of a public supply borehole.
Moderate Adverse	Medium risk site classification and proven (or likely significant) pollutant linkages with human health and/or animal/plant populations, with harm from long-term exposure. Effect on a potable groundwater or surface water resource at a local level e.g. effect on an outer groundwater source protection zone. Temporary alteration to the regional hydrological or hydrogeological regime or permanent alteration to the local regime.
Minor Adverse	Medium risk site classification and potential pollutant linkages with human health and / or animal / plant populations identified. Reversible, localised reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions, minor aquifer, etc.
Negligible	Low risk site classification – No appreciable effect on human, animal or plant health, potable groundwater or surface water resources.
Minor Beneficial	Risks to human, animal or plant health are reduced to acceptable levels. Local scale improvement to the quality of groundwater or surface water resources used for commercial or industrial abstraction.
Moderate Beneficial	Significant reduction in risks to human, animal or plant health, to acceptable levels. Significant local improvement to the quality of potable groundwater or surface water resources. Significant improvement to the quality of groundwater or surface water resources used for public water supply.
Substantial Beneficial	Major reduction in risks to human, animal or plant health. Significant regional scale improvement to the quality of potable groundwater or surface water resources.

Limitations

11.3.10 Our assessment is based on the likely most extensive and deepest foundations for the proposed buildings and the likely greatest extent of landscaped areas.

11.3.11 The information contained within the Generic Quantitative Environmental Risk Assessment is based upon the Phase 1 Ground Contamination Desk Study Report produced by Capita Symonds and the Geotechnical Report produced by RSK Group.

11.4 Baseline Conditions

The Site

11.4.1 The Site is located at National Grid Reference 516130, 173700 and covers an area of approximately 0.96 hectares. The Site is currently occupied by Twickenham Railway Station in LBRUT, comprising the station and railway lines, car parking, a ticket office, an outdoor waste storage area and associated walkways and bridges. There are no basements located on site. The site is largely flat with an increase in level (approximately 1.5m) from the exit of the car park to the west of the site. The entrance to the ticket hall on the western boundary of the site is, therefore, approximately 1.5m higher than the rest of the site.

11.4.2 Overall, the site appeared to be tidy and in a satisfactory state of repair with no obvious signs of contamination noted. However, Japanese Knotweed was noted to be present along the northern boundary adjacent to the River Crane, adjacent to the railway track (western side) and in the western portion of the car park, adjacent to some stairs.

11.4.3 A site location plan and site layout plan, as well as some photographs taken during the site visits and ground investigation are included in *Appendix F-3 of ES Volume III*.

The Surrounding Area

11.4.4 The Site is immediately bound to the north by the River Crane (understood to be within a concrete lined channel at this point of the river), beyond which lies residential housing and gardens, Cole Park Road and then London Road. To the east the railway line continues, beyond which is a pedestrian footpath and residential housing. The site is bounded to the south by Mary's Terrace including residential homes and gardens, beyond which lie commercial buildings, a school and a cemetery. Immediately to the west lies London Road, beyond which lie shops, the railway line and a sorting office.

11.4.5 There are three Environmental Permits (formerly LAPPC's) within a 500m radius of the Site. The closest is located approximately 325m to the southeast and is registered to Shell Oak Lane for a petrol filling station. The other two are for dry cleaning operators.

11.4.6 There is one fuel station recorded within 500m of the Site. This is the Shell Oak Lane petrol station located approximately 325m to the southeast.

Historical Land Use

11.4.7 The Site has been developed as historical railway land since at least the late 1800's. Twickenham Station itself was developed since at least the 1960s. This included a car park, two small buildings, three platforms, railway lines and a footbridge. The site has been in its current layout since at least 2007.

11.4.8 Historical mapping also indicates that the surrounding area was largely open land and residential land use from at least the 1870s with Twickenham Junction Railway Line noted to be present. A Brewery, the River Crane, a School, a Railway Engine Shed, two children's Nurseries and a Carriage Factory were all present within 500m of the site during the late 1800s and early 1900's. A Hospital was located approximately 150m to the southeast between 1896 and 1995, while a Goods Shed, Corporation Depot and a Coal Yard were shown to be present within 150m of the site between 1914 and 1991.

Geology and Ground Conditions

11.4.9 The geology beneath the site was established from the British Geological Survey (BGS) 1:50,000 scale Geological Map, Sheet 270 (South London), Solid and Drift Edition (Ref. 11-12), and from borehole logs produced during the ground investigation at the Site, and is summarised in Table 11-2.

Table 11-2 Geological strata encountered at the Site

Soil Type	Depth of Top of Stratum (m OD)	Thickness (m)	Typical Description
Made Ground	6.69 to 12.10	0.8 to 4.8	Dark brown, silty sandy gravel of flint with fragments of brick, stone and concrete with occasional ash and clinker
Kempton Park Gravel	4.40 to 7.30	2.1 to 7.1	Orange brown, silty and clayey, sandy gravel
London Clay Formation	0.00 to 3.95	up to 31.9 (proven to -31.9mOD)	Dark grey, silty sandy clay

11.4.10 It is understood that there are no landfills within the vicinity of the site.

11.4.11 The Site is located in an area where less than 1% of homes are above the action level associated within radon gas, therefore, protection measures are not considered necessary in new buildings or extensions.

Hydrogeology and Hydrology

Ground waters

11.4.12 According to the EA Aquifer Designation Maps, (online), the geological deposits underlying the site are classified as per Table 11.3.

Table 11.3 Summary of Hydrogeological properties of the main geological strata

Stratum	EA Classification	Hydrogeological significance
Made Ground	Un-productive stratum	Insignificant quantities of groundwater
Kempton Park Gravel	Principal Aquifer	Important for local supplies and base flows to rivers
London Clay Formation	Un-productive stratum	Insignificant quantities of groundwater

11.4.13 The Site is not located within a groundwater protection zone.

11.4.14 Based on available information, it is anticipated that groundwater flow in the Kempton Park Gravel will be in an east to south-easterly direction towards the River Thames.

11.4.15 There are no recorded groundwater abstractions within a 1km radius of the Site. The closest is located approximately 1,050m to the northeast of the Site and is registered to St Margaret's Recreation Ground. The abstraction is for a private non-industrial amenity: lake and pond throughflow.

11.4.16 There have been seven recorded pollution incidents to Controlled Waters within a 500m radius of the Site. The closest was located approximately 50m to the west on 30 September 1996 and was classed as a minor incident involving unknown oils. The remaining six incidents were also classed as minor incidents.

Surface waters

11.4.17 The nearest surface water to the Site is the River Crane, located immediately to the north. The River flows from west to east and has been classified as 'River Quality C' or fairly good by the EA General Quality Assessment (GQA) scheme. The River Crane is an engineered structure with concrete lined walls. There are no recorded surface water abstractions within the vicinity of the Site.

11.4.18 There are three surface water discharges within a 500m radius of the Site. The closest is located approximately 5m to the northwest licensed to Mr S Pannifer (private dwelling) for the discharge of other matter surface water to the River Crane.

11.4.19 According to the EA's indicative flood data, the Site is located immediately adjacent to an area at significant risk of fluvial flooding and the adjacent area is not protected by flood defences. Refer to *Chapter 12: Water Resources* for further information.

Potential Contamination Sources

11.4.20 A summary of the current and historic potential on Site contamination sources identified from these preliminary assessments is provided in Table 11-4. A summary of the potential off Site sources is provided as Table 11-5.

Table 11-4 Potential Contamination Sources Identified on the Site

Source	Potential Contaminants	Key potential Hazards and identified Hazards
Locally occurring Made Ground	Asbestos, oils, metals, organic compounds, ash and ground gases	Dermal contact or ingestion of contaminants and inhalation of gases, vapours and dust. Leaching of contaminants to groundwater and surface water
Historic and recent industrial activities, including railway sidings	Asbestos, oils, PAHs, Creosote, Herbicides, Metals, Ash, Sulphate, Hydrocarbons, PCB's	Dermal contact or ingestion of contaminants and inhalation of gases, vapours and dust. Leaching of contaminants to groundwater and surface water
Groundwater	PAHs, Creosote, Herbicides, Metals, Sulphate, Hydrocarbons, PCB's	Dermal contact with contaminants and inhalation of vapours

Table 11-5 Potential Contamination Sources Identified off Site

Source	Potential Contaminants	Key potential Hazards and identified Hazards
Locally occurring Made Ground	Asbestos, oils, metals, organic compounds, ash and ground gases	Dermal contact or ingestion of contaminants and inhalation of gases, vapours and dust. Leaching of contaminants to groundwater and surface water
Historic and recent industrial activities, including railway sidings, brewery, hospital, coal yard, depot	Asbestos, oils, PAHs, Creosote, Herbicides, Metals, Ash, Sulphate, Hydrocarbons, PCB's, biological	Dermal contact or ingestion of contaminants and inhalation of gases, vapours and dust. Leaching of contaminants to groundwater and surface water
Groundwater	PAHs, Creosote, Herbicides, Metals, Sulphate, Hydrocarbons, PCB's	Dermal contact with contaminants and inhalation of vapours

Results of Ground Investigation

11.4.21 The ground investigation at Twickenham Station was undertaken between 1 June and 8 July 2010 and included the following scope of environmental works:

- 7no light cable percussion boreholes through the full thickness of the Made Ground and the Kempton Park Gravel and to at least 1m into the London Clay;
- 4no drive-in sampler probeholes through the full thickness of the Made Ground and into the Kempton Park Gravel;
- Appropriate in situ testing and sampling including headspace analysis using a PID;
- Installation of 3no dual purpose ground gas/groundwater monitoring standpipes in the Kempton Park Gravel;
- Monitoring of groundwater levels and quality;
- Groundwater sampling;
- Surface water sampling;
- Ground gas monitoring; and
- Chemical laboratory testing of soils, groundwater and surface waters.

11.4.22 The Waterman Generic Assessment Criteria (GAC) was used to assess the soil chemical laboratory data for the site. Elevated contamination (Arsenic, Lead, Mercury, Vanadium, Naphthalene, Benzo(a)anthracene, Chrysene, Benzo(b)flouranthene, Benzo(k)flouranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene and Di-benzo(a,h)anthracene) was identified in soils beneath the site.

11.4.23 The Water Supply (Water Quality) Regulations (REF: 11-13) and Environmental Quality Standards (EQS) for freshwater (REF: 11-14) were used to assess the groundwater and surface water chemical laboratory data for the site. Limited marginally elevated contamination (Iron and Chromium) was identified within the shallow groundwater at the site. No elevated contaminants were identified within the surface water samples taken from the River Crane.

11.4.24 CIRIA C665 was used to assess the Site's ground gassing regime. The Site was found to conform to a Characteristic Situation 2, whereby precautionary ground gas measures will be required for the new development. Elevated concentrations of PAHs were identified in the soils when compared to the Waterman GAC.

Assessment of Risk from Contamination

11.4.25 In consideration of the above and given the proposed end use, the overall risk rating for the Site is currently low to medium. However, with implementation of appropriate mitigation measures as part of the proposed development, this risk can be reduced to low.

11.4.26 Currently, hardstanding across the majority of the Site provides a barrier to ground contamination and therefore the risk to Site users is low. However, a low to medium risk remains to maintenance workers who could come into direct contact with potentially contaminated soils, although this would be minimised through the use of Personal Protective Equipment and Respiratory Protective Equipment. In addition, the majority of the proposed development is hardstanding. Any areas of soft landscaping or residential gardens will be covered with an appropriate thickness of material suitable for the proposed end use.

11.4.27 Buried structures and service supply pipes are considered to be at low to medium risk given the elevated contaminant concentrations encountered. However, mitigation measures such as the use of sulphate resistant cement and metallic water pipes will reduce this to low.

11.4.28 Controlled Waters (groundwater and surface waters) and ecological receptors are also considered to be potential receptors to contamination. A Principal Aquifer underlies the Site and the River Crane lies immediately adjacent to the northern boundary. Potential existing pathways represent a low to medium risk and include infiltration and leaching.

11.5 Site Preparation and Construction Impacts and Mitigation Measures

Potential Impacts

11.5.1 There are four main issues relating to contaminated land that are relevant to the assessment of contamination risks during the demolition and construction phases:

1. Implications for the proposed Development in respect of the soil (which may require treatment prior to disposal) to be removed from the Site;
2. Potential exposure of the general public and Site workforce, from Site demolition and construction activities, to any contamination that is currently isolated by buildings or hard-standing;
3. Potential for the mobilisation of any contamination from soil or groundwater present at the Site to water resources that currently are not adversely affected by contaminants, either through the creation of new migration pathways or exposure of previously sealed contamination to leaching by rainfall; and
4. Potential for demolition and construction activities to cause soil or groundwater contamination, for example, as a result of accidental spillages of fuel or poor storage practices.

11.5.2 Exposure of existing on Site ecosystems to contamination during construction is not considered significant on the basis that these habitats would not be retained and are of very limited nature conservation value. The risks to the River Crane adjacent to the northern boundary of the site are assessed in *Chapter 13: Ecology*.

11.5.3 A conceptual site model illustrating the relationship of the proposed development to the ground conditions is included as Figure 11-1.

Disposal of Contaminated Spoil

11.5.4 Soils will principally be generated by piling operations, formation of foundations, from excavation of trenches for underground services and for the excavations related to the construction of Block A, which forms an undercroft in the western portion of the site. No major earthworks or basement excavations are proposed.

11.5.5 The Site Waste Management Plans Regulations 2008 (Ref. 11-15) aim to prevent or to reduce as far as possible, the adverse environmental impacts of landfill. The current approach to the proposed Development accords with these requirements. However, the opportunities for reusing material on Site are likely to be minimal as no ground raising is proposed and the majority of the soil would therefore require removal from Site. The soil that is anticipated to be generated by the proposed Development would result in a long-term, local/regional effect of **moderate adverse** significance.

11.5.6 Due to the Site's use as railway land and given the results of the ground investigation, a small amount of material excavated from the Site and requiring off Site disposal is likely to be classified as hazardous waste. Such waste material would be disposed of at a licensed landfill site with prior consent from the EA. The material would require transporting and disposal in accordance with the Environmental Protection (Duty of Care) Regulations, 1991 (Ref. 11-16). The excavated material would be tested to determine its classification and to identify an appropriate disposal facility.

11.5.7 In order to determine whether the excavation waste is hazardous or not, the potential contaminants would be identified based on the history of the waste (established from the Phase 1 report and Generic Quantitative Risk Assessment for the Site), with sufficient representative samples of the waste being subjected to appropriate laboratory chemical analysis. The data would be assessed in accordance with EA guidance.

11.5.8 Waste Acceptance Criteria (WAC) testing would be required to confirm the disposal classification prior to disposal. The Made Ground would likely be classified as either 'hazardous' or 'non-hazardous'. The natural soils (e.g. pile arisings) would be expected to be classified as inert.

11.5.9 Following the classification of excavation wastes, the options available for the waste would be considered in the context of the waste hierarchy:

- On site reuse (with or without prior treatment);
- Off site reuse (with or without prior treatment) e.g. use of waste in construction at a site exempt from the requirement to hold an environmental permit such as a golf course development;
- Off site processing for recycling or recovery e.g. screening; and
- Off site disposal (with or without prior treatment) i.e. landfill.

11.5.10 All legislative requirements will be adhered to and the disposal of this material would therefore result in **negligible** environmental impacts.

Risks to Site Workers and Public Safety

11.5.11 In the absence of appropriate mitigation and the use of Personal Protective Equipment (PPE), any contamination present in the soil would present a risk to construction workers. However, worker safety would be the subject of the mandatory requirements of the Control of Substances Hazardous to Health (COSHH) Regulations 2003 (Ref. 11-17) and the Construction (Design and Management) Regulations 2007 (CDM) (Ref. 11-18). These regulations set out the extensive requirements for the protection of the workforce and stress the importance of appropriate procedures in the event of the workforce encountering pockets of unknown contamination. Further details are provided in paragraph 11.5.21.

11.5.12 Adherence to the legislative requirements described above would significantly reduce the health and safety risk posed to construction site workers. The potential impact of demolition and construction works on site workers would therefore be **negligible**.

11.5.13 In respect of public safety, the Site compound and construction areas would be surrounded by hoarding and secured. The risk to individual members of the public during all phases would therefore be **negligible**. Dust control measures would reduce the potential for exposure to contaminants associated with dust to an acceptably low level. The potential effect of demolition and construction works on public safety would therefore be **negligible**.

Risk to Water Resources

11.5.14 The site is situated on a Principal Aquifer (Kempton Park Gravel), with the Made Ground directly overlying the Kempton Park Gravel. Any contamination present within the Made Ground is already likely to have migrated into the aquifer below. The proposed piles are therefore, unlikely to create additional preferential pollution pathways into the Kempton Park Gravel aquifer. In addition, the use of appropriate piling techniques and the requirement to carry out a Foundation Works Risk Assessment and agree the final piling strategy with the EA would significantly reduce the risk to the Kempton Park Gravel aquifer. Therefore, construction activities within the Site would be expected to give rise to **negligible** environmental impacts.

11.5.15 The River Crane is located immediately adjacent to the northern boundary of the site. Given the engineered structure of the river (concrete lined) it is unlikely that contamination mobilised during construction will migrate into the river. In addition, no works are proposed to the engineered structure and it is understood that no weep holes are present along the river at this point. Therefore, the potential impact on the River Crane during construction is considered to be **negligible**.

Exposure of Soil to Leaching

11.5.16 The existing Site incorporates substantial areas of hardstanding. This currently limits infiltration through the soil and, therefore, potential contaminant leaching to the underlying groundwater. However, because construction activity would cause disruption to the existing ground conditions, in conjunction with the possibility that there may be areas of contamination on the Site, a precautionary approach would ensure that any impacts arising from leaching would be temporary, short to medium-term, local and of **minor adverse** significance.

Contamination of Ground during Construction

11.5.17 During the construction works there would be a risk related to material or fuel spillages directly or indirectly to the soil. The risk of additional contamination occurring would be temporary, short-term, local in effect and of moderate adverse significance. However, measures to protect the quality of surface and groundwater are described in *Chapter 12: Water Resources* including:

- Siting of storage areas away from surface water drains and on an impermeable base with an impermeable bund with no outflow and capacity to contain the contents plus an additional 10%;
- Wherever possible, plant and machinery to have drip trays beneath oil tanks/engines/gearboxes/hydraulics which will be checked and emptied regularly via a licensed waste disposal operator;
- An emergency spillage action plan will be produced; and
- On-site provisions will be made to contain a serious spill or leak through the use of booms, bunding and absorbent material.

11.5.18 Adoption of these measures would similarly protect soil quality during construction and result in a **negligible** impact.

Mitigation Measures

Environmental Ground Investigation

11.5.19 Following completion of the environmental ground investigation, a Generic Quantitative Environmental Risk Assessment interpretative report was produced by Waterman. This report identified the outstanding risks and likely adverse impacts at the site and provided the following recommendations and mitigation measures:

- Inclusion of appropriate gas protection measures within new buildings at the site;
- Further risk assessment/remedial works to manage the source of the elevated hydrocarbons and/or vapour protection measures incorporated into the building design;
- Excavated materials should be assessed for their potential for reuse or classified for waste disposal purposes;
- Areas of landscaping and gardens will require the importation of clean soils to ensure a suitability for use to both occupants and plants;
- Consideration should be given to the use of contaminant resistant pipe work and clean service corridors for the proposed redevelopment;
- Ground workers should wear appropriate personal protective equipment (PPE) and adopt appropriate hygiene practices;
- The River Crane (engineered structure) and any drainage runs/sewers beneath the site should be safeguarded during the redevelopment works;
- A Foundation Works Risk Assessment should be completed prior to redevelopment;
- The potential for Asbestos Containing Materials (ACMs) should be investigated and any surveys or reports reviewed by a specialist consultant; and
- Japanese Knotweed identified at the site during the investigation should be appropriately managed and a programme of treatment and disposal undertaken by a specialist contractor.

Pre-Treatment of Spoil prior to Disposal

11.5.20 The proposed method of Site remediation would involve capping the existing soil with hard cover or topsoil/subsoil, and removal of selected areas of gross contamination, where necessary. These measures are described in further detail later in this chapter. The remedial measures would be implemented during construction but also relate to the mitigation of risks in the completed Development phase.

11.5.21 Groundwater encountered within excavations would need to be pumped out and either treated before disposal to sewer under Trade Effluent Consent from Thames Water Utilities Ltd (TWUL) or disposed of via a tanker to a suitably licensed treatment facility.

Protection of Site Workers and Public

11.5.22 During demolition and construction, precautions would be taken to minimise the exposure of workers and the general public to potentially harmful substances. Attention would be paid to restricting possible off Site nuisances, such as those arising from any dust and odour emissions. Such precautions would be included within the Construction Environmental Management Plan (refer to *Chapter 6: Demolition and Construction*) and include:

- Personal hygiene, washing and changing procedures;
- Personal protective equipment, including disposable overalls, gloves and particulate filter masks to be worn;
- Adoption of dust suppression methods, e.g. water spraying, wheel washing facility for vehicles leaving the Site;
- Measures to avoid surface water ponding and positive collection and disposal of all on Site runoff;
- Regular cleaning of all Site roads, access roads and the public highway.

11.5.23 The above measures would be carried out in accordance with the Health and Safety Executive publication 'Protection of workers and the general public during the development of contaminated land' (Ref. 11-19) and CIRIA Report 132, 'A guide for safe working on contaminated sites' (Ref. 11-20). The contractor would, prior to construction, prepare a safety method statement, which would show how the safety of the work force and the public would be addressed.

11.5.24 A Type 2 Asbestos Survey (Ref. 11-21) was carried out of buildings that are to be demolished in June 2009 by Osborne on behalf of Network Rail. Further asbestos surveys would be carried out prior to demolition works commencing, as required by the Control of Asbestos Regulations (Ref. 11-22). On the basis of the survey results, appropriate Health and Safety Plans would be developed as required by the Control of Substances Hazardous to Health (COSHH) Regulations 2003 and the Construction (Design and Management) Regulations 2007 (CDM), which would be mandatory for the demolition works.

11.5.25 The overall effect of demolition and construction works site operatives would therefore be **negligible**.

Piling

11.5.26 The EA guidance document on piling on contaminated land (Ref. 11-23) describes various methods and scenarios for piling through contaminated land. The report recommends that a Foundation Works Risk Assessment report (FWRA) is prepared in such cases. It is considered that with the application of an appropriate piling methodology, the risks to the underlying aquifer from piling works penetrating through potentially contaminated land would be low. The piling method to be used at the Site would be confirmed following further consultation with the EA, although currently it is considered that rotary and CFA piling techniques will be utilised on site. The overall effect of piling on groundwater contamination would therefore be **negligible**.

Exposure of Soil to Leaching

11.5.27 Spoil containing 'leachable' (i.e. potentially soluble or otherwise mobile) contaminants would be identified and suitably contained, by bunding or similar containment measures, to prevent the release of contamination through surface water runoff. The overall effect of contaminated runoff on groundwater contamination would therefore be **negligible.**

11.6 Operational Impacts and Mitigation Measures

Potential Impacts

Risk to Future Occupants

11.6.1 Whilst a large proportion of the proposed Development is for residential use, the majority of this will be elevated above ground level with station buildings, car parking and platforms below. An adequate cover layer suitable for the proposed end use will be placed in areas of soft landscaping and in residential gardens. Therefore, the potential risk posed to future inhabitants from exposure to contaminated soils would be very limited. This is for the following reasons:

- The majority of the Site would be hard-surfaced, forming a barrier between people and direct contact with contaminated soil, and thus breaking the potential contaminant pathway;
- The hard surfacing would also prevent atmospheric exposure of contaminants leading to the potential inhalation of contaminated dust; and
- Landscaped areas would be provided with a clean growth medium to reduce risks of exposure to contaminants in the soil.

11.6.2 In the absence of an adequate cover layer in landscaped areas, a low to medium risk would remain, and without this the Development would give rise to a long-term, local effect of **minor adverse** significance to future occupants.

11.6.3 The potential for exposure to ground gas (generated from the underlying Made Ground) and vapours from hydrocarbon contaminants could exist, although the inclusion of appropriate gas/vapour protection measures within the buildings on site would limit their accumulation. Therefore, the risk arising from the presence of ground gas and vapours would be medium, and in the absence of mitigation, the effect would be long-term, local and of **moderate adverse** significance.

Risk to Water Resources

11.6.4 The potential effect of the constructed piled foundations on the Principal Aquifer is considered to be low given the techniques proposed. Therefore, it is considered that given the mitigation measures proposed during construction to minimise risks, the potential effect of pile induced contamination pathways to the aquifer would be negligible.

11.6.5 Given that no works are proposed to the engineered structure to the River Crane the potential effects are considered to be **negligible**.

Risk to Ecosystems

11.6.6 The exposure mechanisms for fauna would be similar to those for human exposure. However, the principal risk would relate to exposure in landscaped areas and through ingestion via plants. Plants could also be subject to exposure by root uptake. In the absence of an adequate cover layer, the risk and therefore the likely effect would be long-term, local and of **minor adverse** significance.

Contamination of Ground by the Completed Development

11.6.7 The proposed Development does not include land uses that are likely to give rise to the contamination of soil or groundwater. Thus, the risk of soil contamination being caused by the Development itself is negligible. Spillages of fuel within car park areas cannot be excluded. However, the hard-surfacing and use of petrol interceptors in the surface water drainage system would protect to underlying soil from potential impacts. The potential effect of the completed Development on ground would therefore be **negligible**.

Mitigation Measures

Soil Remedial Measures

11.6.8 Following the results of the Generic Quantitative Environmental Risk Assessment Report specific soil remedial measures are not currently considered necessary at the Site. Amendments would be made to accord with any differing conditions encountered during the progress of the works in consultation with LBRUT and the EA.

11.6.9 The proposed building structures, ground slabs and areas of hardstanding would form a physical barrier to migration of any potential contaminants, and thus eliminate any risk to occupants or visitors to the proposed Development. Areas of soft landscaping would be provided with a clean growth medium, as necessary, and this would be tested to ensure it is free of contaminants.

11.6.10 The overall effect of the completed Development on the ground and its impacts on future users and occupants would therefore be **negligible**.

Gas Control Measures

11.6.11 Assessment of the requirement for gas protection measures to the buildings was undertaken as part of the Generic Quantitative Environmental Risk Assessment. Given the elevated concentrations of ground gas (carbon dioxide) and vapours encountered to date, appropriate mitigation measures will need to be incorporated in the building design as necessary in agreement with LBRUT.

11.6.12 On the basis that the appropriate level of protection measures are provided the overall effect of the ground gas and vapours on future users and occupants of the completed Development would be **negligible**.

11.7 Residual Impact Assessment and Conclusions

Site Preparation and Construction

Disposal of Contaminated Spoil

11.7.1 The disposal of any contaminated spoil would be subject to legislative and regulatory control as part of the proposed Development. The residual impacts would remain the same as the identified potential impacts, that is, **negligible**.

Risks to Site Workers and Public Safety

11.7.2 The legislative and regulatory framework set out to protect construction site workers and the public would be implemented as part of the proposed Development. The potential **negligibl**e contamination risks and impacts would be maintained as the residual effect of the Development.

Risk to Water Resources

11.7.3 Although the potential effect of piling is considered to be negligible, this effect would be further safeguarded by the undertaking of a Foundation Works Risk Assessment Report. The residual effect of piles upon water resources would therefore remain **negligible**.

11.7.4 The residual effect on the River Crane would remain as **negligible**.

Exposure of Soil to Leaching

11.7.5 In relation to leachable contaminants which may be present in the soil, the greatest risk would exist in relation to soil being pre-treated on Site prior to off Site disposal. The potential for releases would be controlled by local removal and containment of such materials. The residual effect would therefore be **negligible**.

Contamination of Ground During Construction

11.7.6 The implementation of protective measures would reduce the potential for contamination of the ground during construction. However, owing to unforeseen accidental spillages, some risk would still remain. The worst-case residual effect would therefore be temporary, short-term, local and of **minor adverse** significance.

Operational Development

Risk to Future Occupants

11.7.7 A large proportion of the proposed Development is for residential use. Most of the proposed Development would comprise hardstanding, with some small areas of open landscaping and a limited number of residential gardens. The nature of the proposed Development is such that any contamination present on the Site would be encapsulated beneath the buildings and hardstanding. As mitigation, a clean growth medium would be provided in soft landscaped and garden areas. This would also serve to provide a barrier above any residual contamination.

11.7.8 Gas protection measures incorporated into the proposed Development would minimise the risk of gas/vapour migration into buildings. Appropriate mitigation incorporated into the design of the proposed Development would therefore reduce the risk to the future occupiers to acceptable levels.

11.7.9 Residual contamination risks to human health, following mitigation, would therefore be reduced to a negligible level. Therefore, the likely effect of any ground gas/contamination on human health during the occupational use of the completed Development would be **negligible**.

Risk to Water Resources

11.7.10 Assuming the correct and appropriate installation of piles, the residual effect of the proposed Development on groundwater resources would be **negligible**.

11.7.11 The residual effect on the River Crane would remain as **negligible**.

Risk to Ecosystems

11.7.12 The residual risks to ecosystems would be mainly related to the proposed landscaped areas. The clean growth medium provided would prevent the exposure of plants to contaminants by root uptake. Fauna would also be protected from direct exposure to contaminated soil or indirect exposure by ingestion of plants or soil. The resultant residual effect of the completed Development on ecosystems would therefore be **negligible**.

Contamination of Ground by the Completed Development

11.7.13 For reasons discussed in the assessment of potential impacts, the residual impacts of potential contamination on ground conditions would remain **negligible**.

11.8 Cumulative Impact Assessment

11.8.1 Due to the site specific nature of the effects relating to ground conditions and the absence of any significant below ground structures in the proposed development there are not considered to be any impacts to be considered with respect to other nearby developments.

11.9 References

Ref. 11-1: HMSO, Contaminated Land: Environmental Protection Act, Part I and II, 1990

Ref. 11-2: HMSO, The Contaminated Land (England) Regulations, 2006

Ref. 11-3: DEFRA, Circular 01/2006: Accompanying statutory guidance, Contaminated Land (England) Regulations, 2006

Ref. 11-4: HMSO, The Water Resources Act, 1991

Ref. 11-5: HMSO, Building Regulations, 2000: Approved Document C, Site Preparation and Resistance to Contaminants and Moisture, 2000

Ref. 11-6: Department of Communities and Local Government, Planning Policy Statement 23 (PPS23): Planning and Pollution Control, 2004

Ref. 11-7: Mayor of London, 2008: The London Plan - Spatial Development Strategy for Greater London – Consolidated with Alterations since 2004

Ref. 11-8: Mayor of London, 2009: The London Plan, Spatial Development Strategy for Greater London (Consultation draft replacement plan)

Ref. 11-9: London Borough of Richmond Upon Thames Adopted Unitary Development Plan, 2005

Ref. 11-10 London Borough of Richmond Upon Thames Supplementary Planning Guidance on redevelopment of potentially contaminated sites, 2003

Ref. 11-11: DEFRA, EA and SEPA, Contaminated Land Report 11 (CLR 11), Model Procedures for the Management of Contaminated Land, 2004

Ref. 11-12: British Geological Survey (BGS): BGS Map, 1:10,000 scale, Sheet 270 (South London), Solid and Drift Edition

Ref. 11-13: Environmental Quality Standards (EQS) for List 1 and List 2 dangerous substances (EC Dangerous Substances Directive (76/464/EEC))

Ref. 11-14: Water Supply (Water Quality) Regulations 1989 and 2000 as amended

Ref. 11-15: HMSO, Site Waste Management Plans Regulations, 2008

Ref. 11-16: HMSO, Environmental Protection (Duty of Care) Regulations, 1991

Ref. 11-17: HMSO, Control of Substances Hazardous to Health (COSHH) Regulations, 2003

Ref. 11-18: HMSO, Construction (Design and Management) Regulations, 2007

Ref. 11-19: HSE, Protection of workers and the general public during the development of contaminated land, 1991

Ref. 11-20: CIRIA, Report 132, A guide for safe working on contaminated sites, 1996

Ref. 11-21 Type 2 Asbestos Survey, Osborne on behalf of Network Rail, 2009

Ref. 11-22: HMSO, Control of Asbestos Regulations, 2006

Ref. 11-23: Environment Agency, Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, 2001

12.1 Introduction

12.2.1 This Chapter of the Environmental Statement (ES) assesses the potential impacts of the proposed development on the hydrology and hydrogeology at the site. The Chapter has been written by The Civil Engineering Practice Limited.

12.2.2 The chapter describes the methods used to identify baseline conditions at the site and the surrounding area, identifies key water resources and sensitivities and addresses the potentially significant direct and indirect impacts of the development on these resources.

12.2.3 Potential impacts during construction works and once the development is complete have been considered. The need for mitigation measures is addressed and potential residual impacts are identified.

12.2.4 This Chapter is supported by a Flood Risk Assessment (FRA), also undertaken by The Civil Engineering Practice which is located in *Appendix G-1 of ES Volume III*.

12.2.5 The Flood Risk Assessment identifies the potential flood risk associated with the existing site, provides an estimate of the volume of surface water currently generated, identifies the potential impacts the development may have and suggests mitigation measures to reduce the identified potential impacts and manage the associated risk. The FRA is summarised within this Chapter.

12.2 Planning Policy Context

National Legislation and Planning Policy

Water Resources Act

12.2.1 The Water Resources Act 1991 (Ref.12-1) sets out the relevant statutory regulatory controls that provide protection to water bodies and water resources.

12.2.2 The Water Resources Act 1991 has recently been modernised by the introduction of The Water Act (2003) (Ref. 12-2). The Act governs the control of water abstraction, discharge to water bodies, water impoundment, conservation and drought provision. The Act is supplemented by:

- The Environment Act, 1995 (Ref. 12-3)
- The Environmental Protection Act, 1990 (Ref. 12-4)

12.2.3 A number of specific regulations have also been implemented and include:

- Water Resources (Environmental Impact Assessment) (England and Wales) Regulations, 2003 (Ref. 12-5)
- The Groundwater Regulations, 1998 (Ref. 12-6)
- The Anti-Pollution Works Regulations, 1999 (Ref. 12 -7)

Planning Policy Statement 25: Development and Flood Risk

12.2.4 Planning Policy Statement 25 (PPS25) - Development and Flood Risk (Ref. 12-8), aims to reduce flood risk through development opportunities. The policy aims to ensure flood risks have been taken into account and appropriate measures put in place to ensure that:

- The development is safe
- Where possible the flood risk overall is reduced
- Increased flood risk does not occur elsewhere
- Appropriate mitigation measures are employed to deal with these effects and risks

Regional Planning Policy

The London Plan: Spatial Development Strategy for Greater London Consolidated with Alterations since 2004

12.2.5 The Mayor of London adopted the London Plan in 2004 as the Spatial Development Strategy for Greater London. This was amended in February 2008 (Ref. 12-9). Policies relevant to the proposed development are as follows:

- Policy 4A.3 Sustainable Design and Construction - Future developments should meet the highest design and construction standards, including the most effective and sustainable use of water, managing flood risk including through Sustainable Drainage Systems (SuDS) and flood resilient design.
- Policy 4A.9 Adaptation to Climate Change - Measures that allow adaptation to climate change will be promoted, including reducing flood risk, applying principals of sustainable drainage and minimizing water use.
- Policy 4A.14 Sustainable Drainage - Seeks to ensure that surface water runoff is managed as close to its source as possible.
- Policy 4A.16 Water supplies and Resources - Promotes rainwater harvesting and greywater recycling schemes.
- Policy 4A.17 Water Quality - Improvements to water quality can be made by ensuring adequate sewerage infrastructure capacity is available for developments, refusing proposals that are likely to lead to a reduction in water quality and supporting the use of SuDS to provide water quality benefits.
- Policy 4A.18 Water and Sewerage Infrastructure - Developers should work together with the Local Planning Authority and the water supply companies to enable inspection and repair of water supply and sewerage infrastructure. 'Water and wastewater infrastructure should be put in place in tandem with planned growth to avoid adverse environmental impacts'.

The Draft Replacement London Plan, 2009

12.2.6 A draft replacement Spatial Development Strategy for Greater London was published in October 2009 and is currently under public consultation (Ref. 12-10). The draft replacement sets out an integrated economic, environmental, transport and social framework for the development of London for the next 20-25 years. Draft policies relent to the proposed development are as follows:

- Policy 2.18 Green Infrastructure - the promotion of SuDS will improve water resources, flood mitigation and reduce flood risk.
- Policy 5.3 Sustainable Design and Construction - promotes high standards of design in new developments to improve environmental performance. This includes avoiding impacts from natural hazards such as flooding.
- Policy 5.12 Flood Risk Management - developments proposals must comply with PPS25 and have regard to measures proposed in Thames Estuary 2100 Plan and Catchment Flood Management Plans.
- Policy 5.13 Sustainable Drainage - Developments should utilise SuDS, aim to achieve green field run off rates and manage surface water runoff close to source.
- Policy 5.14 Water Quality and Sewerage Infrastructure - aims to protect and improve water quality and ensure adequate and appropriate sewerage infrastructure.
- Policy 5.15 Water Use and Supplies - developments should minimise the use of treated water by incorporating water saving measures.

Supplementary Planning Guidance: Sustainable Design and Construction

12.2.7 In May 2006 Supplementary Planning Guidance (SPG) was published on Sustainable Design and Construction (Ref. 12-11).

12.2.8 Section 2.3 discusses conserving resources, including water and Section 2.4 relates to reducing water pollution and flooding.

12.2.9 Section 2.3 indicates that the essential standards required of new residential development include a reduction of water use equivalent to approximately 110 litres/head/day.

12.2.10 The SPG also highlights the need for all developments to conform to the Sequential Test of PPS25, identifies that development should incorporate safe access routes above the flood levels likely during the lifetime of the development and adopt the principles of flood resilient design.

The Mayor's Draft Water Strategy, 2009

12.2.11 In 2007, Defra commissioned the EA to identify the parts of England that were 'water stressed'. London was found to be under 'serious' water stress and The Greater London Authority therefore see it as essential to balance water supply and demand and to manage water abstraction from the River Thames. Climate change and an increasing London population will increase water demand pressure in the future.

12.2.12 In response to the issues outlined above, a draft water strategy has been developed by the Mayor of London and was published in August 2009 (Ref. 12-12). It identifies ways in which present water resources could be used more effectively to tackle problems such as water supply, wastewater generation and flood risk.

12.2.13 Policies of relevance to water resource and flood risk issues for the proposed development are:

- Proposal 3, which requires that all new flats in London should have an individually metered water supply.
- Proposal 4, which requires that where possible all new homes should meet the highest level of the Code for Sustainable Homes.
- Proposal 5, which aims to make homes more water efficient.
- Proposal 8, which encourages the use of green roofs, rain water harvesting, grey water recycling and sustainable drainage to reduce flood risk and water demand.

Local Planning Policy

Local Development Framework

12.2.14 The Core Strategy of the LDF (Ref. 12-13) was adopted in April 2009.

12.2.15 Policies of relevance to water resource and flood risk issues for the proposed development are:

- CP1 - Sustainable Development Part 1.A which seeks to maximise the effective use of resources including land, water and energy, and assist in reducing any long term adverse environmental impacts of development and Part 1.D which seeks to reduce environmental impact.
- CP3 - Climate Change - Adapting to the Effects which confirms that development will need to be designed to take account of the impacts of climate change over its lifetime, including water conservation and drainage and flood risk from the River Thames and its tributaries

Relevant Pollution Prevention Guidance

Environment Agency Pollution Prevention Guidance Notes

12.2.16 Pollution Prevention Guidelines Note 1 (PPG01) - General Guide to the Prevention of Pollution (Ref. 12-14), provides an introduction to the prevention of pollution from a variety of sources.

12.2.17 Pollution Prevention Guidelines Note 2 (PPG02) - Above Ground Oil Storage Tanks (Ref. 12-15) offers advice on storage options, equipment and its maintenance and how to deal with spills.

12.2.18 Pollution Prevention Guidelines Note 3 (PPG03) - Use and Design of Oil Separators in Surface Water Drainage Systems (Ref. 12-16), provides guidance oil separator provision and the relevant size and types.

12.2.19 Pollution Prevention Guidelines Note 5 (PPG05) - Works in, near or liable to affect watercourses (Ref. 12-17) provides guidance on general precautions to take when working in the vicinity of a watercourse and measures to take to prevent contamination and to minimise any impacts.

12.2.20 Pollution Prevention Guidelines Note 6 (PPG06) - Working at construction or demolition sites (Ref. 12-18) Complimentary to PPG5 concentrating on demolition and construction sites.

12.2.21 Pollution Prevention Guidelines Note 7 (PPG07) - Refuelling Activities (Ref. 12-19), provides information on the correct delivery, storage and dispensing of fuel to reduce the risk of pollution.

12.2.22 Pollution Prevention Guidelines Note 21 (PPG21) - Pollution Incident Response Planning (Ref. 12-20), provides advice for those developing site specific pollution incident response plans to help prevent and mitigate environmental damage.

Construction Industry Research and Information Association Guidance.

12.2.23 C532 - Control of Water Pollution from Construction sites: Guidance for Consultants and Contractors (Ref. 12-21) brings together the above EA guidance specific to construction sites, likely pollutants and pathways and provides guidance on the type and location of suitable control measures.

12.2.24 C697 - The SuDS Manual (Ref. 12-22) provides best practice guidance on the planning, design, construction, operation and maintenance of SuDS systems.

12.3 Assessment Methodology and Significance Criteria

12.3.1 During the production of this Chapter, consultations have been carried out with the following bodies:

- Environment Agency; and
- Thames Water.

12.3.2 Full details of these consultations is provided in *Appendix G-2 of ES Volume III.*

12.3.3 Additional data has also been collected from the following sources:

- Ordnance Survey Explorer 161 London South 1:25,000 Scale Map (Ref. 12-23);
- BGS Map Sheet 270, South London, Solid and Drift Edition 1:50 000 Series (Ref. 12-24); and
- Thames Water asset location plans (Ref. 12 -25).

12.3.4 Data has also been collected from the following site specific reports:

- Generic Quantitative Environmental Risk Assessment, August 2010 - Waterman Energy, Environment and Design Limited (Ref. 12-26) (*Appendix F-3 of ES Volume III*); and
- Geotechnical Report, August 2010 - RSK Group PLC (Ref. 12-27) (*Appendix F-2 of ES Volume III*).

12.3.5 The methodology used to identify the baseline conditions at the site involved the following stages:

- Identification of potential surface water and groundwater receptors and determination of their current use, quality, trends in quality, levels of protection afforded them by any impermeable strata and any links between receptors;
- Determination of the short-term, medium-term and long-term impacts of development on these receptors;
- Evaluating the significance of the impacts relative to the quality and quantity of the receptors; and
- Identification of suitable and appropriate mitigation measures, if any, for all stages of the development's life (i.e., demolition, construction and operation) and an indication of how these measures will affect the significance of any impacts.

12.3.6 The significance criteria used for water resources are:

- **Extreme:** These effects represent key factors in the decision-making process. They are generally, but not exclusively associated with sites and features of national importance and resources/features which are unique and which, if lost, cannot be replaced or relocated.
- **Major:** These effects are likely to be important considerations at a regional or district scale but, if adverse, are potential concerns to the project, depending upon the relative importance attached to the issue during the decision making process.
- **Moderate:** These effects, if adverse, while important at a local scale, are not likely to be key decision making issues. Nevertheless, the cumulative effect of such issues may lead to an increase in the overall effects on a particular area or on a particular resource.
- **Minor:** These effects may be raised as local issues but are unlikely to be of importance in the decision making process. Nevertheless, they are of relevance in the detailed design of the project.
- **Negligible**: Effects which are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error.

12.4 Baseline Conditions

12.4.1 The baseline scenario is taken as the site and surrounding area in its present pre development state.

Surface Water Features

12.4.2 The site is immediately to the south of the River Crane and approximately 550m to the northwest of the River Thames.

12.4.3 The River Crane is a tributary of the River Thames and is approximately 13.6km in length rising in Hillingdon and flowing south to join the River Thames at Isleworth.

12.4.4 The River Thames rises in the Cotswolds and flows approximately 350km to the east, draining a catchment area of approximately 13,000km^2 and discharging via the Thames Barrier to the North Sea. The river is tidal downstream of Teddington Lock which is located approximately 2.3km upstream of the development site.

12.4.5 There are no watercourses crossing the site.

Figure 12-1 Site Location in relation to the River Crane and River Thames

Surface Water Quality

12.4.6 The EA monitors the River Crane and the River Thames water quality.

12.4.7 The EA currently operates a number of water quality monitoring stations along the River Thames where chemical, biological and nitrate concentrations are monitored each month. A General Quality Assessment (GQA) is applied to chemical, biological and nitrate concentrations and graded 'A' (Very Good) to 'F' (Bad), for chemistry and biological concentrations, and '1' (Very Low) to '6' (Excessively High), for nitrates.

12.4.8 The River Crane is currently classified as Grade 'C', fairly good.

12.4.9 The River Crane was tested as part of the Generic Quantitative Environmental Risk Assessment dated August 2010 undertaken by Waterman Energy, Environment and Design. No evidence of visual or olfactory contamination was observed in the samples taken.

12.4.10 The closest water quality monitoring point on the River Thames is at Teddington Lock approximately 2km to the south of the site and the most recent records classify the river as Grade 'B', good.

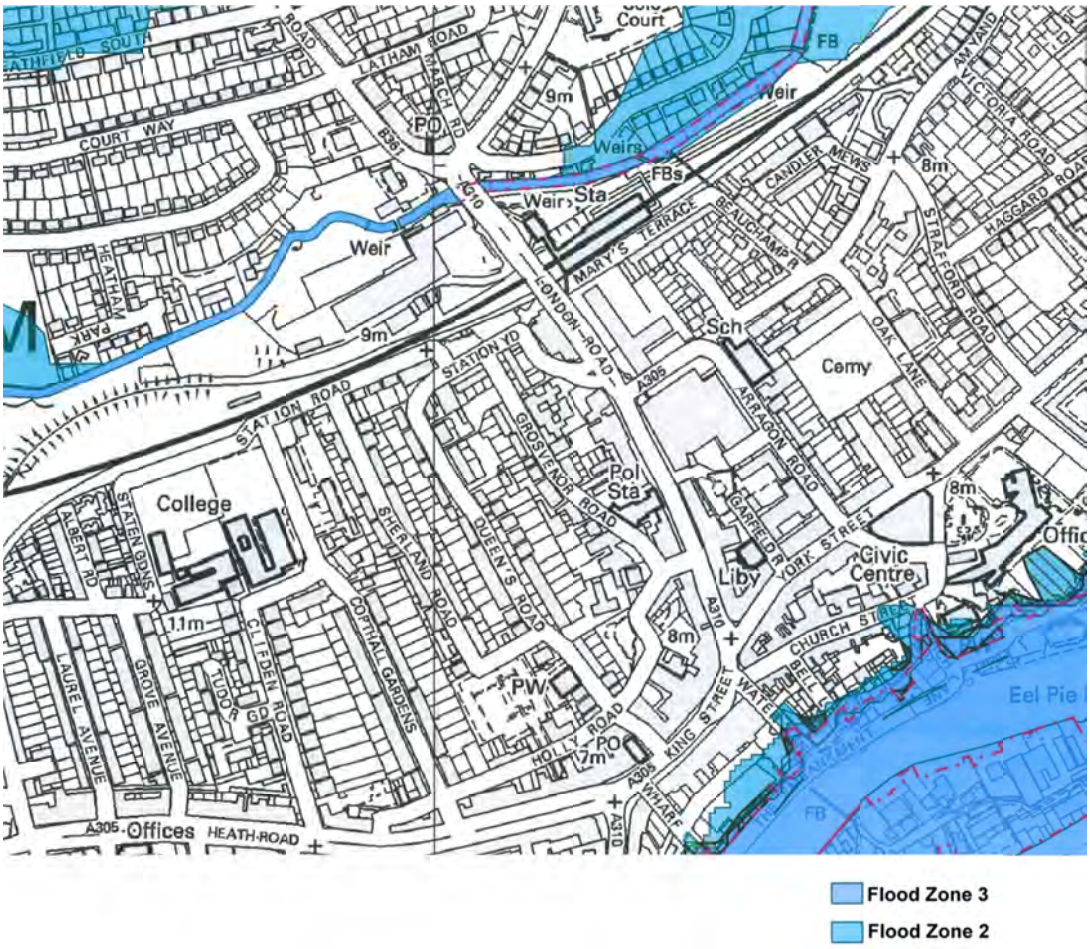
12.4.11 There are no surface water abstractions for drinking water identified in the vicinity of the site.

12.4.12 There are three surface water discharges within a 500m radius of the Site. The closest is located approximately 5m to the northwest licensed to Mr S Pannifer (private dwelling) for the discharge of "other matter surface water" to the River Crane.

Flood Risk

12.4.13 The site lies within Flood Zone 1 as shown on the EA Flood Map (Figure 12-2). This low-risk zone comprises of land assessed as having less than a 1 in 1000 annual probability of fluvial flooding in any given year.

Figure 12-2 EA Flood Map



12.4.14 The Flood Risk Assessment, a copy of which is provided within *Appendix G of ES Volume III* of this ES confirmed the following:

- Neither the Environment Agency nor Thames Water hold any record of flooding in the area.
- The site is located within Flood Zone 1 a minimum of approximately 650mm above the level of a 1 in 100 year return period fluvial flood event including the predicted effects of climate change.
- The Environment Agency's Modelled Flood Extent Map confirms that safe dry access will be available throughout the duration of a 1:1000 return period fluvial event.

Geology

12.4.15 The site Investigation undertaken by RSK Group (*Appendix F-2 of ES Volume III)* confirms made ground of between 1 and 2m in depth underlain by the Kempton Park Gravels extending a further 6.5 to 7 m in depth underlain by London Clay

12.4.16 The made ground comprises dark brown slightly silty sandy gravel of flint, with frequent red brick, crushed stone and concrete. Occasional ash and clinker was also apparent, together with rare tile, glass, and pottery.

12.4.17 Elevated contamination of Arsenic, Lead, Mercury, Vanadium, Naphthalene, Benzo(a)anthracene, Chrysene, Benzo(b)flouranthene, Benzo(k)flouranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene and Di-benzo(a,h)anthracene) has been identified in soils beneath the site.

Groundwater

12.4.18 Groundwater has been recorded at 4.5m AOD, approximately 3.5m below the lowest ground level on site.

12.4.19 The Generic Quantitative Environmental Risk Assessment dated August 2010 undertaken by Waterman Energy, Environment and Design Limited (*Appendix F-3 of ES Volume III)* confirms the results of the groundwater quality testing taken from three samples. On site samples were recorded as light brown/orange in colour and of cloudy-medium solid content. The samples had no odour, sheen or floating product.

12.4.20 Limited marginally elevated contamination (Iron and Chromium) was identified within the shallow groundwater at the site.

12.4.21 The Draft River Basin Management Plan (RBMP) for the Thames River Basin District dated December 2008 (Ref. 12-28), confirms that 43% of groundwater bodies in the Thames River Basin District are achieving good chemical status.

Groundwater Abstractions and Discharges

12.4.22 There are no recorded groundwater abstractions within a 1km radius of the Site. The closest is located approximately 1,050m to the northeast of the Site and is registered to St Margaret's Recreation Ground. The abstraction is for a private non-industrial amenity sited as a "lake and pond through flow".

12.4.23 The site is not located within a groundwater protection zone.

Water Supply

12.4.24 Thames Water has water mains beneath the A310 London Road immediately west of the site and beneath Mary's Terrace immediately to the south.

12.4.25 The water main beneath Mary's Terrace is a 3" diameter distribution main and those beneath the A310 London Road comprise a 6" distribution main and a 33" trunk main

12.4.26 The EA's consultation on 'Identifying Areas of Water Stress for the UK' (Ref. 12-29) identifies London as an area of serious water stress. The Thames Water water supply network is of high importance for the supply of water locally and district level.

Drainage Network

12.4.27 Initial investigations suggest that surface water from the site is positively drained to the 225mm diameter public sewer in Beauchamp Road to the south east of the site.

12.4.28 Foul drainage from the site is discharged to the existing 375mm diameter public foul sewer beneath the A310 London Road at the northwest corner of the site.

12.5 Site Preparation and Construction Impacts and Mitigation Measures

12.5.1 The proposed development involves the construction of three blocks which are referred to as Block A, B and C with a combined footprint of approximately 2,855m^2 to replace the existing station building.

12.5.2 Block A is maximum of 7 storeys from London Road, Block B a maximum of 7 storeys from London Road and Block C 4 Storeys from the River Crane.

12.5.3 The buildings will incorporate undercroft car parking predominantly under Blocks A and B at the River Crane Level with a mezzanine area for cycle parking.

12.5.4 Details regarding construction of the proposed development and a more detailed description of the design are presented in *Chapter 5: Demolition and Construction* and *Chapter 4: The Proposed Development* of this ES respectively.

12.5.5 The potential sources, pathways and receptors in the context of water resources for the site preparation and the construction phase are presented in Table 12-1.

Table 12-1 Potential Sources, Pathways and Receptors for Consideration During the site Preparation & Construction Phases

Sources
Demolition activities/site preparation materials
Localised soil and groundwater contamination in Made Ground and underlying strata
Off-site soil and groundwater contamination migrating on-site
Increase in water supply and waste water discharge
Pathways
Creation of direct contact pathways to ground and surface water
Foundations and Piling
Existing buried obstructions, foundations and party walls
Service routes
Thames Water sewage infrastructure
Migration of groundwater
Receptors
Water Quality of the River Crane and the River Thames
Groundwater
Upstream water supplies, downstream Sewage Treatment Works

12.5.6 Pollution sources arising from demolition and construction, which could impact surface and groundwater comprise of the following:

- Suspended sediments;
- Oils and hydrocarbons;
- Concrete and cement products;
- Disturbance of groundwater;
- Disturbance of contaminated land;
- Preferential Pathways; and
- Disturbance of drainage systems.

12.5.7 Other impacts associated with the demolition and construction phase comprise:

- Additional water demand; and
- Additional wastewater generation.

Suspended Sediments

12.5.8 Potential sources of suspended sediments during the demolition and construction of the proposed development include excavations, exposed ground and stockpiles, plant and wheel washing and dust and sediment generated during demolition. The major pathway for suspended sediments to reach controlled water bodies is through runoff during rainfall events or when areas are being washed down.

12.5.9 Suspended sediments can result in the suffocation of fish, smothering of plants and reduced levels of light within water bodies. Organic matter contained within the sediment can increase the Biological Oxygen Demand (BOD) of the water and result in a lowering of dissolved oxygen. Suspended sediments are also a major transport mechanism for low-solubility contaminants that can bind to sediment particles and enter water bodies resulting in adverse impacts to the receiving water.

12.5.10 The release of potentially polluted suspended sediments could have a moderate adverse and therefore moderate impact on The River Thames in the event of a discharge.

12.5.11 A number of measures will be employed at the construction site to prevent the release of suspended sediments and reduce their impact to negligible. These comprise:

- Site access points which will be regularly cleaned to prevent build up of dust and mud.
- Earth movement will be controlled to reduce the risk of construction silt combining with the site runoff.
- Properly contained wheel wash facilities will be used where required, to isolate sediment rich runoff.
- Removal of silt from site runoff through the use of settlement tanks to allow discharge through the existing surface water sewer without potential impacts downstream. If space is limited, silty water will be stored and removed from site by tanker and disposed of at a suitably licensed location. A discharge consent detailing volumes and rates of

discharge will need to be agreed with Thames Water prior to the commencement of works.

12.5.12 Adoption of these measures will minimise the potential for uncontrolled release of sediment into active drainage systems and should potentially result in a minimal impact on the drainage system and surface waters and therefore be of negligible significance. Mitigation measures will be implemented through the Demolition and Construction Management Statement and Environmental Management Plan. Further details are provided in *Chapter 6: Site Preparation and Construction*.

Oils and Hydrocarbons

12.5.13 The main source for oils and hydrocarbons at the site will be from plant, machinery and from fuel storage.

12.5.14 The release of oils and fuel can result in additional loadings on downstream sewage treatment works and a reduction in quality of local groundwater. If oils are released via the public sewers the result can have a major effect on aquatic life and reduce the quality of industrial and potable abstractions. Oils also bind to sediments and breakdown by microbes can lower the dissolved oxygen content of the water.

12.5.15 Measures will be taken to protect controlled waters from the release of oils and hydrocarbons, which would otherwise have a moderate adverse impact that would be of moderate significance on surface water and groundwater resources at the site. These measures comprise:

- Oils and hydrocarbons will be stored in designated locations with specific measures to prevent leakage and release of their contents, including the siting of storage areas away from surface water drains and on an impermeable base with an impermeable bund with no outflow and capacity to contain the contents plus an additional 10%.
- Wherever possible, plant and machinery will be kept away from the drainage system and will have drip trays beneath oil tanks/engines/gearboxes/hydraulics which will be checked and emptied regularly via a licensed waste disposal operator.
- An emergency spillage action plan will be produced, which site staff will have read and understood, On-site provisions will be made to contain a serious spill or leak through the use of booms, bunding and absorbent material.

12.5.16 With these control measures, potential impacts associated with the release of oil and fuel during construction works are likely to be minimal and therefore of negligible significance.

12.5.17 Implementation of the above measures does not exclude the possibility of an accidental spillage of oils and fuels, the impact of which is dependent upon the volume lost to ground. Although an emergency spillage plan will be designed and implemented through the construction programme to minimise the impact of such an event, accidental spillages still have the potential to result in a medium, adverse impact, which could be of moderate significance.

Concrete and Cement Products

12.5.18 Concrete and cement products are highly alkaline and their release into controlled waters could have a **moderate adverse** impact on aquatic life and on the water quality in general.

12.5.19 A number of precautions will be taken on the site to mitigate the potential impacts from concrete and cement products. These include:

- The majority of concrete used will be pre-mixed and delivered from an off-site source, thereby negating the need to mix concrete on-site and reducing the creation of alkaline wastewater.
- Wherever possible, any mixing and handling of wet concrete on-site will be undertaken in designated areas, away from any drainage channels or surface water.
- A designated area will be used for any washing down or equipment cleaning associated with concrete or cementing processes and wastewater will be discharged to the foul drainage system or contained and removed by tanker to a suitable discharge location.

12.5.20 With these control measures, the impacts associated with concrete and cement products are considered likely to be minimal and therefore of negligible significance.

Disturbance of Groundwater

12.5.21 Site investigation confirmed groundwater at a dept of approximately 3.5m from the lowest part of the site.

12.5.22 The following measures will be considered for controlling groundwater during excavations, if required:

- Any perimeter walls will be capable of preventing seepage of water during excavation.
- Water arising from excavations will be discharged to the local sewer network via settlement facilities. However restrictions may apply if the water is found to be contaminated.

12.5.23 With these control measures in place, the impacts on groundwater at the site are likely to be minimal and therefore **negligible**.

Disturbance of Contaminated Land

12.5.24 Disturbance of potentially contaminated soils during the construction phase may adversely affect groundwater quality.

12.5.25 Due to the historical land uses around the site it is possible that hot spots of contamination could exist, with the potential for disturbance and mobilisation of contaminants into drains, watercourses, or groundwater. In the event that contamination is discovered, work will stop immediately and measures be taken to prevent disturbance and mobilisation of contaminants.

12.5.26 Stockpiling of possible contaminated excavated materials and appropriate management, such as positioning away from any drainage systems and subsequent covering to prevent runoff or infiltration of contaminants will minimise the risk of pollution of water bodies.

12.5.27 Depending on the results of the risk assessment process described in *Chapter 11: Ground Conditions*, contaminants present within the made ground underneath the site may be treated prior to development by:

- Removing, treating or isolating any contamination hotspots under hard standing material; and
- Providing a clean subsoil or topsoil capping or covering layer in landscaped areas.

12.5.28 With the appropriate methodology and control measures in place the impacts on water resources associated with the presence of undiscovered areas of contamination on-site are considered to be minimal and therefore **negligible**.

Preferential Pathways

12.5.29 Piling associated with the construction of building foundations may potentially create a pathway for contaminants found in made ground to reach deeper groundwater. The potential impact would therefore be classed as medium, which in light of the medium importance of the groundwater quality of the attribute would result in a potentially of **minor adverse** residual impact.

12.5.30 Old boreholes may be present at the site and could provide a preferential pathway for contaminated runoff to enter underground strata.

12.5.31 In order to reduce the movement of contamination via these pathways, a number of measures will be undertaken, which are:

- The use of geotextile bunding to isolate and minimise the ingress of surface water runoff to non-decommissioned boreholes;
- Decommissioning of exposed boreholes; and
- Isolation of the area around piling operations from surface water until piling is complete.

12.5.32 The adoption of these measures will reduce the residual impact from preferential pathways to minimal and therefore **negligible**.

Disturbance of Drainage systems

12.5.33 Disturbance of the existing drainage network increases the likelihood of pollutants being re-released in an uncontrolled manner. During demolition and construction on site wastewater generation is expected to be limited. There are no public sewers crossing the site and no inbound flows are expected. The on-site drains will transport surface water and any wastewater generated and may contain suspended sediments, oils and hydrocarbons, sewage, alkaline water and any other potential contaminants that may have been used on site. Release of these contaminants could potentially lead to a **moderate adverse** impact.

12.5.34 A number of measures will be implemented on site to prevent the release of such contaminants. The measures described below are intended to reduce the number of situations whereby pollutants may arise, and to restrict their passage to controlled waters therefore reducing the impact from medium adverse to minimal and therefore of low or **negligible** significance.

- All existing utilities will be identified and marked prior to works commencing;
- Signs will be used to warn of the presence of the drainage system;
- Any damage to the drainage network will be immediately repaired; and
- An emergency action plan will be produced to ensure spillages and leakages are immediately contained.

Water Demand

12.5.35 Processes during the construction phase of the proposed development which may require significant volumes of water supply include sanitary facilities for site staff, dust suppression, wheel washing and washing down of construction areas.

12.5.36 The mixing of concrete (which also requires a significant volume of water) will be undertaken off site and will not contribute directly to the proposed development's supply needs.

12.5.37 The water supply to the site during the construction phase will be provided by the existing Thames Water network in the surrounding area and that the supply for construction purposes will require a Building Water Supply licence from Thames Water.

12.5.38 Any increase in water supply to the site is unavoidable but temporary and will be mitigated by the use of water efficient fixtures and fittings within the temporary offices in use during construction, and by the avoidance of wastefully using water during site processes.

12.5.39 Water supply for construction processes may at worst case represent a temporary minor adverse impact by increasing supply volumes to the site compared to the existing site usage. Due to the high importance rating on the water supply network, there could be an impact of **minor adverse** significance at a local level.

Wastewater Generation

12.5.40 Wastewater generation on construction sites include effluent from sanitary facilities provided on-site, also sediment laden water from washing down and wheel wash facilities. It is expected that foul water generated at the site will be drained via the existing public foul sewer beneath Marys Terrace. The demolition and construction activities are likely to increase the volumes of wastewater generated.

12.5.41 It is anticipated that the impact of construction on wastewater generation will be low adverse and of temporary duration and due to the high importance rating on the drainage network there could be an impact of minor significance at a local level.

12.6 Operational Impacts and Mitigation Measures

12.6.1 The potential sources, pathways and receptors in the context of water resources for the Completed Development are presented in Table 12-2.

Table 12-2 Potential Sources, Pathways and Receptors for Consideration During the site Operational Phase

Sources
Residual localised soil and groundwater contamination in Made Ground and underlying strata
Off-site soil and groundwater contamination migrating on-site
Increased demand for water utilities
Pathways
Creation of direct contact pathways to ground and surface water
Lateral migration of groundwater
Site layout and topography (hard standing, surface water drains)
Drainage/service runs
Foundations and piles
Thames Water Utilities sewage infrastructure
Receptors
River Crane and River Thames
Shallow groundwater within the Kempton Park Gravel Formation
Deep groundwater within the Lambeth Group, Thanet Sand and Chalk Aquifers
Buildings and property, including foundations and underground services

12.6.2 The operational use of the proposed development is likely to result in a lesser impact to the environment compared to those from the demolition and construction processes. Impacts on water resources from the built environment relate to the following areas:#

- Pollution
- Contamination from in-situ materials
- Flood risk
- Physical disturbance of groundwater
- Additional water demand
- Additional wastewater generation

Pollution

12.6.3 Possible sources of pollution from the proposed development will be oil and fuel leaks in the vicinity of parking facilities. The release of oils and chemicals in polluted runoff is anticipated to have a negligible to minor adverse impact on the water environment as the quantities are likely to be relatively small and dilution will be available within the environment. Such contaminants can however accumulate in shallow soils and groundwater, potentially resulting in a minor to moderate adverse impact.

12.6.4 The main pathway for these pollutants to impact the groundwater environment is via infiltration through soft landscaped areas. However, due to the large areas of impermeable surfaces at the site, it is expected that this is likely to have a minimal impact and therefore **negligible** effect on the underlying groundwater.

12.6.5 In the unlikely event that oils enter the on site drainage system there is a risk of them entering the River Thames through the public sewers. The low volume of any potential spill will result in a low adverse event. The high importance of the River Thames makes this an impact of moderate significance.

12.6.6 The site will be predominantly hard paved with an impermeable surface and positive drainage system incorporating hydrocarbon interception and the risk associated with infiltration of pollutants into the groundwater is considered to be low and the impact therefore **negligible**.

Contamination from In-Situ Materials

12.6.7 Ground water has been recoded at a depth of 3.5m at it shallowest and the impact on groundwater quality from the proposed structure is likely to be minimal and therefore **negligible**.

12.6.8 All drainage/service runs will be surrounded by appropriate granular bedding materials and located above the level of any shallow groundwater. Tests of the new systems may need to be carried out during construction and the effect of any permanent horizontal pathways on water flows is considered to be **negligible**.

Flood Risk

12.6.9 An assessment of the impacts of the development on flood risk at the site is provided within *Appendix G of Volume III* of this ES. This states that the proposed development is in Flood Zone 1, at low risk from fluvial and tidal flooding. Redeveloping a brownfield site to a more vulnerable use in a low risk flood zone is considered to be a **negligible** impact

12.6.10 The proposed development will marginally increase the impermeable area of the existing site.

12.6.11 The surface water from the site will discharge to the 225mm diameter public sewer in Beauchamp Road to the south east of the site using the existing private on site drainage connection.

12.6.12 In order to retain the current rate of discharge to the existing surface water drainage system during normal storm events, whilst providing additional protection to the site for more intense storms and a benefit to the wider area the surface water discharge from the site will be restricted to 30l/s.

12.6.13 On site storage will be provided to accommodate the volume of water experienced on storms of up to a 1:100 year intensity including a 30% increase to account for the predicted effects of future climate change.

12.6.14 Detailed design features will incorporate suitable SUDS drainage systems such as voided sub bases to external works, oversized pipes, below ground storage tanks or a combination thereof..

12.6.15 Based on the implementation of these measures, the proposed development will have a low, beneficial effect and therefore a **minor beneficial** impact on overall flood risk associated at the site and elsewhere.

Physical Disturbance of Aquifers

12.6.16 The proposed development involves the construction of sizeable structures that have the potential to induce minor ground settlement.

12.6.17 The Geotechnical Report dated August 2010 undertaken by RSK Group PLC confirms that the development is unlikely to have any affect on shrinking or swelling of the underlying clay formations. The impact is considered **negligible**.

Water Demand

12.6.18 It is estimated that the water demand of the development will be approximately 31,000 l/day.

12.6.19 Thames Water will need to be consulted at the detailed design stage to confirm whether the existing infrastructure is adequate to supply the development.

12.6.20 The increase in water supply is expected to be significant and is considered in the short term to be of medium adverse impact and therefore moderate significance.

12.6.21 Given Thames Water's current water resourcing strategy and its duty to ensure the supply of adequate water for domestic purposes in accordance with the Water Industry Act 1991, the long-term impact on water demand is predicted to be **negligible** at a district scale.

Wastewater Generation

12.6.22 As with the existing buildings, the proposed development will, subject to agreement with Thames Water, discharge foul water into the public foul sewer located beneath the A310 London Road.

12.6.23 It is estimated that the waste water generation of the development will be approximately 29,500 l/day.

12.6.24 The wastewater flows will significantly increase from the existing development. If capacity of the sewers were reached then foul water could potentially be discharged directly into the River Thames via combined sewer overflows. This would cause a low short-term adverse impact of minor significance on the water quality of the Thames River.

12.6.25 Thames Water has a responsibility to maintain the drainage network to cope with additional loads and as a result the long-term impact is predicted to be **negligible** at a district level.

12.6.26 In March 2007, the 32km Thames Tunnel was given the go ahead to increase the capacity of London's sewer network by 1.5 million m^3 and a 14 week phase one public consultation on the initial proposals began on 13 September 2010.

12.6.27 The Tunnel will run beneath the River Thames from west London to Beckton, intercepting storm sewage and providing storage and transfer of sewage to Beckton sewage treatment works.

12.6.28 Construction is provisionally scheduled for 2012 for completion by 2020.

12.6.29 The proposals will increase the capacity of the Thames Water's sewer network and enable it to accommodate additional flows from the brownfield redevelopment sites across London.

12.6.30 The overall impact of the development on the network is therefore likely to be **negligible** at a district scale in the longer term.

12.7 Residual Impact Assessment and Conclusions

12.7.1 Tables 12-3 and 12-4 summarise the residual impacts on the water environment and their significance through the construction and operational phases respectively.

12.7.2 No significant impacts to water resources are expected through the construction phase of the proposed development provided that the mitigation measures as discussed above are applied. The impact of increased water demand and wastewater generation is anticipated to be of **minor adverse** significance.

12.7.3 The assessment also concludes that the operational development will have a negligible/minor beneficial impact on surface water runoff, flood risk, pollution and disturbance of groundwater.

12.7.4 Operational impacts from the proposed development are restricted to issues of available capacity within the downstream foul sewerage system and the resources to supply the site with adequate water. Without further information available capacity, the residual impact on this receptor is assumed to be of a short-term, **minor adverse** nature at a district scale.

12.7.5 Thames Water has a responsibility to ensure adequate water supplies and drainage capacity and the impact will therefore be **negligible** in the long term.

Table 12-3 Summary of Construction Impacts and Significance

Description	Nature of Impact	Geographic Scale	Significance
Impact associated with the release of suspended sediment	Minimal	Local	Negligible
Use and storage of hydrocarbon fuels and oils	Minimal	Local	Negligible
Use of concrete and cement products	Minimal	Local	Negligible
Disturbance to Groundwater	Minimal	Local	Negligible
Disturbance of contaminated land	Minimal	Local	Negligible
Preferential pathways	Minimal	Local	Negligible
Disturbance of the existing drainage network - re-release of pollutants into the sewerage system	Minimal	Local	Negligible
Water Demand	Low, Temporary, Adverse	Local	Minor
Additional wastewater generation	Low, Temporary, Adverse	Local	Minor

Table 12-4 Summary of Operational Residual Impacts and Significance

Description	Nature of Impact	Geographic Scale	Significance
Oils and Hydrocarbons	Minimal	Local	Negligible
Contamination from In-situ Materials	Minimal	Local	Negligible
Flood Risk	Low, Permanent, Beneficial	Local	Minor
Disturbance of Groundwater	Minimal	Local	Negligible
Water Demand	Low, Adverse (short-term) Minimal (long term)	Local District	Moderate (short-term) Negligible (long-term)
Wastewater Generation	Low, Adverse (short-term) Minimal (long term)	Local District	Minor (short-term) Negligible (long-term)

12.8 Cumulative Impact Assessment

12.8.1 The potential cumulative impacts associated with those schemes in the vicinity, which are under construction, consented or in for planning as described in *Chapter 2: EIA Assessment Methodology* have been assessed.

Construction Impacts

12.8.2 Cumulative impacts to water resources during construction and demolition processes are associated with the generation of sediments and the release into the surface water drainage network, spillage and leakage of oils and fuels, leakage of wet concrete and cement and disturbance of contaminated land and foul drainage.

12.8.3 As outlined above, measures exist to manage and control these impacts and reduce the magnitude and significance of any impacts to a minimum.

12.8.4 As a result of these control measures and the statistical likelihood that a site along the catchment will discharge into receiving surface waters or groundwater at the same time is unlikely, a cumulative impact is considered negligible.

Operational Impacts

12.8.5 It is possible that foul drainage from consented developments elsewhere, combined with the development impacts of the proposed development, could result in a moderate adverse and therefore significant impact to any downstream sewage treatment works, if the capacity is limited and assuming all foul drainage is directed to the same treatment plant.

12.8.6 Thames Water has a responsibility to accept flows from developments given planning consent in accordance with the Water Industry Act 1991 and no significant impact is anticipated in the long term.

12.8.7 An increase in water supply requirements at the site, coupled with increased requirements at other developments in the vicinity may put pressure on sources of water supply in the area (e.g. river, reservoirs and groundwater supplies), and may lead to a moderate adverse impact to water supply. However, given Thames Water's responsibilities no long term impact is expected and the cumulative impact is considered **negligible**.

12.9 References

Ref.12-1 The Water Resources Act 1991

Ref. 12-2 The Water Resources Act 1991

Ref. 12-3 The Environment Act 1995

Ref. 12-4 The Environmental Protection Act 1990

Ref. 12-5 Water Resources (Environmental Impact Assessment) (England and Wales) Regulations 2003

Ref. 12-6 The Groundwater Regulations 1998

Ref. 12-7 The Anti-Pollution Works Regulations 1999

Ref. 12-8 Planning Policy Statement 25 (PPS25) - Development and Flood Risk

Ref. 12-9 The London Plan: Spatial Development Strategy for Greater London Consolidated 2004 amended in 2008

Ref. 12-10 The Draft Replacement London Plan 2009

Ref. 12-11 Supplementary Planning Guidance: Sustainable Design and Construction May 2006

Ref. 12-12 The Mayor's Draft Water Strategy, 2009

Ref. 12-13 The Core Strategy of the LDF, 2009

Ref. 12-14 Pollution Prevention Guidelines Note 1 (PPG01) - General Guide to the Prevention of Pollution

Ref. 12-15 Pollution Prevention Guidelines Note 2 (PPG02) - Above Ground Oil Storage Tanks

Ref. 12-16 Pollution Prevention Guidelines Note 3 (PPG03) - Use and Design of Oil Separators in Surface Water Drainage Systems

Ref. 12-17 Pollution Prevention Guidelines Note 5 (PPG05) - Works in, near or liable to affect watercourses

Ref. 12-18 Pollution Prevention Guidelines Note 6 (PPG06) - Working at construction or demolition sites

Ref. 12-19 Pollution Prevention Guidelines Note 7 (PPG07) - Refuelling Activities

Ref. 12-20 Pollution Prevention Guidelines Note 21 (PPG21) - Pollution Incident Response Planning

Ref. 12-21 C532 - Control of Water Pollution from Construction sites: Guidance for Consultants and Contractors

Ref. 12-22 C697 - The SuDS Manual

Ref. 12-23 Ordnance Survey Explorer 161 London South 1:25,000 Scale Map

Ref. 12-24 BGS Map Sheet 270, South London, Solid and Drift Edition 1:50 000 Series

Ref. 12-25 Thames Water asset location plans

Ref. 12-26 Generic Quantitative Environmental Risk Assessment, August 2010 - Waterman Energy, Environment and Design Limited

Ref. 12-27 Geotechnical Report, August 2010 - RSK Group PLC

Ref. 12-28 The Draft River Basin Management Plan (RBMP) for the Thames River Basin District December 2008

Ref. 12-29 Identifying Areas of Water Stress for the UK (EA Publication)

13.1 Introduction

13.1.1 This chapter of the Environmental Statement (ES) assesses the potential impacts of the proposed development on Twickenham Railway Station, London Road, Twickenham, TW1 1BD (NGR: TQ 161 738). The Chapter has been written by Wardell Armstrong LLP. For the purposes of this Chapter, the term 'site' is used to refer to the proposed development area.

13.1.2 This chapter aims to:

- Describe the ecological baseline conditions within the proposed development area;
- Identify and evaluate the nature conservation/biodiversity interest present;
- Identify any potential impacts during construction and operational phases;
- Establish the magnitude and significance of those identified impacts;
- Identify mitigation measures to address significant impacts, and
- Assess any residual impacts and the need for any compensation.

Site Description

13.1.3 The site comprises approximately 0.96 hectares of an active railway station, associated hard standing car parking facilities, trees and scrub within a predominantly urban area. The site is restricted to the north by the River Crane and residential buildings. The south is defined by Mary's Terrace residential dwellings and a large office building (Regal House); further east the south is defined by railway lines and residential buildings. The London Road rail bridge and large Royal Mail sorting office defines the western boundary and the east is open to station approach. The site boundary is defined on the Extended Phase 1 Habitat Plan (*Appendix H-1 of ES Volume III)*.

13.1.4 The proposed development is restricted to a zone of influence in and adjacent to the site boundary. The zone of influence is defined by IEEM Guidelines for Ecological Impact Assessment (Ref. 13-1) as:

'The areas/resources that may be affected by the biophysical changes caused by activities associated with a project'.

13.1.5 The zone of ecological influence for the site occupies the development boundary, but also extends to the land surrounding the site, to a distance of 30m.

The Development Proposals

13.1.6 The proposed development comprises improvements to the railway station facilities, the construction of approximately 115 residential units and a new pedestrian footpath along the River Crane.

Scoping Stage

13.1.7 As part of the Environmental Impact Assessment (EIA) process, ecological constraints to the development and thus potential impacts were identified during the scoping phase of the project and resulted in the production of a Scoping Report. A baseline description for the site was derived from field survey findings and the acquisition of existing ecological records from a range of sources.

13.2 Planning Policy Context

Legislative Framework

13.2.1 Nature conservation policy is implemented by a series of areas, habitats and species designated under legislation from a local to an international level. The key pieces of legislation relevant to the proposed development are discussed below.

13.2.2 The Wildlife and Countryside Act 1981 (as amended) remains the primary UK mechanism for statutory site designation and protection, and the protection of individual species. Through it, areas of national or regional conservation value (in terms of their biological or geological interest) can be designated as Sites of Special Scientific Interest (SSSIs). This affords protection by way of limiting the activities which can be carried out on such sites, and imposing penalties for damage or destruction of the special interest. The Wildlife and Countryside Act also contains a number of schedules listing species subject to varying levels of protection. The provisions of the Wildlife and Countryside Act are modified and in some cases replaced by subsequent legislation contained within the Conservation (Natural Habitats &c.) Regulations 1994 and the Countryside and Rights of Ways Act (the 'CRoW Act') 2000.

13.2.3 EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna ('the Habitats Directive') was adopted in May 1992. The Annexes to this Directive list species and habitats identified as of 'community interest' and for which the Commission requires the establishment of a network of sites to protect examples of value at European level. These sites, called Special Areas of Conservation (SACs), in conjunction with Special Protection Areas (SPAs) designated under the Birds Directive, form a network of protected sites across Europe referred to as Natura 2000 Network.

13.2.4 The Conservation (Natural Habitats, &c.) Regulations 1994 transposed 'the Habitats Directive' into UK law. This legislation was strengthened, in line with the rest of Europe, in 2007 and 2009. Individual habitats and species are protected under these Regulations; those which received protection are listed in Annex I and Annex II of the Habitats Directive with additional bird species also listed in Annex IV of the Habitats Directive and Annex I of the Birds Directive.

13.2.5 The Hedgerows Regulations 1997, under Section 97 of the Environment Act 2005. The aim of the Regulations is to protect important hedgerows by controlling their removal through a notification system. To qualify for the regulations a hedgerow must meet the criteria, cultural or ecological, set out within the regulations.

13.2.6 The Countryside and Rights of Way Act 2000 strengthens the provisions of the 1981 Wildlife and Countryside Act both in respect of statutory sites such as SSSIs and protected species. It also places a statutory obligation on local authorities and other public bodies to further conservation of biodiversity in the exercise of their functions, thus providing a statutory basis to the Biodiversity Action Plan (BAP) process which begun with the Governments publication of the UK Biodiversity Action plan in 1994.

13.2.7 Biodiversity Action Plans – The British government was one of over 150 signatories to the Convention on Biological Diversity at the Earth Summit in Rio de Janero in 1992. Biodiversity: The UK Action Plan in 1994 and subsequent UK Steering Group Report established a national framework for biodiversity but also emphasises the importance of action through biodiversity action plans at a local level. Practical measures to safeguard biodiversity are described in the UK Biodiversity Action Plan (BAP).

13.2.8 The key legislation for individual species that are relevant to this project is summarised in Table 13-1.

Table 13-1 Protected Species Legislation

Species	Key legal protection
Birds	All wild birds, their nests and eggs are, with few exceptions, fully protected by law. In addition, over eighty species or groups of species, are listed under Schedule 1 of the *Wildlife and Countryside Act.* These species are specially protected by increased penalties and cannot be intentionally disturbed when nesting, with additional protection also provided to species listed in Annex IV of the *Habitats Directive.*
Bats	All bat species are protected in accordance with Schedule 5 of the *Wildlife and Countryside Act (1981, as amended)*. This protection extends to both the bats themselves and roost sites. Bat roosts are protected at all times of the year regardless of whether bats are present at the time. In addition, all bats are listed under Annex II of the European Unions *Habitats Directive*. Bat species have been identified as Biodiversity Action Plan species. Where a project or plan has been identified as impacting on a bat roost, the appropriate authority (in England, Natural England) can issue licenses which make otherwise illegal actions lawful, e.g. closing a roost. Such licenses can, however, only be issued for "preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment." Likewise, licenses for bat species can only be issued if there is no alternative solution and sufficient mitigation is provided to ensure that overall the species will not be subject to any significant adverse impact(s).
Otter (*Lutra lutra*)	The otter is fully protected under the *Wildlife and Countryside Act* making it an offence to damage, destroy or obstruct access to any structure or place which is used by otters. Otter is also listed under Annexes II and IV (a) of the European Union *Habitats Directive.*
Water vole (*Arvicola terrestris*)	The water vole is now fully protected under the *Wildlife and Country Act 1981 (as amended)*. The legal protection makes it an offence to intentionally damage, destroy or obstruct access to any structure or place which water voles use for shelter or protection, or to disturb water voles whilst they are using such a place. As of the 6th April 2008, it is now an offence to intentionally kill, injure or take a water vole.
Reptiles	All native reptiles are listed on Schedule 5 of the *Wildlife and Countryside Act* and are afforded different levels of protection. For the four most commonly occurring species (adder *Vipera berus,* grass snake *Natrix natrix*, slow-worm *Anguis fragilis* and common lizard (*Zootoca vivipera*), the protection extends to killing and injury although does not include habitat protection.

Species	Key legal protection
Great crested newt (*Trituris cristatus*)	Protected under the *Wildlife and Countryside Act* and under Annex II and IV(a) of the European Union's *Habitats Directive*. Under the legal protection afforded great crested newt it is an offence to knowingly kill, harm, injure or disturb a great crested newt or its habitat. It is also an offence to damage, destroy or obstruct access to any structure or place used for shelter protection or breeding by the species; or to disturb it while it is occupying such a structure or place. Where a project or plan has been identified as impacting on great crested newt, the appropriate authority (in England, Natural England) can issue licenses which make otherwise illegal actions lawful. Such licenses can, however, only be issued for "preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment." Likewise, licenses for species such as great crested newt can only be issued if there is no alternative solution.

National Policy

13.2.9 Planning Policy Statements (PPS) set out the Government's national policies on different aspects of planning in England. PPS9 sets out planning policies on protection of biodiversity and geological conservation through the planning system. These policies complement, but do not replace or override, other national planning policies and should be read in conjunction with other relevant statements of national planning policy. This PPS replaces Planning Policy Guidance Note 9 (PPG9) on nature conservation published in October 1994.

13.2.10 A joint Office of the Deputy Prime Minister (06/2005) and Department of Environment, Food and Rural Affairs (01/2005) Circular is published to accompany PPS9. This sets out the wide range of legislative provisions at the international and national level that can impact on planning decisions affecting biodiversity and geological conservation issues. The presence of a protected species is a material consideration for a local authority dealing with a planning application which would be likely to result in harm to the species or its habitat (paragraph 15 and 16, PPS9).

13.2.11 Paragraph 12 of PPS9 notes that "*networks of natural habitats* (such as the Crane Corridor) *are a valuable resource. Consequently, local authorities should aim to maintain such networks by avoiding or repairing the fragmentation and isolation of natural habitats through policies and plans. In addition, such networks should be protected from development, and, where possible, strengthened by or integrated within it*".

13.2.12 As part of its commitment to the Convention on Biological Diversity drawn up at the Earth Summit in Rio de Janeiro in 1992, the government published 'Biodiversity: The UK Action Plan' (DOE 1994). Following this a National Biodiversity Action Plan was produced and Species and Habitat Action Plans (SAPs and HAPs respectively) drawn up for key species and habitats. The SAPs and HAPs set out targets for retention and enhancement of the identified key habitats and species.

13.2.13 Many counties now have their own local Biodiversity Action Plans (LBAPs) which set out objectives for their own localities.

Regional Policy

The London Plan: Spatial Development Strategy for Greater London 2008

13.2.14 The London Plan: Spatial Development Strategy for Greater London (Consolidated with Alterations since 2004) was published in February 2008 by the Greater London Authority. It is the strategic spatial planning document for London and endorses the protection of land of strategic importance for biodiversity. In addition, it stresses the requirement for development proposals to include new or enhanced natural habitats, or design and landscaping that promotes biodiversity, the greening of the built environment and associated provisions for its management.

13.2.15 Among the key objectives of the London Plan are to: "*…protect and improve Metropolitan Open Land, other designated open spaces, the Blue Ribbon network and Green Grid*".

13.2.16 Policy 3C.21 concerning walking includes the aim: "*…to identify, complete and promote high quality walking routes including the six strategic walking routes identified in the Mayor's Transport Strategy*". This links with the proposals from Walk London to develop the Crane Walk as a Strategic Walking Route.

13.2.17 Policy 3D.11 on Open Space states that Development Plan Documents (DPDs) should: "*encourage functional and physical linkages within the network of open spaces and to the wider public realm, improve accessibility for all throughout the network and create new links based on local and strategic need*" and "*identify, promote and protect Green Corridors and Green Chains and include appropriate designations and policies for the protection of local open spaces that are of value, or have the potential to be of value, to local communities*".

13.2.18 Policy 3D.14 regarding Biodiversity and Nature suggests that: "*opportunities should be taken to achieve positive gains for conservation*" and "*…it is important that biodiversity is protected in areas where habitat restoration and re-creation would be appropriate to achieve the aims of the London HAPs*".

"*…Where appropriate, measures may include creating, enhancing and managing wildlife habitat and natural landscape and improving access to nature. Priority for both should be given to sites which assist in achieving the targets in Biodiversity Action Plans (BAPs) and sites within or near to areas deficient in accessible wildlife sites*".

"*…Where development is proposed which would affect a site of importance for nature conservation or important species, the approach should be to seek to avoid adverse impact on the species or nature conservation value of the site, and if that is not possible, to minimise such impact and seek mitigation of any residual impacts. Where, exceptionally, development is to be permitted because the reasons for it are judged to outweigh significant harm to nature conservation, appropriate compensation should be sought*".

13.2.19 Policy 3D.15 on Trees and Woodland states that: "*the Mayor and the boroughs should protect, maintain and enhance trees and woodland in support of the London Tree and Woodland Framework*".

13.2.20 Policy 3D.17 on London's countryside and the urban fringe indicates that: "*the Mayor will and boroughs should support sub-regional and cross-borough boundary urban fringe management through the Green Arc partnership initiatives…*"

13.2.21 Policy 4C.1 The Blue Ribbon Network notes that the Network "*includes the Thames, the canal network, the other tributaries, rivers and streams within London and London's open water spaces such as docks, reservoirs and lakes. The Mayor will and boroughs should recognise the strategic importance of the Blue Ribbon network when making strategies and plans, when considering planning applications and when carrying out their other responsibilities*."

13.2.22 Policy 4C.22 regarding Rivers, brooks and streams also states that: "*the Mayor will, and boroughs should, ensure that rivers, brooks and streams of all sizes are protected, improved and respected as part of the Blue Ribbon Network and as valuable entities in themselves. In particular, measures should be taken to improve the habitat and amenity value of such waterways*".

The Draft Replacement London Plan

13.2.23 A draft replacement Spatial Development for Greater London was published in October 2009. This draft replacement London Plan sets out an integrated economic, environmental, transport and social framework for the development of London over the next 20-25 years. Draft policies of relevance to planning within the context of this development have been considered.

Mayor's Biodiversity Strategy 2002

13.2.24 The major's Biodiversity Strategy details the Mayor's vision for protecting and conserving London's natural open spaces. The strategy aims to:

- Ensure that people have access to nature by creating new green spaces, improving existing ones and encouraging people to visit less well-known places;
- Protect wildlife habitats, stating that sites which are important for nature conservation should not be built on;
- Encourage businesses to incorporate green design into their development proposals; and
- Protect London's most vulnerable wildlife, for example, bats and birds.

Local Policy

London Borough of Richmond Upon Thames Local Development Framework

13.2.25 The London Borough of Richmond Upon Thames Local Development Framework (LDF) Core Strategy was adopted on 21st April 2009.

13.2.26 Policy CP4 regarding biodiversity states that: "*the Borough's biodiversity including the SSSIs and other Sites of Nature Importance will be safeguarded and enhanced. Biodiversity enhancements will be encouraged particularly in areas of deficiency (parts of Whitton, Hampton, Teddington, Twickenham and South Kew), in areas of new development and along wildlife corridors and green chains such as the River Thames and River Crane corridors*".

"*…Weighted priority in terms of their importance will be afforded to protected species and priority species and habitats in the UK, Regional and Richmond upon Thames Biodiversity Action Plans*".

13.2.27 Policy CP10 regarding open land and parks states that: "*The open environment will be protected and enhanced. In particular: The Borough's … green chains and green corridors will be safeguarded and improved for biodiversity…"*

13.2.28 Policy CP12 regarding the River Crane Corridor states that: "*The Council will improve the strategic corridor to provide an attractive open space with improvements to the biodiversity. Developments in and adjacent to the River Crane Corridor will be expected to contribute to improving the environment and access, in line with planning guidance*".

13.3 Survey and Assessment Methodology

13.3.1 The methodology described below details the desk study and field surveys and has been reported in accordance with the Institute of Ecology and Environmental Management (IEEM) guidance on Ecological Impact Assessment (EcIA). All ecological surveys undertaken for the EcIA were carried out by appropriately qualified and experienced Wardell Armstrong ecologists.

Desk Study

13.3.2 The desktop study involved conducting database searches for statutory and non-statutory designated sites, legally protected species and features of interest. An area of 5km surrounding the site was searched for internationally designated sites e.g. Special Protection Areas (SPAs) with all other statutory designated sites, non-statutory designated sites and records of protected/notable fauna and flora being searched for within 2km of the site. The central grid reference of the site (TQ: 161 738) was used as the central point for all searches. The baseline conditions were based on a review of existing available information including:

- MAGIC (Multi-Agency Geographical Information for the Countryside) website;
- Ordnance Survey mapping (to identify potentially notable habitats);
- Aerial photography (e.g. google mapping);
- Nature on the Map (Natural England website);
- Richmond Local Biodiversity Action Plan (LBAP);
- UK Biodiversity Action Plan (UKBAP);
- Greenspace Information for Greater London (GiGL).

13.3.3 The desktop study also involved consultation with the Planning Services at Richmond upon Thames London Borough Council.

Field Surveys

Phase 1 Habitat Survey

13.3.4 An Ecological walkover of the site was initially undertaken in January 2009 by two Wardell Armstrong ecologists; this survey was subsequently updated in June 2010. The area was surveyed to Phase 1 Habitat Survey standard with target notes made as appropriate.

13.3.5 Features of interest were mapped along with the following signs of protected species considered most likely to be found within the area:

- badger activity including setts, snuffle holes and latrines;
- suitable habitat for bats;
- suitable habitats for reptiles;
- invasive plants, such as Japanese knotweed (Fallopia japonica);
- signs of breeding birds and suitable nesting habitat;
- signs of water voles including latrines, burrows and feeding stations;
- signs of otters such as holts and spraints; and
- suitable habitat for amphibians, including great created newts.

13.3.6 Standard survey methodologies were adopted for all ecological surveys, based upon the following publication: Handbook for Phase 1 Habitat Survey: A technique for environmental audit (Ref. 13-2).

Bat Survey

13.3.7 Dusk emergence and dawn re-entry surveys were undertaken within the immediate vicinity of the potential roost sites on 24th/25th June 2010. The emergence survey was undertaken in the evening approximately thirty minutes before sunset and a further two and a half hours after. During the dawn survey the surveyors returned to site (the following morning) approximately ninety minutes before and fifteen minutes after sunrise. The site was also walked to record any bat foraging activity; particularly along the River Crane. A Batbox Duet and Creative Zen mp3 recorder was used to record any bats during the site survey. The recordings were analysed using BatScan V9. Species identification was made on the basis of the characteristics of the call including peak frequency.

Arboricultural Survey

13.3.8 An arboricultural survey was initially undertaken in January 2009 by two Wardell Armstrong ecologists; this survey was subsequently updated in June 2010. The area was surveyed to British Standard 5837 (Ref. 13-3). The survey included consultation and a desktop review. The purpose of the survey is to give detailed, independent, arboricultural advice on the trees present, in the particular context of potential development.

13.3.9 All trees within the site boundary with a stem diameter greater than 75mm at 1.5m from ground level are included within this report. Additionally, tree stumps, hedgerows and shrub masses and trees that are situated adjacent to the site that are within a distance of 12 times their stem diameter (or 10 times base diameter for multi-stemmed trees) are also included.

13.3.10 All inspections were made from ground level, using binoculars where necessary. Height measurements were estimated to the nearest metre, stem diameters were calculated from the stem circumference which was measured using a measuring tape. No digging or drilling was undertaken during this survey. The description of the trees has followed the following terminology:

- **Height -** measured in metres from the stem base. Where the ground has a significant slope the higher ground is selected.
- **Crown height** - measured in metres and is an indication of the average height at which the main crown begins.
- **Stem diameter -** measured in millimetres at 1.5m above the adjacent ground level (upslope on sloping ground) or immediately above the root flare for multi-stemmed trees.
- **Crown spread -** measured in metres and taken at the four cardinal points to derive an accurate representation of the crown.
- **Age class -** described as young, semi-mature, early-mature, mature, or over-mature.
- **Physiological condition -** classed as good, fair, poor, or dead. This is an indication of the health of the tree and takes into account vigour, presence of disease and dieback.
- **Structural condition -** classed as good, fair or poor. This is an indication of the structural integrity of the tree and takes into account significant wounds, decay and quality of branch junctions.
- **Life expectancy -** classed as; less than 10 years (<10), 10-20 years, 20-40 years, or more than 40 years (40+). This is an indication of the number of years before the removal of the tree is likely to be required.

Tree Categorisation

13.3.11 Tree categories (A/B/C & R) are in accordance with BS 5837:2005 Trees in relation to construction. Categorised trees are further sub-divided to depict their value in terms of arboriculture (1), landscape (2) or culture/conservation (3).

13.3.12 **Category A** trees are those for which retention is most desirable. They are identifiable on plans as light green. These trees are of high quality and value with a good life expectancy. They may be further sub-divided as follows:

- **A1 -** Trees that are particularly good examples; perhaps rare or unusual species, or forming an essential part of arboricultural features;
- **A2 -** Trees, groups or woodlands having a significant landscape impact or with excellent screening properties, or those softening the effect of existing structures;
- **A3 -** Trees, groups or woodlands are those having a significant conservation or historical value.

13.3.13 **Category B** trees are those for which retention is desirable. They are identifiable on plans as mid blue. These trees are of moderate quality and value with a significant life expectancy. They may be further sub-divided as follows:

- B1 – Trees that might be included in the high category but are downgraded because of their impaired condition;
- B2 - Trees that are usually present in groups forming distinct landscape features, thereby attracting a higher collective rating than they might as individuals;
- B3 - Trees with clearly identifiable conservational or cultural benefits.

13.3.14 **Category C** trees are those which could be retained. They are identifiable on plans as grey. These trees are of low quality and value, and are currently in adequate condition to remain until new planting could be established. They may be further sub-divided as follows:

- C1 - Trees that do not qualify in the higher categories;
- C2 - Trees that are present in groups or woodlands that do not form a distinct landscape feature;
- C3 - Trees with very limited conservational or other cultural benefits.

13.3.15 **Category R** trees are those recommended for removal. They are identifiable on plans as dark red. These trees are in such a condition that any existing value would be lost within 10 years. This may be due to any of the following:

- Failure is likely due to serious, irredeemable, structural defects;
- Removal of other category R trees will render them exposed and unstable;
- In serious, overall decline or are dead;
- Of low quality and suppressing adjacent trees of better quality;
- Diseases are present which may affect the health of adjacent trees.

13.3.16 These trees should be removed or treated in such a way as to safe-guard public health and structural health and to maintain any ecological value they provide.

Root Protection Area

13.3.17 In order to avoid damage to the roots or rooting environment of retained trees, the root protection area (RPA) is plotted around each of the category A, B and C trees. The RPA represents the minimum area which should be left undisturbed around each retained tree.

13.3.18 Once determined, the RPA is plotted on the Tree Constraints Plan (TCP) taking full account of the following factors which may change the RPA's shape but not reduce its area; to ensure adequate protection for the root system.

- The likely tolerance of the tree to root disturbance or damage, based on factors such as species, age and condition and presence of other trees. (For individual open grown trees only, it may be acceptable to offset the distance by up to 20% in one direction);
- The morphology and disposition of the roots, when known to be influenced by past or existing site conditions (e.g. the presence of roads, structures and underground services);
- The soil type and structure;
- Topography and drainage; and
- Where any significant part of a tree's crown overhangs the provisional position of tree protection barriers, these parts may sustain damage during the construction period. In such cases, it may be necessary to increase the extent of tree protection barriers to contain and thereby protect the spread of the crown. Protection may also be achieved by access facilitation pruning. The need for such measures, including the precise extent of pruning, should be assessed by an arboriculturist.

Above Ground Constraints

13.3.19 The current and ultimate height of category A, B and C trees is annotated on the TCP where this would cause unreasonable obstruction of sunlight or daylight to the development. This is represented by a segment with a radius from the centre of the stem equal to the height of the tree drawn from due northwest to due east indicating the shadow pattern through the main part of the day.

13.3.20 It should be noted that this varies between species and depends on foliage size and density. Additionally, the spatial relationship of the proposed development to the tree(s) affects the amount of sunlight received, the amount of sky visible from the development and the solar gain received by the development.

13.3.21 The current and ultimate height and spread of a tree is also a constraint due to its size, dominance and movement in strong winds. For this reason, as well as in relation to shading, the existing spread of branches and the future branch growth is taken into account as a constraint and should be taken into consideration in the design phase.

Tree Constraints Plan

13.3.22 The TCP provides information on the influence that trees on and adjacent to the site will have on the site layout design. This is a design tool which illustrates the below ground constraints, represented by the RPA, and the above ground constraints the trees pose by virtue of their size and position. The TCP for Twickenham is presented in *Appendix H-2 of ES Volume III*.

13.3.23 Each individual tree or group of trees were allocated a tree reference number. This number is recorded on the TCP. Survey sheets listing all referenced trees are attached as *Appendix H-3 of ES Volume III*.

Presentation of Results

13.3.24 This chapter follows the guidance presented in the IEEM guidelines for Ecological Impact Assessment (July 2006). Significance of impacts can be assessed by identifying ecological features, evaluating their importance and defining impacts. The IEEM guidelines define a significant impact as:

'an impact (adverse or positive) on the integrity of a defined site or ecosystem(s) and/or the conservation status of habitats or species within a given geographical area, including cumulative impacts.'

13.3.25 It, therefore, entails an analysis of the value of ecological features and magnitude of impact on such features.

Determining Value of Ecological Features

13.3.26 In order to objectively assess impacts arising from a particular development it is essential to establish the nature conservation value of each ecological feature/receptor likely to be affected by the proposals, both within and adjacent to the development area.

13.3.27 The importance of each ecological feature identified through desk study and survey is evaluated according to its importance in a geographical context, each falling into one (or more) of the following categories:

- International (in this case within the EU, unless stated otherwise);
- National (within the UK or England, depending on legislative scope);
- Regional (South East);
- County (London);
- District (Richmond upon Thames);
- Local (Twickenham);
- within zone of influence; or
- of negligible importance.

13.3.28 The conservation status of a site is defined in the *EC Directive 92/43/EEC* on the Conservation of Natural Habitats and of Wild Flora and Fauna (1992) as it relates to internationally designated sites. The IEEM guidance modifies the definition in order for it to be applicable to sites, habitats or species within any defined geographical area.

13.3.29 When a feature falls into more than one category, the highest level is considered to be the level at which the feature is evaluated. Some features can be readily assigned to one of the above categories, particularly sites that support designations. For example, a site with a designation assigned through European legislation such as a Special Area of Conservation (SAC) would be considered of International significance, an SSSI designated by UK statute would be of National importance and a site designated by a Local Authority would be of County or District importance.

13.3.30 Individual species may be protected under European or National legislation. Legal protection is relevant to the assignment of the value of species, but additional factors, such as population size and the nature of the distribution of the species are also considered within this account.

13.3.31 The assignment of undesignated features such as Biodiversity Action Plan habitats and species, or areas of ancient woodland may not fall clearly into the designations as described above. Therefore a number of other criteria are used to assess the nature conservation value of a defined area of land. Accepted criteria are set out in A Nature Conservation Review (Ref. 13-4) and include diversity, rarity, naturalness, intrinsic appeal, typicalness and recorded history.

13.3.32 Some features that are currently of no particular ecological interest in themselves may nevertheless perform an ecological function, e.g. because they act as a buffer against negative impacts, or because they enable in some other way the effective conservation of a more valuable feature.

13.3.33 Each ecological feature is described and evaluated in the 'Baseline Conditions' section of this Chapter.

Magnitude of Impact

13.3.34 Likely impacts on the ecological features occurring within the site have been identified through consideration of the nature of the proposed works. The impacts are characterised with reference to levels of certainty in the prediction of an impact occurring, the extent of the impact, its magnitude, duration of the impact, whether the impact is reversible, its timing and frequency and whether any of the impacts are cumulative in effect.

Evaluation of Significance

13.3.35 This comprises analysis of the interaction between the value of the ecological features and the nature and duration of impact. However, this is a complex process because, as indicated in the IEEM guidance, the impact may influence the conservation status and integrity of ecological features.

13.3.36 Thus, the definition in relation to habitats is as follows:

'conservation status is determined by the sum of the influences acting on the habitat and its typical species, that may affect its long term distribution, structure and functions as well as the long term survival of its typical species within a given geographical area.'

13.3.37 For species, conservation status is as follows:

'determined by the sum of influences acting on the species concerned that may affect the long term distribution and abundance of its populations within a given geographical area.'

13.3.38 The level at which an impact is assessed follows the IEEM guidelines but for continuity between chapters, DETR's 'Guidance on the New Approach to Appraisal' (Ref 13-5) has also been taken into consideration. Table 13-2 outlines how the significance of each impact has been described.

13.3.39 Any perceived residual impacts are also categorised as follows:

- **Short term:** those considered to be associated with the construction phase;
- **Medium term:** those considered to be associated with the construction phase;
- **Long term:** those considered to be associated with the completed, operational development.

Table 13-2 Impact Significance Criteria

Impact Significance	Significance Criteria
Extreme Adverse	Where the proposals may adversely affect the integrity of the site or its features that are of national importance and which, if lost cannot be replaced.
Major Adverse	Where the proposals may adversely affect the integrity of the site, in terms of the coherence of its ecological structure and function that enables it to sustain the habitat/complex of habitats and/or the population levels of species for which it is valued.
Moderate Adverse	Where the site's integrity will not be adversely affected, but the effects on the site is likely to be significant in terms of its ecological objectives (with reference to BAP or Local Plan).
Minor Adverse	If no expected impact does not apply, but some minor negative impact is expected.
Negligible	No expected impact.
Minor Beneficial	Where improvements provide general wildlife gain through, for example new design features (hedges, ponds, green roofing, etc.)
Moderate Beneficial	Where there is an expected net positive wildlife gain at the regional/metropolitan level, for example by significantly aiding the achievement of UKBAP objectives through the provision of sustainable new habitat.
Major Beneficial	Where there is an expected net positive wildlife gain at the national level, for example by significantly aiding the achievement of UKBAP objectives through provision of substantial new habitat.
Extreme Beneficial	Where there is an expected net positive wildlife gain at the international level, for example by significantly aiding the achievement of substantial new habitat and successful colonisation of protected species.

13.4 Baseline Conditions

Statutory Designated Sites

13.4.1 Consultation highlighted two internationally designated sites for nature conservation within 5km of the site boundary and two nationally designated sites for nature conservation within 2km of the site boundary:

- South-West London Water Bodies RAMSAR, Special Protection Area (SPA) comprises a series of embanked water supply reservoirs and former gravel pits that support a range of man-made and semi-natural open water habitats. The reservoirs and gravel pits function as important feeding and roosting sites for wintering wildfowl, in particular Gadwall (Anas strepera) and Shoveler (Anas clypeata), both of which occur in numbers of European importance. The closest of these reservoirs is situated within Richmond Park approximately 2.1km east of the site boundary.
- Richmond Park is situated approximately 2km east of the site boundary. The park has been designated a Special Area of Conservation (SAC), a Site of Special Scientific Interest (SSSI) and a National Nature Reserve (NNR) owing to its diverse habitats which support a number of rare invertebrates including stag beetles (Lucanus cervus).
- Ham Lands Local Nature Reserve (LNR) is situated approximately 650m south east of the site boundary. It has developed into a mosaic of different ecological zones that is important for wildlife and for educational purposes.
- Isleworth Ait LNR is an island in the River Thames, which is situated approximately 2km north east of the site boundary. Isleworth Ait is designated as a LNR owing to its importance for notable birds, invertebrates and molluscs.

Non-statutory Designated Sites

13.4.2 There are nineteen non-statutory Sites of Importance for Nature Conservation (SINC) within 2km of the site:

- Crane Corridor covers approximately 5km and is situated adjacent to the northern border of the site boundary;
- Moormead Park is situated approximately 350m northeast of the site boundary;
- River Thames and tidal tributaries is situated approximately 500m southeast of the site boundary;
- Twickenham Junction Rough is situated approximately 700m southwest of the site boundary;
- River Crane at St Margaret's is situated approximately 900m north of the site boundary;
- Marble Hill Park and Orleans House Gardens are situated approximately 920m east of the site boundary;
- River Crane at St Margaret's (Richmond side) is situated approximately 950m north of the site boundary;
- Duke of Northumberland's River south of Kneller Road is situated approximately 1.3km west of the site boundary;
- Petersham Lodge Wood and Ham House Fields are situated approximately 1.3km southeast of the site boundary;
- Duke of Northumberland's River north of Kneller Road is situated approximately 1.4km northwest of the site boundary;
- Ham Lands is situated approximately 1.5km southeast of the site boundary;
- Mogden Sewage Works is situated approximately 1.5km northwest of the site boundary;
- The Copse, Holly Hedge Field and Ham Avenues are situated approximately 1.6km east of the site boundary;
- Twickenham Road Meadow is situated approximately 1.6km northeast of the site boundary;
- Petersham Meadows is situated approximately 1.8km east of the site boundary;
- Terrace Field and Terrace Garden are situated approximately 2km east of the site boundary;
- Royal Mid-Surrey Golf Course is situated approximately 2km northeast of the site boundary;
- Strawberry Hill Golf Course is situated approximately 2km southwest of the site boundary;
- Teddington Cemetery is situated approximately 2km southwest of the site boundary.

Biodiversity Action Plans (BAPs)

13.4.3 The UK Biodiversity Action Plan (UK BAP) and the local Biodiversity Action Plan for Richmond (LBAP) are relevant for this site. A comprehensive list of the habitats and species listed on the Richmond LBAP are shown in Table 13-3.

Table 13-3 Richmond LBAP Habitats and Species

Habitat Action Plans (HAPs)	
Acid grasslands	Ancient parkland and veteran trees
Broad-leaved woodland	Tidal Thames
Reedbeds	
Species Action Plans (SAPs)	
Stag beetle (*Lucanus cervus*)	Song thrush (*Turdus philomelos*)
Mistletoe (*Viscum album*)	Water vole (*Arvicola terrestris*)
Bats (all species)	Tower mustard (*Arabis glabra*)

13.4.4 There are two areas of UKBAP priority habitat as defined on "Nature on the Map", situated within 2km of the site boundary. There is an area of lowland dry acidic grassland situated approximately 2km east of the site boundary and there is an area of mudflats situated approximately 2km north east of the site boundary.

Protected/Notable Species Records

Avifauna

13.4.5 Consultation with Greenspace Information for Greater London (GiGL) provided many records of avifauna within 2km of the site boundary. A summary of these records including the approximate distance of the closest record in relation to the site boundary are shown in Table 13-4. Consultation with the NBN Gateway identified no specific records of avifauna within 2km of the site boundary.

Badger (Meles meles)

13.4.6 Consultation with GiGL provided thirty five records of badger within 2km of the site boundary; the closest of which is situated approximately 900m south east of the site boundary. Consultation with the NBN Gateway identified no specific records of badger within 2km of the site boundary.

Bats

13.4.7 Consultation with GiGL identified four hundred and eighty six records of bats within 2km of the site boundary. A summary of these records including the approximate distance of the closest record in relation to the site boundary are shown in Table 13-5.

Table 13-4 Bird records provided by GiGL

Species	No. of records	Date	Closest record
House sparrow (*Passer domesticus*)	354	1998-2007	90m SE
Song thrush (*Turdus philomelos*)	258	1998-2006	300m N
Goldeneye (*Bucephala clangula*)	15	1987-2001	600m SE
Kingfisher (*Alcedo atthis*)	10	1987-2005	600m SE
Herring gull (*Larus argentatus*)	51	1987-2001	600m SE
Bullfinch (*Pyrrhula pyrrhula*)	11	1997-2006	600m SE
Dunnock (*Prunella modularis*)	111	1999-2002	900m S
Starling (*Sturnus vulgaris*)	78	1999-2005	1.1km W
Greylag goose (*Anser anser*)	1	1987	1.2km S
Smew (*Mergus albellus*)	1	1987	1.2km S
Hobby (*Falco subbuteo*)	8	1987	1.2km S
Golden plover (*Pluvialis apricaria*)	1	1987	1.2km S
Lapwing (*Vanellus vanellus*)	1	1987	1.2km S
Turtle dove (*Steptopelia turtur*)	2	1987	1.2km S
Cuckoo (*Curculus canorus*)	2	1987-1997	1.2km S
Lesser spotted woodpecker (*Dendrocopos minor*)	18	1987-2001	1.2km S
Skylark (*Alauda arvensis*)	2	1987	1.2km S
Sand martin (*Riparia riparia*)	1	1987	1.2km S
Tree pipit (*Anthus trivialis*)	2	1987	1.2km S
Yellow wagtail (*Motacilla flava*)	2	1987	1.2km S
Fieldfare (*Turdus pilaris*)	7	1987-2004	1.2km S
Redwing (*Turdus iliacus*)	5	1987-2007	1.2km S
Reed bunting (*Emberzina schoeniclus*)	4	1997-2006	1.5km S
Common scoter (*Melanitta nigra*)	1	1987	1.5km NE
Common tern (*Sterna hirundo*)	9	1998-2001	1.8km E
Linnet (*Cardeulis cannabina*)	1	2006	1.9km S

Table 13- 5 Bat records provided by GiGL

Species	No. of records	Date	Closest record
Pipistrelle species (*Pipistrellus sp.*)	177	1985-2007	281m NE
General bats (*Vespertilionade sp.*)	159	1999-2006	374m SE
Soprano pipistrelle (*Pipistrellus pygmaeus*)	1	2007	403m S
Noctule bats (*Nyctalus noctula*)	25	1994-2001	592m SE
Common pipistrelle (*Pipistrellus pipistrellus*)	23	1994-2007	698m SE
Unidentified bats (*Myotis sp.*)	39	2001-2006	699m S
Daubentons bats (*Myotis daubentonii*)	35	1994-2006	700m SE
Natterer's bats (*Myotis nattereri*)	12	2006	728m S
Nathusius' pipistrelle (*Pipistrellus nathusii*)	11	2006	821m S
Serotine bats (Eptesicus serotinus)	3	1994-2001	1305m E
Brown long-eared bat (*Plecotus auritus*)	1	2001	1908m S

13.4.8 Consultation with the London Bat Group also provided further information on bat roosts and sightings. A summary of these records including the approximate distance of the closest record in relation to the site boundary are shown in Table 13-6. Consultation with the NBN Gateway identified no records of bats within 2km of the site boundary.

Table 13- 6 Bat records provided by the London Bat Group

Species	No. of records	Roosts	Closest record
Pipistrelle species (*Pipistrellus sp.*)	76	19	281m NE
General bats (*Verspertilionidae*)	6		675m SE
Nathusius's bat	9		697m SE
Common pipistrelle	21		698m SE
Natterer's bat	8		728m S
Unidentified bat (*Myotis sp.*)	24		744m SE
Daubenton's bat	24		751m S
Noctule	21		806m S
Serotine	2		1210m E

Herpetofauna

13.4.9 Consultation with GiGL identified several herpetological records within 2km of the site boundary. A summary of these records including the approximate distance of the closest record in relation to the site boundary are shown in Table 13-7. Consultation with the NBN Gateway identified no specific records of amphibians or reptiles within 2km of the site boundary.

Table 13- 7 Herpetofauna records provided by GiGL

Species	No. of records	Date	Closest record
Common frog (*Rana temporaria*)	247	1999-2002	303m SW
Common toad (*Bufo bufo*)	10	1999-2002	447m W
Slow worm (*Anguis fragilis*)	1	1998	1908m S

Invertebrates

13.4.10 Consultation with GiGL identified many records of terrestrial invertebrates within 2km of the site boundary. A summary of these records including the approximate distance of the closest record in relation to the site boundary are shown in Table 13-8.

Table 13- 8 Invertebrate records provided by GiGL

Species	No. of records	Date	Closest record
Stag beetle	339	1998-2005	90m SE
White admiral (*Ladoga camilla*)	5	1999	800m S
Pirate spider (*Ero aphana*)	1	2007	1.9km S

13.4.11 Consultation with the NBN Gateway identified records of stag beetles known within the 100m grid square that encapsulates the western section of the site and cinnabar (*Tyria jacobaeae*) known within the 1km grid square that encapsulates the site.

Water vole (Arvicola terrestris)

13.4.12 Consultation with GiGL and the NBN Gateway identified no records of water vole within 2km of the site boundary.

Otter (Lutra lutra)

13.4.13 Consultation with GiGL and the NBN Gateway identified no records of otter within 2km of the site boundary.

Common dormouse (Muscardinus avellanarius)

13.4.14 Consultation with GiGL idenitified two records of common dormouse; both situated approximately 1.9km south of the development site. Consultation with the NBN Gateway identified no records of common dormouse within the 2km of the site boundary.

Invasive species

13.4.15 Consultation with GiGL and the NBN Gateway identified no specific records of invasive species within 2km of the site boundary.

Wild flora

13.4.16 Consultation with GiGL identified records of the following species of wild flora present within 2km of the proposed site. A summary of these records including the approximate distance of the closest record in relation to the site boundary are shown in Table 13-9. Consultation with the NBN Gateway identifies no specific records of wild flora within 2km of the site boundary.

Table 13-9 Wild flora records provided by GiGL

Species	No. of records	Date	Closest record
Mistletoe (*Viscum album*)	18	1995-2002	530m SW
Bluebell (*Hyacinthoides non-scripta*)	2	1999	900m E
Autumn squill (*Scilla autumnalis*)	1	1981	1.6km S
Corn buttercup (*Ranunculus arvensis*)	1	1982	1.7km S
Black poplar (*Populus nigra betulifolia*)	2	1995-2002	1.8km S

Trees

13.4.17 Consultation with the Planning Services at Richmond upon Thames London Borough Council (undertaken by telephone conversation on 7th July 2010) gave Wardell Armstrong LLP an informal opinion that from their records there appears to be no Tree Preservation Orders in place within the site boundary or the immediate surrounding area.

13.4.18 Due to the large potential penalties for illegally carrying out work to protected trees, it is recommended that a further check is carried out prior to any works commencing that may have an adverse impact upon the health of any trees identified in the TCP.

Field Survey

Habitats within the Zone of Influence

13.4.19 An Ecological walkover and Arboricultural survey of the site was initially undertaken in January 2009 by two Wardell Armstrong ecologists; these surveys were subsequently updated in June 2010. The main habitats within the survey area are described below. Additional details are shown on the Extended Phase 1 Habitat Plan (*Appendix H-1 of ES Volume III*) and Target Notes are listed in *Appendix H-4 of ES Volume III*. Details of the arboricultural survey are shown on the Tree Constraints Plan (*Appendix H-2 of ES Volume III*) and the Arboricultural Survey Sheets (*Appendix H-3 of ES Volume III*).

Hard standing and buildings

13.4.20 Approximately 0.5 hectares of the site comprises buildings, railway lines and car parking facilities (see Plate 13-2) associated with Twickenham Railway Station. The main station building (see Plate 13-1) situated in the south of the development site is brick with a flat felted roof. The footbridges associated with the station comprise brick and corrugated metal sides with an asbestos roof. In addition, there is a small building (see Plate 13-4) and bicycle shelter (see Plate 13-3) situated in the north of the site. The small building is made of brick with a flat felted roof and the bike shelter comprises a metal frame with glass panels.

13.4.21 A small stand of Japanese knotweed was recorded adjacent to the small building during the 2009 survey (Target Note 13-1). This stand was not evident during this survey; however, Japanese knotweed has the ability to lie dormant for 20 years so unless a known eradication scheme has been undertaken on this stand, it should be presumed as present. Subsequently, this stand has been mapped on the Japanese knotweed plan (see *Appendix H-5 of ES Volume III* - Approximate Japanese Knotweed Extent Plan).

Plates 13-1 & 13-2 View of station building and associated car parking facility.

Plate 13-3 and Plate 13-4 View of bike shed in the north west of the site and View of small building adjacent to bike shed.

13.4.22 There are two footpaths that extend over the River Crane and there were also two small buildings adjacent to the site boundary to the east of the site. One building was inaccessible due to dense vegetation (see Plates 13-9 & 13-10), but it appeared to be of wooden structure with a felt roof. The other was a small, open concrete structure, covered in common ivy (*Hedera helix*).

Tall ruderal

13.4.23 Two small vegetated areas (see Plates 13-5 & 13-6) are situated adjacent to the bike shed in the north west of the site. It is presumed that these areas are for amenity purposes; however, Japanese knotweed is the dominant species. Other species present include; common nettle (*Urtica dioica*), mugwort (*Artemisia vulgaris*), dandelion (*Taraxacum officinale*), creeping buttercup (*Ranunculus repens*), field bindweed (*Convolvulus arvensis*), ribwort plantain (*Plantago lanceolata*), broad-leaved dock (*Rumex obtusifolius*) and common tormentil (*Potentilla erecta*).

Plates 13-5 & 13-6 View of small vegetated areas in the north west of the site.

Semi-improved grassland/tall ruderal mosaic

13.4.24 There is a small (approximately 0.1 hectares) area of semi-improved grassland inundated with tall ruderals and shrubs situated within the west of the site (see Plates 13-7 & 13-8). This area could only be viewed from a distance as it is entirely enclosed by fencing. Common nettle dominated areas of this grassland that also had dandelion, creeping buttercup, field bindweed, ribwort plantain, broad-leaved dock, bramble (*Rubus fruticosus*), greater willowherb (*Epiolobium hirsutum*), common ivy and many young ash (*Fraxinus excelsior*) and sycamore (*Acer pseudoplatanus*) shrubs.

13.4.25 A small stand of Japanese knotweed was recorded within this area during the 2009 survey. This stand was not evident during this survey; however, Japanese knotweed has the ability to lie dormant for 20 years so unless a known eradication scheme has been undertaken on this stand, it should be presumed as present. Subsequently, this stand has been mapped on the Japanese knotweed plan (see LO10145/EIA13-2 Approximate Japanese Knotweed Extent Plan).

Plates 13-7 & 13-8 View of enclosed semi-improved grassland/tall ruderal mosaic.

Trees

13.4.26 Reference should be made to the Tree Constrains Plan (*Appendix H-2 of ES Volume III)* and the Arboricultural Survey Sheets (*Appendix H-3 of ES Volume III)*. All trees within the site are situated within a corridor between the station security fencing and the River Crane. This corridor of semi-mature to mature trees, with a scrub and tall ruderal understory, is wider and gradually becomes a small woodland towards the east of the site. Broad-leaved woodland is a LBAP habitat.

13.4.27 The majority of the trees within the site are semi-mature. However, several young, mature and dead tree stumps are also present. Seven different species were identified during the survey. Sycamore is the most dominant species followed by ash. Wild cherry (*Prunus avium*), weeping willow (*Salix* x *sepulcralis*), bay willow (*Salix pentandra*), holly (Ilex aquifolium), false-acacia (*Robinia pseudoacacia*), Lombardy poplar (*Populus nigra Italica*), butterfly bush (*Buddleia davidii*) and Lawson cypress (*Chamaecyparis lawsoniana*) were also identified but these are in low numbers or as lone representatives. In addition, there were several unidentifiable dead stumps within the site boundary and horse chestnut (*Aesculus hippocastanum*), English plane (*Plantanus x hispanica*) and several ornamental species within the zone of influence.

13.4.28 The mature trees within the site are in varying levels of decline and have become inundated by ivy and some have suffered branch loss. As a result, none of the trees within the survey would individually qualify as Category A trees. Collectively however these trees have a high amenity value owing to their age, location and size. They also form a large band of continuous tree cover that has conservational value for birds, bats and invertebrates.

13.4.29 In total, 16 individual trees or groups were assessed. One group (WAGF) was awarded the tree retention category A. It should be noted that individually these trees would be rated as tree retention category B and C; however, as a group these trees are important both conservationally and aesthetically. Seven individuals and groups were awarded a retention category B and this was generally due to their conservational value or the screening they provide for the residents to the north of the station. Seven individuals were awarded a retention category C due to their screening value and the large tree stumps were also awarded a retention category C due to their conservational value.

13.4.30 Japanese knotweed (see *Appendix H-5 of ES Volume III*) Approximate Japanese Knotweed Extent Plan), bramble, common nettle and ivy were the dominant understory species.

Scrub

13.4.31 There is a large extensive scrub area to the east of the site (see Plates 13-9 & 13-10). Bramble is the dominant species; however, common nettle, field bindweed, common ivy, common hops (*Humulus lupulus*) and common cleavers (*Galium aparine*) were also common.

Plates 13-9 & 13-10 View of extensive scrub area to the east of the site. A small wooden structure was situated in the centre of this area.

River Crane

13.4.32 Adjacent to the northern boundary is the River Crane (part of the Crane Corridor SINC). This section of the river was shallow (approximately 10-15cm deep) with tall concrete sides (evident on Plate 13-11) and a concrete base. It flowed from west to east at a moderate speed. Aquatic vegetation was sparse and the majority of its banks were shadowed by tree canopy.

Plates 13-11 & 13-12 Example sections of the River Crane adjacent to the site.

Species within the Zone of Influence

Avifauna

13.4.33 During the field survey the following species were identified within the site and its zone of influence; collared dove (*Streptopelia decacoto*), house sparrow, moorhen (*Gallinula chloropus*), mallard (*Anas platyrhynchos*), blackbird (*Turdus merula*), magpie (*Pica pica*), ring necked parakeet (*Psittacula krameri*) and grey heron (*Ardea cinerea*). All of these species were identified along the River Crane and the river and its associated habitats are considered to provide opportunities for a range of breeding birds.

Badger

13.4.34 During the field survey no signs of badger activity, including setts, prints and latrines were identified. The site is considered to provide very limited potential for badgers and there are no records of badger within 900m of the site. Additionally, it is not considered that the proposed development of the site would have an adverse affect upon any badgers that may be present locally. Badgers are not considered further in this report.

Bats

13.4.35 No evidence of bats was identified during the Extended Phase 1 Habitat survey. However, several mature sycamore trees on the northern boundary and the buildings to the north east of the site were identified as potentially providing suitable habitat for roosting bats and consequently, a bat survey was undertaken. The weather conditions for the survey are summarised in Table 13-10. The survey was undertaken in accordance with the following publications:

- Bat Workers' Manual, 3rd Edition (Ref. 13-6); and
- Surveys: Good Practice Guidelines (Ref. 13-7).

Table 13-10 Bat survey weather conditions

	24th June 2010 (dusk)	**25th June 2010 (dawn)**
Temperature	27.2 - 24.7°C	15.6 - 15.0°C
Wind	Negligible	Negligible
Precipitation	None	None
Cloud Cover	2/8	1/8

13.4.36 During the dusk survey on 24th June, a common pipistrelle bat was recorded at 21.48hrs commuting along the River Crane. From approximately 22.30hrs the River Crane was walked to record foraging activity within the area. Between 22.35hrs and 23.15hrs four common pipistrelle and three Soprano pipistrelle bats were recorded commuting and foraging along the River Crane. During the dawn survey on 25th June no bats were observed or recorded (see *Appendix H-6 of ES Volume III* - Bat Survey Sheets).

13.4.37 No bat roosts or foraging bats were identified within the site during this survey. The illuminated, anthropogenic nature of the station makes this section of the railway line unsuitable for foraging bats and the buildings associated with the station are considered to provide low bat roosting potential. However, the River Crane and its associated trees, to the north of the site, are of importance to local bat species for foraging and commuting.. In addition, bats are highly mobile animals that can use a number of roost sites within and between years. A number of the mature trees to the north of the site may provide potential roost sites for bats.

Herpetofauna

13.4.38 The site is considered to provide very limited opportunities for amphibians and reptiles due to the lack of records, suitable aquatic habitats (for amphibians) and suitable terrestrial habitats (for reptiles). It is not anticipated that development of the site will have any adverse affect upon any amphibians or reptiles. Amphibians and reptiles are not considered further in this report.

Invertebrates

13.4.39 During the site survey a solitary female stag beetle was identified just outside the site boundary, along the River Crane (Full Grid Reference: 516187 173750; see Target Note 2). No other notable invertebrates were identified. It is not anticipated that the site has the potential to support any notable pollinators due to the limited floral diversity on site. In addition, the concrete, shallow, un-vegetated nature of the River Crane is considered to limit its potential to support notable aquatic invertebrates. Aquatic invertebrates are not considered further in this report. However, the habitats associated with the River Crane are considered to provide suitable opportunities for a number of invertebrates; particularly those that depend on deadwood, such as the stag beetle.

Water vole

13.4.40 The section of River Crane which is adjacent to the site is concrete, shallow and very sparsely vegetated. It is considered unsuitable for water voles due to the lack of suitable burrowing areas and limited foraging opportunities. Therefore it is not anticipated that development of the site will have an adverse effect on water voles. Water voles are not considered further in this report.

Otter

13.4.41 The section of River Crane which is adjacent to the site is concrete, shallow and very sparsely vegetated. It is considered sub-optimal habitat for otter; however, the 4th National Otter Survey of England & Wales 2000-2002 (Ref. 13-8) states '*it is anticipated that otters will continue to spread from the Upper Thames through Oxford to colonise the middle and lower parts of the catchment*'. Otter may use the stretch of the River Crane adjacent to the site when migrating between more suitable habitat; Moormead Park and the River Thames to the east and Crane Park to the west, in particular. It is not anticipated that development of the site will have an adverse effect on the River Crane's capacity as a wildlife corridor for otter. Therefore, otter are not considered further in this report.

Common dormouse

13.4.42 No signs of common dormice were identified during the site survey. There is no suitable habitat for common dormouse within the site. It is not anticipated that development of the site will have an adverse affect on common dormice. Common dormouse are not considered further in this report.

Invasive species

13.4.43 Japanese knotweed was identified throughout the site during the site survey (see *Appendix H-5 of ES Volume III* - Approximate Japanese Knotweed Extent Plan). Two small stands of Japanese knotweed identified during the 2009 Extended Phase 1 Habitat Survey were not present during the 2010 survey. Japanese knotweed has the ability to lie dormant for 20 years so this area has been mapped on the Japanese knotweed plan and should be treated as present unless an eradication scheme is known to have been undertaken.

13.4.44 By law it is an offence to plant, or cause Japanese knotweed to grow in the wild. Under the Environmental Protection Act (1990), cut Japanese knotweed material and soil containing rhizome material are classified as controlled waste and must be disposed of safely at a licensed landfill site. Landowners may incur costs and damages if they fail to prevent knotweed from spreading to a neighbouring property. Also failure to manage and dispose of Japanese knotweed responsibly may lead to prosecution. Advice on an appropriate management strategy for Japanese knotweed will be developed and implemented in conjunction with site clearance and construction and is not considered further in this report.

13.4.45 In addition, Chinese mitten crabs (*Eriocheir sinensis*) were identified within the River Crane. These crabs are highly invasive and are listen on schedule 9 of the Wildlife and Countryside Act (2010), which makes it an offence to release or allow the escape of them into the wild. However, this species will not be affected as part of development and is therefore not considered further in this report.

Wild flora

13.4.46 No notable plant species were identified during the site survey. The hard standing nature of the station and competitive nature of the habitats associated with the River Crane are considered to limit the sites potential for notable flora. It is not anticipated that development will have an adverse affect on any protected flora. Wild flora is not considered further in this report.

Nature Conservation Evaluation

13.4.47 An evaluation of ecological features which have potential to be directly or indirectly affected by the proposed development is presented in Table 13-11. Those features which are considered unlikely to be affected, either directly or indirectly, by virtue of their distance from the proposed development and the nature of the development are not considered further in this ES chapter. This includes all of the statutory designated sites and the majority of the non-statutory designated sites situated within 2km of the site boundary.

Table 13-11 Nature Conservation Evaluation of Ecological Features

Feature	Discussion	Nature Conservation Value
Non-statutory Sites of Nature Conservation		
The River Crane	There are several SINCs associated with the River Crane and the section that is situated adjacent to the site boundary is named the Crane Corridor. Although the section of the River Crane that lies adjacent to the site is a poor example (i.e. concrete sides and base), the river is thought to be one of the most natural rivers in London and a stronghold for a number of uncommon aquatic plants. Development within this area also has the potential to cause the spread of Japanese knotweed; particularly downstream.	County
Habitats		
Hard standing	No ecological value. However, development within this area also has the potential to cause the spread of Japanese knotweed.	Negligible
Buildings within the site boundary.	The buildings within the site boundary have no intrinsic value or potential to support bat roosts.	Negligible
Buildings within the zone of influence.	The small wooden building situated adjacent to the site in the east was inaccessible. It may provide opportunities for breeding birds and roosting bats.	Potentially County
Tall Ruderal	The two areas of tall ruderals to the west of the site are small, species poor and dominated by Japanese knotweed. This area is considered to provide very little value in terms of biodiversity; however, development within this area has the potential to cause the spread of Japanese knotweed.	Negligible
Semi-improved grassland/tall ruderal mosaic	Small area of moderately species-rich semi-improved grassland inundated with ruderal and shrubs. Potential value for foraging birds and invertebrates.	Zone of influence

Feature	Discussion	Nature Conservation Value
Trees and scrub	Broad-leaved woodland is a LBAP habitat. The mature trees have the potential to support roosting bats. The trees and scrub as a whole provide nesting opportunities for birds and foraging opportunities for bats and birds and are also important for invertebrates including the stag beetle.	District
Species		
Breeding Birds	The site is important for a number of common breeding bird species.	Local
Bats	The site supports relatively low numbers of foraging common and soprano pipistrelle. In addition, the mature trees within the site and the zone of influence may provide opportunities for bat roosts.	Local to District
Invertebrates	The most notable habitats with regards to invertebrates are the standing and lying deadwood. These habitats are likely to support a range of invertebrates including the stag beetle. The remainder of the River Crane and its associated habitats may support a number of common and widespread terrestrial and aquatic invertebrates.	Local

Future Baseline Conditions (Without Development)

13.4.48 It is considered that future baseline conditions would not be significantly different to the current baseline in terms of broad habitat types.

13.5 Impact Assessment

13.5.1 This section of the Ecology chapter assesses the likely impacts arising from the construction, and operational phases of the proposed development with respect to each ecological receptor of value at Zone of Influence level, or above. Impacts upon features of negligible ecological value, or which are too distant from the site for direct or indirect impacts to occur have not been assessed. This section of the ES assesses impacts without mitigation; mitigation and residual impacts are described in later sections.

Potential Impacts – Construction Phase

13.5.2 It is proposed that existing buildings, station concourse, cycle parking, sculpture, foot bridges, car park, fencing, a small section of scrub and small areas of landscaping will be removed to facilitate the development. There will be some temporary construction compounds created on site; however, it is not anticipated that these will have a significant affect on the local environment as they will be installed away from the northern boundary of the site (i.e. away from the River Crane SINC and associated trees). This impact is considered as **negligible**.

13.5.3 The loss of the small section (approximately 70m) of scrub to facilitate the footpath installation is also considered as **negligible**.

Potential Impacts – Operational Phase

13.5.4 The site development proposes the construction of approximately 165 residential units, a new train station ticket office and 734 sqm of commercial floor space in a series of buildings rising to 8 storeys in height. In addition, a new station concourse, areas of public space, a public footpath, a new taxi rank and undercroft commuter parking spaces will be installed.

13.5.5 A report prepared by Behan Partnership LLP investigating the potential impacts of the proposed development on daylight, sunlight, shadowing and solar dazzle includes a detailed analysis of 'overshadowing' of the site, including the River Crane. The analysis concludes that the River Crane and adjacent trees are only partially shaded by the new buildings and that amenity areas within the site will not suffer any practical adverse effect as a results of this partial shading.

13.5.6 The River Crane is already subject to shading from adjacent trees and it is considered unlikely that the additional partial shading of the river channel associated with the new buildings would be significant in the context of shade cast by trees. With regard to the trees themselves, the partial shading caused by the new development is considered unlikely to adversely affect the health of the trees (as might be expected if they were subject to permanent shadow).

13.5.7 However, the increased elevation and intensity of the new buildings may increase light pollution on the River Crane and its associated trees. This has the potential to adversely affect locally foraging bats. Without mitigation this impact is considered to be a long term major adverse impact of significance at a local level.

13.5.8 In addition, the installation of the footpath has the potential to increase the level of disturbance to the River Cranes habitats and this may adversely affect breeding birds, foraging bats and stag beetles. Without mitigation this impact is considered a long term major adverse impact of significance at a local level.

River Crane

13.5.9 Although it is not anticipated that development will have any adverse impacts upon the Crane Corridor SINC, the River Crane and its associated habitats are also valued at County level. It is considered that the relatively small scale of impacts (in terms of extent of low value habitat affected) during development is unlikely to result in an overall adverse effect on the integrity of the river and its habitats. Therefore, without mitigation, direct impacts upon the River Crane are considered to be negligible. However, light pollution and increased pedestrian disturbance may adversely affect species that reside within the zone of influence. Without mitigation these impacts are considered to be a long term moderate adverse impact within the zone of influence.

Habitats

13.5.10 It is not anticipated that any habitats of value will be lost as a result of development. Therefore impacts associated with habitats are not significant. However, it should be noted that although the loss of the hard standing and tall ruderal areas within the site are considered to be negligible with regards to nature conservation, Japanese knotweed is present within these areas and this should be taken into consideration.

Trees

13.5.11 It is not anticipated that any trees will be lost or adversely affected as a result of development. Therefore impacts associated with trees are not significant.

Avifauna

13.5.12 It is not anticipated that any habitats of value to breeding birds will be lost or adversely affected as a result of development. Therefore impacts associated with avifauna are not significant.

Bats

13.5.13 It is not anticipated that any habitats of value to foraging or roosting bats will be lost or adversely affected as a result of development. Therefore direct impacts associated with bats are not significant.

13.5.14 However, increased artificial lighting onto the River Crane and its associated trees has the potential to disturb bat roosts and foraging bats. In addition to direct disturbance, artificial light has the potential to delay bats from emerging thus shortening available foraging time. The main peak of nocturnal insect abundance occurs at and soon after dusk, a delay in emergence means this vital time for feeding is missed. The presence of lit conditions is also thought to increase the rate of predation on bats by birds. Without mitigation, the affect of increased lighting onto the River Crane and its associated habitats is considered to be a long term major adverse impact at a local level.

Invertebrates

13.5.15 It is not anticipated that any habitats of value to notable invertebrates (particular deadwood and stag beetles) will be lost or adversely affected as a result of development. Therefore direct impacts associated with stag beetles are not significant.

Summary

13.5.16 Table 13-13 summarises impacts associated with the construction and operational phase of development.

13.6 Mitigation and Residual Impacts

13.6.1 The mitigation strategy aims to minimise any adverse impacts upon the biodiversity within the site and its zone of influence and to remediate for any adverse impacts to ensure a net increase in biodiversity as a result of development. Best practice methods of construction (in particular PPG 1 and PPG 5 regarding working near water; see *Appendix H-7 of ES Volume III*) will be implemented during the development of the scheme to reduce the likelihood of accidental spillages occurring and to ensure any spillages are remediated effectively.

River Crane

13.6.2 The River Crane and its associated habitats are already subjected to a moderate amount of artificial light by on-site lighting and light spill from the adjacent residential buildings and street lights. Development of the site will be used as an opportunity to reduce the level of artificial lighting by keeping it to a minimum. Lighting that is proposed for security and safety reasons will use low pressure sodium lights of no greater than 2000 lumes (150 W), directed to where it is needed with minimal light spillage onto the River Crane and its associated habitats.

13.6.3 Where lighting is needed to meet health and safety requirements, impacts will be overcome by using low column lights, angling the lights downwards and placing shields over them so that the light is directed downwards. Where areas of habitat that are of value to bats require lighting (i.e. the riverside footpath), low level bollard lighting will be used. Artificial lighting will not directly illuminate any mature trees or the River Crane. Furthermore, additional trees will be planted along the River Crane to provide screening and reduce light spillage. The location of the footpath has been specifically chosen to minimise disturbance to habitats associated with the River Crane and a fence line will be installed to define the footpath that will prevent pedestrians straying into adjacent habitats; thus, minimising pedestrian disturbance along the River Crane. With the implementation of these mitigation measures the impacts of development upon the River Crane are considered to be negligible.

Habitat Loss

13.6.4 The position of the proposed footpath has been specifically chosen to ensure that no valuable habitats are lost or disturbed during development. This will also ensure that any disturbance to the wildlife that resides along the River Crane is kept to a minimum. As a result, it is proposed that no trees will be removed or adversely impacted upon during development. The footpath will be installed along a disused hard standing platform edge with only a small section passing through some scrub to connect with an existing pathway to the east of the site. In addition, trees of local provenance will be planted along the River Crane to provide screening and reduce light spillage. With the implementation of these mitigation measures the impacts associated with habitat loss are considered to be negligible and probably beneficial in the long term.

Trees

13.6.5 No trees will be removed to facilitate development and site development has been specifically designed to ensure limited impacts upon any existing trees. With the implementation of these mitigation measures the impacts associated with trees are considered to be negligible.

13.6.6 A tree protection plan would normally be produced to fulfil the requirements of an Arboricultural Impact Assessment. The trees along the River Crane are protected from development from existing hard standing and security fencing; therefore, it is considered that no plan is required for this scheme.

Avifauna

13.6.7 There are no anticipated impacts associated with breeding birds. However, with the implementation of tree planting, in the long term, development has the potential to be beneficial for locally breeding birds.

Bats

13.6.8 There are no direct impacts associated with bats anticipated during development.

13.6.9 Following the implementation the above mentioned mitigation, regarding light pollution and tree planting, the impact of development on bats is anticipated to be negligible and potentially beneficial in the long term.

Invertebrates

13.6.10 There are no anticipated impacts associated with invertebrates. However, with the implementation of tree planting, in the long term, development has the potential to be beneficial for invertebrates, including stag beetles.

Securing Enhancements

13.6.11 The ecological enhancements identified above will be secured through planning condition. Planting and the provision of bat boxes can be secured through submission of a detailed landscaping scheme under condition. A lighting scheme will be secured under planning condition. Any scheme will prioritise the principles of Secured by Design, but adopt the recommendations identified above where feasible.

Monitoring

13.6.12 Bat monitoring surveys should be undertaken to determine the impacts of development upon bats foraging along the River Crane. These surveys should be undertaken after 1, 3 and 5 years of development and will record bat activity along the River Crane. These surveys will provide the opportunity for additional remediation works, should they be required.

Summary

13.6.13 Table 13-13 summarises impacts associated with the construction and operational phase of development.

Table 13-13 Summary of Construction and Operational Impacts (without Mitigation)

Receptor	Characterisation of Unmitigated Impact and Significance	Proposed Mitigation	Significance with Mitigation and Confidence
River Crane	Effects to Crane Corridor SINC. **No effect:** certain.	Footpath to be installed away from the River Crane and associated trees on a disused, hard-standing station platform and through a small section of scrub	**No effect:** certain
	Effect to the integrity of the River Crane and its associated habitats. **Negligible:** likely.	-	**Negligible:** likely.
	Light pollution and increased pedestrian disturbance **Moderate adverse** effect within the zone of influence: probable.	Artificial lighting kept to a minimum. Lighting directed to required areas through appropriate angling and use of directional shields. Use of low light columns. Tree planting to increase screening. Installation of fenceline to prevent pedestrians straying into adjacent habitats	**Negligible**: probable.

Receptor	Characterisation of Unmitigated Impact and Significance	Proposed Mitigation	Significance with Mitigation and Confidence
Habitats	Effect of loss of scrub **Negligible** effect: certain.	The location of the proposed footpath has been specifically chosen so that only a short section of habitats of limited value will be lost	**Negligible:** certain.
Trees	Effects to trees with TPO's. Effects to aesthetic and screening value of trees as a whole. Effects to conservational value of trees as a whole. Effects to individual mature trees. Effects to semi-mature trees as individuals. Effects to standing deadwood as individuals. Effect of accidental damage of trees to be retained. **Negligible** effect: certain.	No trees or deadwood to be removed or adversely affected during development	**Negligible**: Certain

Receptor	Characterisation of Unmitigated Impact and Significance	Proposed Mitigation	Significance with Mitigation and Confidence
Avifauna	Loss of breeding habitat. Loss of foraging grounds. Effects to breeding birds if works are undertaken within the breeding bird season. **Negligible** effect: certain.	No habitats of value to breeding birds to be removed or adversely impacted upon during development.	**Negligible**: certain.
Bats	Potential loss/disturbance of roosts. Potential loss/disturbance to foraging grounds and potential to kill or injure individuals. Potential to disturb individuals. **Negligible** effect: likely.	No habitats of value to foraging or roosting bats to be removed or adversely impacted upon during development. Lighting mitigation described above. Monitoring proposed to determine impacts of development.	**Negligible**: likely.

Receptor	Characterisation of Unmitigated Impact and Significance	Proposed Mitigation	Significance with Mitigation and Confidence
Invertebrates	Potential loss/ disturbance to foraging grounds and potential to kill or injure individual stag beetles. Potential loss/ disturbance to foraging grounds and potential to kill or injure other invertebrates. **Negligible** effect: certain.	No habitats of value to invertebrates to be removed or adversely impacted upon during development.	**Negligible:** certain.

13.7 Conclusions

13.7.1 It is not anticipated that the proposed development will adversely affect any statutory or non-statutory designated sites for nature conservation. In addition, the integrity of the River Crane and its associated habitats will be maintained throughout development. This is in line with paragraph 12 of PPS9, policy 4C.22 of the London Plan and policy CP4 of the London Borough of Richmond Upon Thames LDF.

13.7.2 No trees will be lost or adversely affected as a result of development and the proposed diverse planting of trees of local provenance will maintain and enhance the woodland within the site; in line with policy 3D.15 of the London Plan.

13.7.3 Artificial light spillage and pedestrian disturbance will be kept to a minimum within the River Crane and its associated habitats.

13.7.4 No significant impacts are anticipated towards bats; bat monitoring surveys will be undertaken to confirm this. In addition, the mitigation proposed may be beneficial to foraging and roosting bats in the long term. This is in line with policy 3D.14 of the London Plan.

13.7.5 There are no significant impacts anticipated on any other species.

13.7.6 On balance, the overall impact on site ecology and the River Crane is anticipated to be negligible and probably beneficial in the long term as steps will be taken to increase its biodiversity. This is in line with policy 3D.14 of the London Plan and policies CP4 and CP12 of the London Borough of Richmond Upon Thames LDF.

13.8 Cumulative Impact

13.8.1 The Design and Access statement for the Regal House Extension states that the 'site itself has no ecological or biodiversity value as it is hard standing tarmac car park. The trees and bushes along the boundary between Regal House and residential properties in Cheltenham Avenue and those on London Road will be unaffected by the proposals'. It is considered that through the construction phase of Regal House there is the potential for minor impacts on bat and bird nesting and foraging habitat through disturbance from plant equipment and machinery and light spillage. Providing similar mitigation is implemented as detailed in *Chapter 6: Site Preparation and Construction* the noise air quality and light spillage effects of the Regal House extension on ecological receptors are anticipated to be negligible.

13.8.2 The cumulative impact remains the same as the impact of the proposed Development in its own right.

13.9 Reference

Ref: 13-1 IEEM (2006) 'Guidelines for Ecological Impact Assessment in the United Kingdom'.

Ref: 13-2 JNCC (1993) 'Handbook for Phase 1 habitat survey: A technique for environmental audit', English Field Unit, Nature Conservancy Council.

Ref: 13-3 British Standard 5837 (2005) 'Trees in relation to construction', British Standards Institution.

Ref: 13-4 Ratcliffe. D. (1977) 'A Nature Conservation Review', Cambridge University Press.

Ref: 13-5 DETR (1998) Guidance to the New Approach to Appraisal.

Ref: 13-6 Mitchell-Jones, A.J, & McLeish, A.P. (2004) 'Bat Workers' Manual 3rd Edition', Joint Nature Conservation Committee

Ref: 13-7 Bat Conservation Trust (2007) 'Bat Surveys – Good Practice Guidelines'. Bat Conservation Trust, London

Ref: 13-8 Crawford. A. (2003) Fourth Otter Survey of England 2000 – 2002 Environment Agency

Ref: 13-9 London Wildlife Trust (2000). 'Stag Beetle: an advice note on its conservation in London'.

14.1 Introduction

14.1.1 This Chapter of the Environmental Statement (ES) assesses the potential impacts of the proposed development on neighbouring properties around the site. The Chapter has been written by Behan Partnership LLP.

14.1.2 Behan Partnership LLP has been instructed by Solum Regeneration to prepare a daylight, sunlight, shadow and solar dazzle study of a scheme proposal to assess the likely impact of the proposed works of the Rolfe Judd Architect scheme on the neighbouring residential properties adjacent to the development site.

14.1.3 This study has been carried out in accordance with the recommendations of the Building Research Establishment Report "Site Layout Planning for Daylight & Sunlight 1991" and in accordance with the provisions of British Standard Code of Practice for Daylighting, BS8206 Part 2, 2008.

14.2 Planning Policy Context

14.2.1 The section below reviews the existing national, regional and local planning policy relevant to daylight, sunlight and overshadowing.

National Legislation and Policy

14.2.2 There is no specific National Planning Policy relating to developments and their potential impacts on daylight, sunlight and overshadowing.

14.2.3 There is no general right to sunlight established in English law. The common law rules, statutory rules and procedures that exist are complex and complicated and no set criteria exist under which a right would be upheld.

14.2.4 A right to light can exist and will come into existence if it has been enjoyed for 20 years or more, granted by deed, or registered under the Rights to Light Act 1959. The right to light is a matter of property law rather than planning law.

The Regulatory Reform (Housing Assistance) (England and Wales) Order 2002

14.2.5 The Regulatory Reform Order (Ref. 9-1), which came into force on 6 June 2002, documents the statutory requirement for the adequate provision of lighting to housing. The order states:

"In assessing the severity and extent of defects in respect of natural and artificial lighting, regard may be had to the following standard, draft for development, code and specification for new building work, although failure to meet these would not, in itself, necessarily constitute grounds for unfitness.

(1) British Standard (BS) 8206: Lighting for buildings, Part 2: 2008 Code of practice for daylighting;

(2) CIBSE: Code for interior lighting 1994; and

(3) Site layout planning for daylight and sunlight: a guide to good practice, Building Research Establishment (BRE), 1991. Also: Site layout for sunlight and solar gain, BRE IP/92, and Site layout planning for daylight, BRE IP5/92."

Planning Policy Statement 1: Delivering Sustainable Communities (PPS1)

14.2.6 Paragraph 34 of Planning Policy Statement 1: Delivering Sustainable Communities (PPS1) (Ref. 9-2) advises that design should contribute positively to making places better for people.

Regional Planning Policy

14.2.7 There is no regional planning policy for the development specifically relevant to daylight, sunlight and overshadowing. English Heritage and the Commission for Architecture and the Built Environment have, however, produced guidance on the design of tall buildings in which reference is made to overshadowing.

Policy Guidelines

14.2.8 This study has been carried out in accordance with the recommendations of the Building Research Establishment Report "Site Layout Planning for Daylight & Sunlight 1991" and in accordance with the provisions of British Standard Code of Practice for Daylighting, BS8206 Part 2, 2008.

14.2.9 The London Borough of Richmond UDP confirms that the Council will normally have regard to the guidelines:-

UDP March 2005 - BLT 15

"DAYLIGHTING AND SUNLIGHTING

The Council will generally seek to ensure that the design and layout of buildings enables sufficient sunlight and daylight to penetrate into and between buildings, and that adjoining land or properties are protected.

The Council will be guided by the standards set out in Site Layout, Planning for Sunlight and Daylight, and in Sun on Ground Indicators (BRE 1991); or any standards replacing them, to ensure this."

14.2.10 The BRE Guide is intended for building designers and their clients, consultants and planning officials. The advice given is not mandatory and the Report should not be seen as a part of planning policy. Its aim is to help rather than constrain the designer. Although it gives numerical guidelines, these should be interpreted flexibly because natural lighting is only one of the many factors in site layout design. In certain circumstances, the developer or planning authority may wish to use alternative target values.

14.2.11 Whilst technical analysis can be carried out in accordance with numerical guidelines and reported by comparison with those guidelines, the final assessment as to whether affected dwellings are left with acceptable amounts of daylight and sunlight is a matter of subjective opinion.

English Heritage/Commission for Architecture and the Built Environment Guidance on Tall Buildings, March 2003

14.2.12 Paragraph 4.6(vi) of this guidance (Ref. 9-3) recommends that consideration be given to:

"the effect on the local environment, including microclimate, overshadowing, night time appearance, vehicle movements and the environment and those in the vicinity of the building."

Reference Documents

14.2.13 There are two documents frequently referred to in planning guidance for daylight sunlight and overshadowing. These are the British Standard (BS) 8206-2:2008 Lighting for Buildings Part 2 Code of Practice for Daylighting (Ref. 9-5) and the Building Research Establishment (BRE) report Site Layout Planning for Daylight and Sunlight: A Guide to Good Practice (Ref. 9-6).

14.2.14 These documents describe the methodology by which daylight, sunlight and overshadowing can be assessed and provide guidance values.

14.3 Assessment Methodology and Significance Criteria

14.3.1 The technical studies undertaken to assess the impact to daylight and sunlight availability follow the methods as set out in the BRE Guidance and BS 8206-2:2008.

14.3.2 As stated in the BRE Guidance "guidelines may be used for houses and any non domestic buildings, where daylight is required". In accordance with the BRE Guidance, and with best practice, the assessment undertaken therefore considers primarily residential properties.

14.3.3 The BRE Guidance is intended for building designers and their clients, consultants and planning officials. The advice given is not mandatory and the report should not be seen as a part of planning policy. Although it gives numerical guidelines, these should be interpreted flexibly because natural lighting is only one of the many factors in site layout design. In certain circumstances the developer or planning authority may wish to use alternative target values.

14.3.4 Whilst technical analysis can be carried out in accordance with numerical guidelines and reported factually by comparison with those guidelines, the final assessment as to whether affected dwellings are left with acceptable amounts of daylight and sunlight in an inner city context where the findings are to be interpreted in a flexible manner is a matter of subjective opinion and for the planning authority to decide.

14.3.5 With regard to overshadowing, Part 3.3 of the BRE Guidelines provides specific guidance on the overshadowing of gardens, open spaces and amenity areas of existing buildings.

Assessment Methodology

Daylight and Sunlight Analysis

14.3.6 The BRE Guidance gives numerical methodology to calculate levels of daylight and sunlight but advises that in some cases the assessment of these levels should be interpreted flexibly. This is particularly relevant in a city environment where it would be unrealistic to expect strict compliance with the recommendations due to the presence of densely built up areas.

14.3.7 The BRE Guidance advises that daylight and sunlight levels should be assessed at the main habitable rooms of neighbouring residential properties. Habitable rooms in residential properties are defined as kitchens, living rooms and dining rooms. Bedrooms are less important as they are mainly occupied at night-time. The BRE Guidance also makes reference to other property types, which may be regarded as 'sensitive receptors' such as schools, hospitals, hotels and hostels, small workshops and most offices.

14.3.8 The BRE Guidance states that:

"If for any part of the new development, the angle from the centre of the lowest affected window to the head of the new development is more than 25^{o}, then a more detailed check is needed to find the loss of skylight to the existing buildings."

14.3.9 The BRE Guidance proposes several methods for calculating daylight. These assume that if, for any part of the new development, the angle from the centre of the lowest affected window to the head of the new development is more than 25º. Then more detailed assessment is required to assess the loss of skylight to the adjacent buildings.

14.3.10 The three methods predominantly used for the detailed assessment are those involving the measurement of the Vertical Sky Component (VSC), the No-Sky Line, and Average Daylight Factor (ADF).

14.3.11 The VSC calculation is a general test of potential for daylight to a building, measuring the light available on the outside plane of the windows.

14.3.12 The No-Sky Line divides those areas of the working plane, which can receive direct skylight, from those that cannot. It provides an indication of how good the daylight distribution is within a room.

14.3.13 The ADF calculation assesses the quality and distribution of light within a room served by a window and takes into the account the VSC value, the size and number of the windows and room and the use to which the room is put. ADF assesses actual light distribution within a defined room area whereas the VSC considers potential light. BS 8206-2:2008 recommends ADF values of 1% in bedrooms, 1.5% in living rooms and 2% in kitchens. For other uses, where it is expected that supplementary electric lighting will be used throughout the daytime, such as in offices, the ADF value should be 2%.

14.3.14 Whilst a valuable assessment tool, it is understood that ADF is secondary to that of the VSC and No-Sky Line assessments when considering daylight adequacy to neighbouring properties and for this reason only the two primary tests have been undertaken, although the ADF has been used for the self-test analysis which is considered to be the primary tool in this instance.

14.3.15 The BRE have produced sunlight templates for London, Manchester and Edinburgh indicating the Annual Probable Sunlight Hours (APSH) for these regions. The London template has been selected for this study because it is the nearest of the 3 available templates in terms of latitude.

14.3.16 Sunlight analysis is undertaken by measuring APSH for the main windows of rooms, which face within 90^{o} of due south. The maximum number of annual probable sunlight hours for the London orientation is 1,486 hours. The BRE Guidance propose that the appropriate date for undertaking a sunlight assessment is on 21st March, being the spring equinox. Calculations of both summer and winter availability are made with the winter analysis covering the period from the 21st September to 21st March. For residential accommodation, the main requirement for sunlight is in living rooms and it is regarded as less important in bedrooms and kitchens. There is a general requirement for sunlight in non-domestic buildings. The BRE Guidance suggests that in non-domestic buildings any spaces that are deemed to have a special requirement for sunlight should be checked.

14.3.17 The studies have been undertaken by calculating the daylight and sunlight based on the template drawings provided within the BRE Guidance. The study was undertaken with plan drawings derived from:

- Existing 3D Model, associated room and window locations
- Proposed Model; derived from architects drawings
- Site photography
- Site inspection

14.3.18 For the daylight study all windows in neighbouring properties known to be in residential use, which are likely to be affected by the development have been assessed using the VSC and Daylight Distribution/No-Sky methods. No plans of the neighbouring properties were available at the time of the assessment so reasonable assumptions have been made as to internal layouts and notional rooms have been set up behind windows in order to assess the likely daylight distribution.

14.3.19 For the sunlight study the sunlight availability indicator for London has been overlaid onto the tested windows in question and orientated correctly in accordance with the orientation of the Site.

Overshadowing Analysis

14.3.20 The BRE Guidance considers it important to maintain sunlight to amenity spaces between buildings as well as providing good natural lighting inside buildings.

14.3.21 The BRE Guidance advises that for gardens and open spaces to appear to be adequately sunlit throughout the year, no more than 40% (two-fifths) and preferably no more than 25% (one quarter) of any such space should be in shadow as a result of development. As with daylight and sunlight, analysis of overshadowing is undertaken in comparison with sunlight received on the 21st March. If as a result of any new development, any existing space does not meet with BRE Guidance, and the area that can receive some sun on 21st March is less than 0.8 times its former value, then the loss of sunlight is likely to be noticeable.

14.3.22 It follows that if some sun is received on 21st March, there will be sun over the summer months, however this may be reduced by the development proposals.

14.3.23 The overshadowing study has been undertaken in relation to the new amenity areas being created within the site boundary as part of the development proposals. There are currently no existing public amenity spaces within the vicinity of the development site that may be affected by the proposal.

14.3.24 The full results of the Overshadowing analysis on the relevant adjacent amenity areas are presented in *Appendix I of ES Volume III.*

14.3.25 It is clear that the amenity areas will not suffer any practical adverse effect. The moving shadows during March 21st will be cast over parts of the green/amenity areas adjacent station but there is no permanent shadow which signifies that the scheme will meet the standards set the BRE guidelines. At no point during March 21st will the proposal cast permanent shadow onto the selected green areas and is considered to have a **negligible** impact on all adjacent amenity areas in overshadowing terms. The green areas will not experience any significant increase in permanent overshadowing and all of these areas will comfortably satisfy the BRE Guidelines.

14.3.26 Solar glare principally occurs when the sun is low in the sky and dazzles the eye either directly or indirectly via a reflected surface. It is a highly localised and temporary effect dependent on the direction of the viewer is "looking, the position of the sun relative to the viewer and reflecting surface, plus localised weather conditions. The effect of Solar Glare, the reflected image of the sun on the glass façade of the Development was analysed at specific locations chosen on the basis that they are most likely to be significantly affected by any development generated glare. These locations are: -

- Test Point 1-3: Along London Road looking toward the development site.
- Test Point 4: On the railway platform

14.3.27 The solar glare assessments have been carried out by reference to the Building Research Establishment (BRE) Information Paper "Solar dazzle reflected from sloping glazed facades" by P J Littlefair (*Appendix I of ES Volume III).* The BRE paper presents a technique which can be used to predict solar reflection at the design stage. At the heart of the technique is the mathematical modelling of reflection from a sloping plane. For this assessment, the analysis was carried out using the 3D model of the Development and surrounding area and the specialist lighting software within 3D Studio Max to identify where, when and if any glare occurs and whether the glare is likely to create a safety issue to local pedestrian and vehicular daytime traffic. The solar glare template drawing is contained in *Appendix I of ES Volume III.*

Significance Criteria

14.3.28 In describing the significance criteria as set out in the following sections, it should be noted that they relate specifically to residential properties, which are the most sensitive receptors with respect to the proposed development.

Daylight and Sunlight

14.3.29 The guidance given by BRE has been used as a basis for the criteria to assess the Development's potential impacts. The BRE guidance specifies:

"…in special circumstances the developer or planning authority may wish to use different target values. For example, in an historic city centre a higher degree of obstruction may be unavoidable if new developments are to match the height and proportions of existing buildings."

14.3.30 The Guidance adds:

"…different criteria may be used, based on the requirements for daylighting in an area viewed against other site layout constraints."

14.3.31 In consideration of the above, it is important to note that the Site is located in a town centre, urbanised environment that, in parts, currently experiences adverse daylight and sunlight levels (This is discussed within the 'Baseline Conditions' section of this Chapter). Thus, in these instances the BRE Guidance states that the:

"…guidelines should be applied sensibly and flexibly".

14.3.32 Under these circumstances, the less stringent, higher BRE target percentage loss values and significance criteria may be justifiable.

14.3.33 The BRE guidance is summarised in the table below and this sets the criteria used in the assessment of daylight and sunlight impacts of the development.

BRE Standards

14.3.34 The BRE Guidance is summarised in the Table 14-1 and this has been used as the basis for the criteria used in the assessment of daylight, sunlight and overshadowing impacts.

Table 14-1 BRE Guidance Summary

Test:	Building Research Establishment (BRE) Criteria:
Daylight	A window may be adversely affected if the vertical sky component **(VSC)** measured at the centre of the window is less than 27% and less than 0.8 times its former value. **(DD)** A room may be adversely affected if, following the development, the area of the working plane that can receive direct skylight is less than 0.8 times its former value. A room may be adversely affected if the average daylight factor **(ADF)** is less than 1% for a bedroom, 1.5% for a living room or 2% for a kitchen. For offices a minimum figure of 2% is required.
Sunlight	A window may be adversely affected if a point at the centre of the window receives in the year less than 25% of the annual probable sunlight hours including at least 5% of the annual probable sunlight hours during the winter months (21 September to 21 March) and less than 0.8 times its former sunlight hours during either period.
Shadow	The BRE advises that for gardens and open spaces to appear to be adequately sunlit throughout the year, no more than 40% (two-fifths) and preferably no more than 25% (one quarter) of any such space should be prevented by buildings from receiving any sun at all on 21 March. If as a result of any new development there is a reduction of more than 20% of the former values, then the loss of sunlight is likely to be noticeable. It follows that if some sun is received on 21 March, there will be sun over the summer months.

14.3.35 This BRE guidance has been used to generate significance criteria that have been used to assess the impact of the Development. For VSC criteria, they are:

- Windows experiencing less than 20% reduction represent negligible to minor beneficial impacts;
- Windows experiencing between 20 and 29.9% reduction represent minor adverse impacts;
- Windows experiencing between 30 and 39.9% reduction represent moderate adverse impacts; and
- Windows experiencing greater than 40% reduction represents major adverse impacts.

14.3.36 A room within a neighbouring residential property is considered to suffer a materially adverse impact if, as a result of development proposals, the room fails to meet the minimum BRE standard for any of the three assessments. It should be noted that VSC results which can only be viewed as "…a general test of potential for daylight." The BRE Guide intends this assessment to be used as a tool to aid window positioning during the building design process. When testing neighbouring properties it should, be accompanied by an assessment of internal daylight distribution by calculation of the Daylight Distribution (DD). It is noted that the DD form of assessment is an accurate indication of the distribution of light within a room and takes the room and window dimensions into account.

14.4 Baseline Conditions

14.4.1 An analysis of the impact of the existing buildings (the baseline conditions) against which to compare any potential impact arising from the development has been undertaken based on the survey information provided as confirmed in paragraph 14.3.17.

14.4.2 An analysis of the existing daylight and sunlight levels enjoyed by the relevant neighbouring property has been undertaken in order to provide a baseline against which the impacts arising from the proposed development can be assessed. The detailed results of this analysis are presented in the tables at *Appendix I of ES Volume III.*

14.4.3 It is noted that the site of the Regal House development is situated adjacent to Twickenham Station and is in close proximity to its neighbouring buildings.

14.4.4 The table below identifies the sensitive properties that will be assessed as part of the daylight and sunlight assessment.

Table 14-2 Neighbouring properties considered in the Daylight and Sunlight Assessment.

Daylight	Sunlight
2, 2a, 2b & 4 Cole Park Road	2, 2a, 2b & 4 Cole Park Road
11-16 Mary's Terrace	

Note: No internal arrangement inspections obtained but reasonable assumptions made as to notional room layouts for daylight distribution.

Daylight and Sunlight

14.4.5 An analysis of the existing daylight and sunlight levels enjoyed by the surrounding residential buildings in the vicinity of the site has been undertaken in order to provide a baseline against which the impacts arising from the proposed development can be assessed. The detailed results of the surrounding properties in the existing baseline conditions are presented in *Appendix I of ES Volume III.* The site is in a relatively dense urban environment. The surrounding buildings currently receive varying degrees of natural lighting levels as the existing massing of the site and surrounding buildings contribute to reduce the available daylight and sunlight to relevant windows.

14.4.6 The analysis of existing baseline conditions revealed that generally the neighbouring properties currently receive good levels of light considering their town centre location in relation to the BRE recommendations.

Overshadowing

14.4.7 As there are amenity areas within the vicinity of the site that will be affected by the development proposals, a baseline assessment has been undertaken.

14.5 Construction Impacts and Mitigation Measures

Demolition and Construction

14.5.1 Demolition of the existing buildings on-site will result in a temporary reduced impact from the Site and hence improvement in daylight, sunlight and overshadowing affecting neighbouring buildings and public open spaces. The potential impacts of the demolition and construction of the Development will occur on a regular frequency, steadily increasing in magnitude as the superstructure is built and then clad. During this phase, a number of tall cranes may be present on-site; however their size and temporary presence will lead to generally negligible impacts of a temporary nature.

14.5.2 The light spillage from demolition and construction of the Development is likely to be at times greater than that of the completed Development, particularly prior to the external cladding being erected. The light spillage will be occasional and temporary and will be necessary for safe access to and from the Site during the hours of darkness. The use of Site hoardings will help reduce light spill into the adjacent properties and roadways. Further reductions will occur through the use of directional floodlight controls for any higher positioned luminaries, as specified within the Demolition and Construction Method Statement and Environmental Management Plan. The impacts of the construction phases are considered to be **negligible**.

14.6 Operational Impacts and Mitigation Measures

Daylight - VSC

14.6.1 Several plans were obtained for the surrounding properties assessed and the Vertical Sky Component (VSC) measurements were undertaken assessing the potential for daylight on the face of the window.

14.6.2 For 1, 2a, 2b, 5 Cole Park Road and 10 and 11 Mary's Terrace plans were obtained to enable the more accurate and reliable DD assessment to be carried out with assumptions derived from these for the adjacent properties.

14.6.3 The results of the daylight analysis on the relevant overlooking windows and rooms of the properties are presented in the Table 14-3 below. The full results of the daylight analysis are presented in *Appendix I of ES Volume III.*

Table 14-3 Number of Windows Experiencing Negligible and Adverse Daylight Impacts as a Result of the Development

Address	Total Number of Windows Tested	Windows Meeting BRE Guidelines for VSC	Number of Windows Experiencing Adverse Impacts			
			<20% reduction (negligible impact)	20-29.9% reduction (minor adverse impact)	30-39.9% reduction (moderate adverse impact	>40% reduction (major adverse impact)
2 Cole Park Road	8	8	8	0	0	0
2a Cole Park Road	15	14	11	4	0	0
2b Cole Park Road	8	8	6	2	0	0
4 Cole Park Road	15	14	13	2	0	0
11 Mary's Terrace	4	4	4	0	0	0
12 Mary's Terrace	3	3	3	0	0	0
13 Mary's Terrace	3	3	3	0	0	0
14 Mary's Terrace	3	3	3	0	0	0
15 Mary's Terrace	3	3	3	0	0	0
16 Mary's Terrace	4	4	4	0	0	0
Total:	66	64	58	8	2	0

14.6.4 The above table indicates that of the 66 windows assessed 64 (97%) of the windows assessed will comply with the BRE recommendations for VSC, 8 (12%) will experience a minor adverse impact, 2 (3%) will experience a moderate adverse impact and no windows will experience a major adverse impact.

Daylight – "No Sky" Contour

14.6.5 The results of the "No Sky" Contour analysis on the relevant overlooking rooms are presented in the summary Table 14-4 and at *Appendix I of ES Volume III.*

Table 14-4 Number of Rooms/Windows Experiencing Negligible and Adverse Daylight Impacts as a Result of the Development

Address	Total Number of Rooms/ Tested	Rooms/ Windows Meeting BRE Guidelines for VSC	Number of Rooms/Windows Experiencing Adverse Impacts			
			<20% reduction (negligible impact)	20-29.9% reduction (minor adverse impact)	30-39.9% reduction (moderate adverse impact	>40% reduction (major adverse impact)
2 Cole Park Road	6	6	6	0	0	0
2a Cole Park Road	7	7	10	0	0	0
2b Cole Park Road	6	6	6	0	0	0
4 Cole Park Road	5	5	5	0	0	0
11 Mary's Terrace	2	2	2	0	0	0
12 Mary's Terrace	3	3	3	0	0	0
13 Mary's Terrace	3	3	3	0	0	0
14 Mary's Terrace	3	3	3	0	0	0
15 Mary's Terrace	3	3	3	0	0	0
16 Mary's Terrace	2	2	2	0	0	0
Total:	40	40	40	0	0	0

14.6.6 The above table indicates that of the 40 neighbouring rooms assessed 100% will fully comply with the target values set by the BRE for "No Sky Contour" or Daylight Distribution assessment. Whilst it is recognised that some of the rooms used are notional, these results give a very good indication that the neighbouring rooms will remain well lit as a result of the proposed development. Whilst internal access to the neighbouring properties has not been obtained, we were able to source rooms layouts from a planning search and source details on 10, 16 mary's Terrace, 2A and 2B Cole Park Road. This information was used to set up notional rooms for the adjacent properties.

14.6.7 The overall impact to the neighbouring properties is considered to be **negligible** when measured against the significance criteria.

Sunlight - APSH

14.6.8 The results of the Annual Probable Sunlight Hours (APSH) analysis on the relevant overlooking windows are presented in the Table 14-5. The full results of the sunlight analysis are presented in *Appendix I of ES Volume III.*

14.6.9 Due to the orientation of the site not all of the elevations tested for daylight analysis qualify for sunlight analysis.

Table 14-5 Number of Windows Experiencing Negligible and Adverse Daylight Impacts as a Result of the Development

Address	Total Number of Windows Tested	Windows Meeting BRE Guidelines for VSC	Number of Windows Experiencing Adverse Impacts			
			<20% reduction (negligible impact)	20-29.9% reduction (minor adverse impact)	30-39.9% reduction (moderate adverse impact	>40% reduction (major adverse impact)
2 Cole Park Road	1	1	1	0	0	0
2a Cole Park Road	1	1	1	0	0	0
2b Cole Park Road	1	1	1	0	0	0
4 Cole Park Road	1	1	1	0	0	0
Total:	4	4	4	0	0	0

14.6.10 The table indicates that of the main south facing living rooms assessed as required by the BRE, 100% will comply with the BRE target values for APSH as a result of the proposed development.

14.6.11 Overall the development proposals are considered to have a **negligible** impact on sunlight adequacy to neighbouring habitable rooms in sunlight terms.

Daylight VSC & DD

14.6.12 The full results of the Vertical Sky Component (VSC) and Daylight Distribution (DD) analysis on the relevant overlooking windows are presented on the drawings and tables in *Appendix I of ES Volume III.*

2 Cole Park Road

14.6.13 There are minor reductions but all VSC figures remain above the BRE target standard. The VSC is a measure of the potential for natural light on the outer face of the glazing taken at the centre point of the window. We have therefore assessed the actual light enjoyed within the rooms using the Daylight Distribution test. All rooms comfortably pass the minimum standards with much of the room receiving good natural daylight, i.e 91-100% of room area is well lit.

2A Cole Park Road

14.6.14 Again there are reductions in the potential light on the outside face of the glazing and in four instances the initial VSC study confirms marginal values that do not meet the target value of 0.8 its former value, however all will pass and have more than 27% VSC. Only one window fails to meet the target value of 0.8 with a resultant value of 0.76 which is marginal. We have therefore undertaken an accurate assessment of the natural lighting within the room. The DD figure again far exceeds the minimum standard and therefore passes the daylight criteria with almost the entire room receiving good light, i.e. 90-100% of room area is well lit.

2B Cole Park Road

14.6.15 There are minor reductions with all windows being above the 27% guideline. We have also assessed the actual light enjoyed within the rooms using the Daylight Distribution test. All rooms comfortably pass the minimum standards with much of the room receiving good natural daylight, i.e. 98.9-99% of room area is well lit.

4 Cole Park Road

14.6.16 The initial VSC study shows that all windows pass with the exception of one room which achieves 0.75 its former value rather than the 0.8 minimum standard. A detailed assessment has therefore been undertaken using the daylight distribution method. The DD figures again far exceed the minimum standard and therefore pass the daylight criteria with almost the entire area of each room receiving good light, i.e. 99.8-100% of room area is well lit.

11-16 Mary's Terrace

14.6.17 Both the VSC and Daylight Distribution studies were undertaken as before to demonstrate the effect on the natural lighting. The resultant tables at *Appendix I of ES Volume III* confirm full compliance with the VSC and DD criteria, i.e. 99.49-100% of room area is well lit.

Sunlight

14.6.18 Due to the orientation of the site only the windows of 2, 2A, 2B and 4 Cole Park Road qualify for sunlight analysis. From an examination of the template and resultant table, the south facing main habitable living room windows receive excellent summer, winter and annual sunlight.

Overshadowing

14.6.19 The BRE advises that for gardens and open spaces to appear to be adequately sunlit throughout the year, no more than 40% (two-fifths) and preferably no more than 25% (one quarter) of any such space should be prevented by buildings from receiving any sun at all on 21 March. If as a result of any new development there is a reduction of more than 20% of the former values,

then the loss of sunlight is likely to be noticeable. It follows that if some sun is received on 21 March, there will be sun over the summer months.

14.6.20 The full results of the Overshadowing analysis on the relevant adjacent amenity areas are presented in *Appendix I of ES Volume III.*

14.6.21 It is clear that the amenity areas will not suffer any practical adverse effect. The moving shadows during March 21st will be cast over parts of the amenity areas but there is no permanent shadow which signifies that the scheme will meet the standards set the BRE guidelines. At no point during March 21st will the proposal cast permanent shadow onto the selected neighbouring gardens or River Crane and is considered to have a **negligible** impact on all adjacent amenity areas in overshadowing terms.

Solar Glare

14.6.22 The glass facades of the Development will produce some solar glare as any building with glass or bright, shinny surface would at some point throughout the year. The Site is surrounded by existing buildings along its northern and southern boundaries which partly overshadow the lower floors therefore preventing any significant solar glare affecting the surrounding street level. *Appendix I of ES Volume III* provides the Solar Dazzle Analysis diagram.

14.6.23 Using test point 1 as an example, we have illustrated the direction from where the reflection is coming from that is appears on the diagram. For example, upon review of section B marked on the Sun path Diagram, the sun needs to be in the SSE to reflect back to point B. The Sun needs to be almost due west to arrive at point 1 from Area A (the long elevation facing London Road). This will be the setting sun after 5:00pm from March through to September. The Thick Red line pointing NNW from point 1 to the end of the building marks the furthest point North that could give a reflection this is marked by the thick red line at the top of the Sun path diagram. However, this will never give a reflection as it is too far North (the sun sets just North of West in London during the summer).

Test Point 1

14.6.24 Point 1 is testing reflection dazzling a vehicle driving NW up London road. Reflection from Area B is from the end of the building and will only cause reflection from the side for approx 2hr period 9:30am-11:30am from March through to September. Area A will cause reflection from 5:00pm until sunset from mid March through to mid September. At no time will this reflect directly down London Road.

Test Point 2

14.6.25 Reflection is from the main face of the building facing SW. Reflection can occur from 12:00 noon from all year. Again the reflection cannot occur directly down London Road. We would suggest the glare is more significant for someone crossing London Road towards the station at this point than driving north up London Road.

Test Point 3

14.6.26 Can receive Dazzle from 10:00am - 11:30 am from mid-October through until Mid-February. This location is to test dazzle for a vehicle travelling south east down London Road. The direction of reflection is oblique at an angle of approx 20 degrees from the main façade at the station entrance.

Test Point 4

14.6.27 This location is to test for dazzle received by a passenger standing on the platform. It is worth noting neighbouring obstructions to dazzle are not shown (in fact the canopy over the adjoining platform will obscure the majority of dazzle especially at low angles and this is true for the other test points. The main area of reflection occurs from 7:30 am and 14:00 pm from March to October

14.6.28 The technical analysis shows that for the majority of the year there would be negligible impact from solar glare. The nature of the proposed glazed cladding does mean that reflected solar glare would be unavoidable at certain times of the day and at certain times of the year assuming that there are actually clear skies at these times to allow the sun to reflect off the building facades. The analysis shows, however, that at worse this would be a highly localised minor adverse impact lasting only a few hours at any one time.

14.6.29 The solar glare analysis reveals that there is a **negligible** / **minor adverse** impact from daytime solar glare but this is not considered to be detrimental to the safe movement around the roads and pavements surrounding the development.

Internal Daylight and Sunlight of Proposed Scheme

14.6.30 The analysis of the proposed accommodation from a daylight and sunlight perspective has shown that there is a very high level of compliance with the BRE guidance and the majority of the façade receiving VSC values of 27% or more and therefore demonstrating a very good level of daylight potential. Where daylight levels are more restricted it has been seen through the more detailed methods of assessments that again high levels of compliance are achieved in respect of Average Daylight Factor and No Skyline. In all cases of the rooms assessed, full compliance with the BRE criteria has been demonstrated. The internal sunlight analysis of the proposed accommodation again is focused purely on the living rooms at the lowest levels of the residential accommodation. Again this confirms compliance and the worse case scenario far exceeds the BRE criteria.

Overshadowing within the Development

14.6.31 The technical analysis of the permanent overshadowing was undertaken as a result of the transitory overshadowing path studies. It is clear from this that the amenity spaces within the development would enjoy sunlight for significant periods of the day throughout the year. This effect at this area would be considered to be **negligible**. The amenity spaces will see good levels of direct sunlight throughout the year. The effect to the proposal on the transitory overshadowing of the amenity areas would therefore be **negligible.**

14.7 Residual Impact Assessment and Conclusions

14.7.1 The site is situated in the London Borough of Richmond and is in close proximity to the adjacent residential properties on Cole Park Road and Mary's Terrace.

14.7.2 To assess the development's potential impact on daylight, sunlight and shadowing on neighbouring properties a baseline assessment has been undertaken. The main methods of assessment included the Vertical Sky Component (VSC) and No-sky line/daylight distribution (DD) method for daylight and sunlight analysis using the template drawings provide by the Building Research Establishment.

14.7.3 The VSC daylight and DD tests were undertaken and confirms that all rooms would PASS. The development is considered to have a **negligible** impact.

14.7.4 Two of the VSC figures confirm losses that do not fully meet the BRE criteria. However most of the rooms assessed around the site will have the benefit of dual aspect. The Daylight Distribution results show that all rooms will be left adequately lit well within the BRE guidelines. Therefore whilst the two windows have been poorly designed around the tested property, the daylight distribution results show that the neighouring room configurations in relation to their serving windows have been designed to allow sufficient light into their properties in the existing scenario. The proposed daylight distribution results show that Twickenham Station has been designed to continue to allow sufficient light into the neighbouring residential rooms. Therefore whilst the VSC figure show potential for light, the daylight distribution assessment shows the amount of effective penetrable light and thus is the appropriate form of assessment for this study.

14.7.5 To assess the development's potential shadow on neighbouring amenity land an assessment was undertaken in accordance with the Building Research Establishment guidelines.

14.7.6 The scheme proposals demonstrate that the impact of the proposed development will create **negligible** impact on the residential amenity adjacent to the development site and is considered acceptable in terms of the BRE.

14.7.7 The development should therefore be considered and the guidelines applied flexibly to meet the requirements of London Borough of Richmond UDP in daylight and sunlight terms.

14.8 Cumulative Impact Assessment

14.8.1 There is a proposed scheme for Regal House in the vicinity of the site that may have an influence on daylight, sunlight and overshadowing at the developed site.

14.8.2 Due to the moderate height and to the position of the scheme relative to the Twickenham Station development site, the cumulative impact on daylight, sunlight and overshadowing is considered to be **negligible**.

14.8.3 With regard to the impact Twickenham Station development will have on the Royal Mail building, it is considered that the development will breach a 25 degree line, however the Royal Mail building footprint is much lower than the development which gives rise to a perception of the development as being higher. As the Royal Mail building is likely to be implemented after the completion of Twickenham Station it is considered that in the design stage the Royal Mail building could be built to suit daylight requirements to ensure BRE target values are met by introducing window glazed areas sufficient for adequate ADF values.

14.9 References

Ref. 14-1 The Regulatory Reform (Housing Assistance) (England and Wales) Order 2002,

Ref. 14-2 Department of Communities and Local Government, 2005. *Planning Policy Statement 1 (PPS 1) Delivering Sustainable Development*. Her Majesty's Stationary Office (HMSO). London

Ref. 14-3 English Heritage/Commission for Architecture and the Built Environment Guidance on Tall Buildings, March 2003,

Ref. 14-4 London Borough of Richmond UDP

Ref. 14-5 British Standard (BS) 8206, Part 2, British Standards Institution, 2008,

Ref. 14-6 Building Research Establishment Guidance *Site layout planning for daylight and sunlight: a guide to good practice* (BRE Garston Watford Hertfordshire WD2 7JR)

Ref. 14-7 Ordinance Survey, 2006. *Landranger Map 173: Swindon and Devizes 2006. '*

Ref. 14-8 Rolfe Judd Architects' scheme drawings

Ref. 14-9 EWL 14418, nos.1-14. - Surveys Plans.

15.1 Introduction

15.1.1 This Chapter of the Environmental Statement (ES) assesses the potential impacts of the proposed development on wind microclimate. The Chapter has been written by RWDI, a specialist wind engineering consultancy, with wide experience of providing consulting advice on wind microclimate issues in the UK and overseas.

15.1.2 The Chapter will consider the long-term meteorological conditions for the area, adjusted to the site and how the wind interacts with the buildings that comprise the Proposed Development. The proposed development is shown in Figure 15-1.

15.1.3 The wind microclimate will be described in terms of the familiar Lawson Comfort Criteria which have been used for many years in studies of this kind across the UK. The criteria are familiar to many planning authorities.

Figure 15-1 View of the Proposed Development from North

15.2 Planning Policy Context

National Planning Policy

15.2.1 There are no National Planning Policies related to the determination of wind microclimate in the built environment.

Regional Planning Policy

The London Plan, Spatial Development Strategy for Greater London, 2008

15.2.2 The planning guidance contained within the Mayor's London Plan (Ref. 15-1) places great importance on the creation and maintenance of a high quality environment for London. Under Policy 4B.9 'Tall buildings – location' the plan states that "The Mayor will promote the development of tall buildings where they create attractive landmarks enhancing London's character… and where they are also acceptable in terms of design and impact on their surroundings".

15.2.3 Under Policy 4B.10 'Large-scale buildings – design and impact', the London Plan 2008 (Ref. 15-1) states that: "All large-scale buildings including tall buildings should be of the highest quality design and in particular…be sensitive to their impact on micro-climates in terms of wind, sun, reflection and overshadowing". Wind micro-climate is therefore an important factor in achieving the desired planning policy objective.

15.2.4 The London Plan provides the framework for the Mayor to produce more detailed strategic guidance on issues which cannot be addressed in sufficient detail in the plan. To provide detailed advice on its policies, Supplementary Planning Guidance (SPG) and Best Practice Guidance (BPG) documents have been produced.

Sustainable Design and Construction, Supplementary Planning Guidance, 2006

15.2.5 The 'Sustainable Design & Construction, Draft Supplementary Planning Guidance' (Ref. 15-2) is a formal supplement to the London Plan. This SPG, under Section 2.4.5 'Microclimate', stipulates that a wind environment assessment should be carried-out for tall buildings and that the results of the assessment should show that the Lawson criteria can be met. In addition there is a preferred outcome that the wind impacts on neighboring surrounding buildings should be negligible implying no significant change in the wind conditions.

Local Planning Policy

15.2.6 A review of the London Borough of Richmond Upon Thames UDP and LDF publications did not reveal any specific requirements or guidance on the issue of wind microclimate.

15.3 Assessment Methodology and Significance Criteria

15.3.1 The wind microclimate assessment is based upon analysis of long-term historical meteorological data for the London area that is adjusted to the site taking account of the different ground roughness in all directions that approach the site. The building massing is then reviewed in context with the site specific meteorological data and the resulting wind microclimate benchmarked in terms of the Lawson Comfort Criteria.

15.3.2 Knowledge of the prevailing wind direction allows attention to be focused on the likely impact of these winds on the site and, for the southern UK, south westerly winds have a dominant effect on the wind microclimate. However, the building massing/layout can also lead to winds from other directions creating potential nuisance at the site and so these other directions are also considered.

15.3.3 The desk-based study was conducted by an experienced, specialist wind engineer and was intended to assess the wind microclimate and whether further more detailed assessment would be necessary in the event that significant impacts were identified.

Comparison of the wind conditions with the desired conditions

15.3.4 Often a new development alters the pedestrian activity on site and consequently a comparison of the original wind conditions with those on the developed site can be misleading. For example, wind conditions currently suitable for pedestrian walking and which remain suitable for pedestrian walking after development may lead to the conclusion that there is negligible impact due to the development. However, if on the new development the location of interest is outside a main entrance then the impact is adverse and will require remedial action.

15.3.5 In the assessment of the proposed development, comparison is made between the wind conditions expected on the developed site and the desired wind conditions. This is generally the most useful baseline for comparison because it is an assessment which indicates whether the wind conditions are suitable for the intended pedestrian activity at a particular location.

15.3.6 For an urban, town centre development, the target wind microclimate would typically be suitable for leisure walking on pedestrian thoroughfares, standing at bus-stops, outside retail units or main entrances, and sitting in amenity spaces. However, the focus for amenity spaces is usually towards sitting conditions during the summer months when there is a greater expectation that such areas would be used more frequently.

Pedestrian Comfort – Lawson Comfort Criteria

15.3.7 RWDI routinely uses criteria developed by Lawson (Ref. 15-1). Lawson devised a twelve-point scale (not shown here) to represent equal increments of annoyance or reaction to the wind and these were then used to set threshold values for particular pedestrian activities. The criteria account for the fact that the wind conditions perceived as tolerable by pedestrians depend on the activity they are engaged in. For example, wind conditions in an area designated for sitting need to be calmer than a location that people merely walk past. In total there are five pedestrian activities described in Table 15-1 in ascending order of activity: sitting, standing/entrance, leisure walking, business walking and roadways/car parks. Table 15-2 summarises the Beaufort Land Scale and quantifies the wind speeds associated with each Beaufort Range.

15.3.8 The threshold criteria in Table 15-1 show both the wind speed and frequency of occurrence beyond which the wind microclimate is unsuitable for the stated pedestrian activity. For example, the 6%>B3 classification implies that if the wind speed is greater than Beaufort Force 3 (B3) for more than 6% of the time then the wind microclimate will be unsuitable for standing.

Table 15-1 Lawson Comfort Criteria

Prescribed Usage	Upper Threshold of Wind Speed
Road and car parks	6% > Beaufort Wind Scale 5 (B5)
Business walking	2% > B5
Leisure walking	4% > B5
Pedestrian standing / Entrance Doors	6% > B3
Sitting	1% > B3

Table 15-2 Beaufort Land Scale

Beaufort Force	Hours Average Wind Speed (m/s)	Description of Wind	Noticeable Wind Effect
0	< 0.45	Calm	Smoke rises vertically
1	0.45 - 1.55	Light Air	Direction shown by smoke drift but not by vanes
2	1.55 - 3.35	Gentle Breeze	Wind felt on face; leaves rustle; wind vane moves
3	3.35 - 5.60	Light Breeze	Leaves & twigs in motion; wind extends a flag
4	5.60 - 8.25	Moderate Breeze	Raises dust and loose paper; small branches move
5	8.25 – 10.95	Fresh Breeze	Small trees, in leaf, sway
6	10.95 - 14.10	Strong Breeze	Large branches begin to move; telephone wires whistle
7	14.10 - 17.20	Near Gale	Whole trees in motion
8	17.20 - 20.80	Gale	Twigs break off; personal progress impeded
9	20.80 - 24.35	Strong Gale	Slight structural damage; chimney pots removed
10	24.35 - 28.40	Storm	Trees uprooted; considerable structural damage
11	28.40 - 32.40	Violent Storm	Damage is widespread; unusual in the U.K.
12	> 32.40	Hurricane	Countryside is devastated; only occurs in tropical countries

Pedestrian Safety – Strong Winds

15.3.9 The Lawson Criteria also specify a lower limit safety criterion when winds exceed Beaufort Force 6. If this safety criterion is exceeded then there may be a need for mitigation measures or a careful assessment of the expected use of that location, e.g. is it reasonable to expect vulnerable pedestrians to be present at that location on the windiest day of the year?

15.3.10 Experience has shown that occurrences of business walking and roadway wind conditions are associated with wind speeds in excess of the B6 safety criterion and therefore pedestrian safety as well as comfort should be considered if such conditions occur.

Significance criteria

15.3.11 The Significance criteria used in this assessment are based on a comparison of the predicted wind microclimate with the desired pedestrian use of an area and use the Lawson Comfort Scale to quantify that comparison. The scale used to determine the Significance of an effect is summarised below:

Beneficial: Defined as a wind microclimate that is calmer than required by the pedestrian use of a location

Adverse: Defined as a wind microclimate that is windier than required by the pedestrian use of a location

Extreme: A wind microclimate that is at least two categories windier than desired and experiences strong winds in excess of Beaufort Force 7 for a significant period of time.

Major: A wind microclimate that is two categories calmer/windier than desired.

Moderate: A wind microclimate that is two categories calmer/windier than desired.

Minor: A wind microclimate that is one category calmer/windier than desired.

Negligible: A wind microclimate that is suitable for the intended pedestrian use of a site.

15.3.12 For example, if the wind microclimate outside an entrance is suitable for sitting then that would imply a minor beneficial effect whereas leisure walking conditions would imply a minor adverse effect.

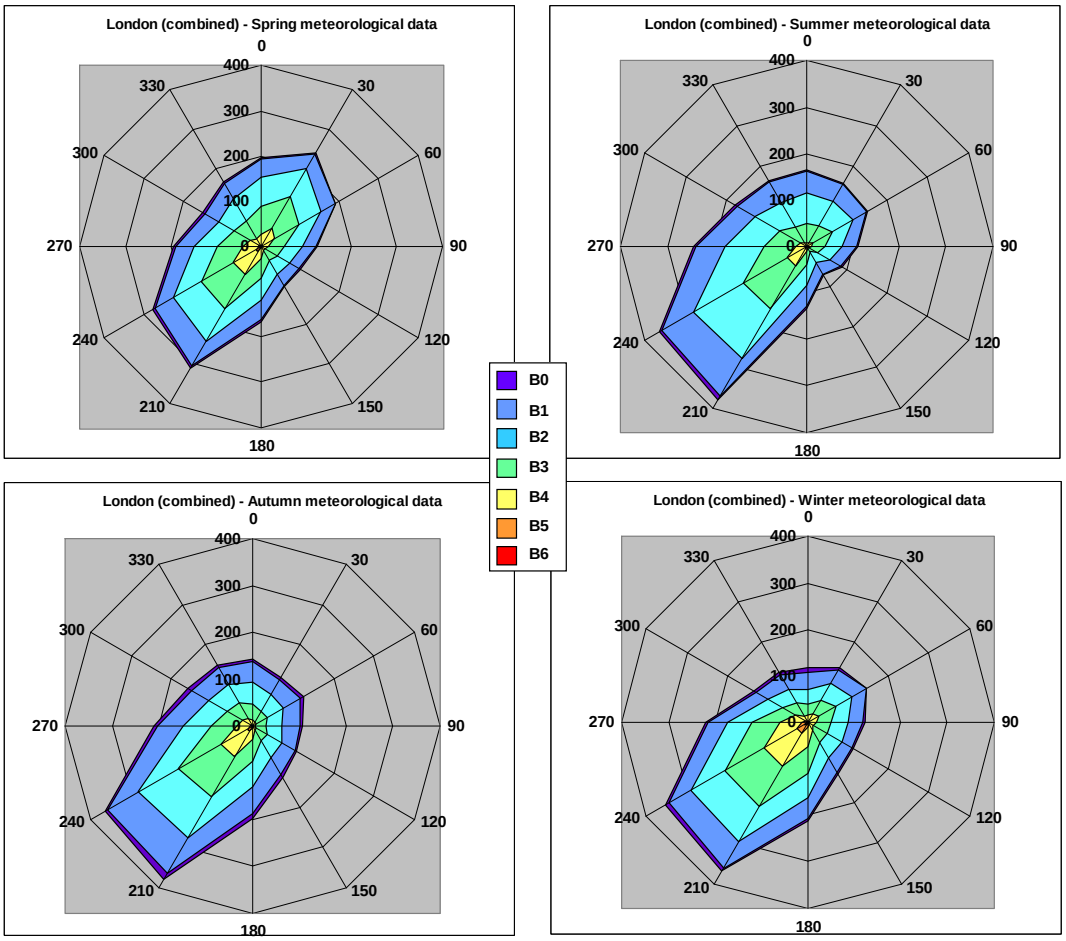
15.4 Baseline Conditions

General Meteorological Data

15.4.1 Joint frequency tables of wind speed, divided into ranges of the Beaufort Scale, and direction on an annual basis for 30° sectors around the compass were obtained for London. This data provides a measure of the general background windiness for the area which can then be adjusted to the Twickenham site by modelling the effect of the ground surface roughness in all directions. The presentation of the wind rose in this report is for annual and seasonal data defined as spring (March, April, and May), summer (June, July and August), autumn (September, October, November) and winter (December, January, February). The London wind roses for standard open-country terrain are shown in Figure 15-2.

Figure 15-2 Seasonal wind roses for London (in Beaufort Force)

(Radial axis indicates the hours for which the stated Beaufort Range is exceeded)



15.4.2 The meteorological data indicates a peak from the south-westerly direction which is prevalent throughout the year and secondary north-easterly during the spring.

Surface Roughness around the Site

15.4.3 Analysis of the surface ground roughness, due to buildings, park areas approaching the site was conducted in each wind direction in order to correct the Meteorological data to the site. The assessment of the ground roughness was conducted using the BREVe2 software (Ref. 15-2) and the results of this are presented in Table 15-3 in terms of the 'mean factor'.

15.4.4 The mean factor represents the ratio of wind speed on site, at the stated reference height, as a fraction of the wind speed in open, flat countryside at a height of 10m. The mean factors for the site at 10m above ground are relatively constant for all wind directions and typical of an urban site where the wind speeds are 60% of the open country wind speed at 10m above ground.

Table 15-3 Mean factors for the Twickenham Site

	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
2m	0.42	0.42	0.42	0.43	0.42	0.44	0.44	0.44	0.43	0.43	0.43	0.42
10m	0.57	0.58	0.58	0.59	0.58	0.60	0.60	0.60	0.58	0.58	0.59	0.57

The current wind conditions on site

15.4.5 Analysis of the meteorological data for London adjusted to account for the terrain roughness approaching the site, indicates that the existing conditions on an idealised open site are likely to be suitable for standing/entrance use or better during the windiest season (i.e. winter). In this baseline assessment, the idealised open site scenario represents a measure of the 'background windiness' of the site away from any localised effects attributed to isolated tall buildings. The low-rise existing buildings on the site are not expected to significantly change the wind environment relative to the open site scenario assessed above.

15.4.6 The implication of this result is that, after development, if the site has a number of locations where the conditions are tolerable for (say) leisure walking, then these are likely to be perceived to be 'windy' relative to general conditions in the area.

15.4.7 It is desirable, as part of a good neighbour policy, to minimise adverse changes to the wind conditions on neighbouring buildings due to a development. Generally, development may lead to increased wind speeds on adjacent properties for some wind directions but increased shelter for other directions.

15.5 Site Preparation and Construction Impacts and Mitigation Measures

15.5.1 During Preparation and Construction phases the site will be initially similar to the existing layout and then gradually approach the wind microclimate described in more detail in the following section, as construction progresses.

15.5.2 This implies a **negligible** effect with conditions generally suitable for standing/entrance use.

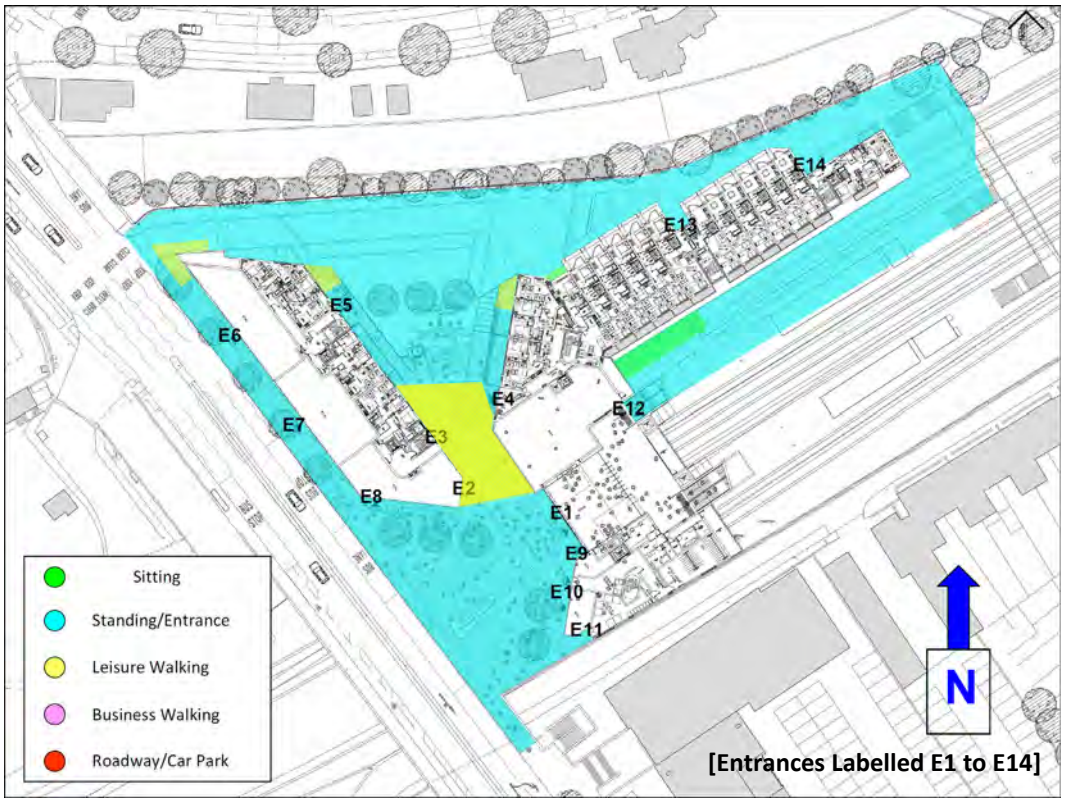
15.6 Operational Impacts and Mitigation Measures

15.6.1 For wind microclimate the Operational Impacts can be categorised as: long-term because they are dependent upon the building massing and site meteorology which are fixed; localised because the main effects are restricted to the site and its immediate environs and direct.

15.6.2 The overall wind comfort assessment is summarised in Figure 15-3 where the shaded areas represent the different pedestrian activities for which the wind microclimate will be suitable during the windiest season.

15.6.3 The range of wind conditions shown in Figure 15-3 vary from standing/entrance use to leisure walking which covers the typical desired range for an urban development.

Figure 15-3 Site plan showing expected windiest season comfort levels (windiest season)



Entrances

15.6.4 The north elevation of the site is shielded from the direct effects of the prevailing south-westerly winds and is therefore relatively sheltered. The new thoroughfare between the two new buildings is an area which is expected to focus northerly winds into the site and also act as a channel through which the south westerly winds will be directed by the south west elevation of the Station building.

15.6.5 Entrances in this zone (E2 and E3) are therefore exposed to conditions suitable for leisure walking during the windiest season, which is one category windier than desired and implies a **minor adverse** effect. Remaining entrances around the site are classified as suitable for standing/entrance use which implies a **negligible** effect.

Amenity Space

15.6.6 Public amenity spaces are normally assessed with regard to the summer season because there is an expectation that these would be more frequently used during this season. In the summer, the results shown in Figure 15-2 would generally improve by one category because of the lighter winds that occur during the summer. Areas which are classified as suitable for leisure walking during the windiest season would generally become suitable for standing/entrance use during the summer and standing/entrance conditions would become suitable for sitting.

15.6.7 Consequently, the north-west corner of the development is expected to be suitable for standing/entrance use during the summer whereas, other areas are expected to be suitable for sitting. There is one exception to this, the throughfare between the two proposed buildings, where conditions would be locally suitable for leisure walking use during the summer season.

15.6.8 These conditions imply **negligible** to **minor beneficial** effects as outdoor amenity areas. If any areas intended for long term sitting were located in the throughfare between the two buildings, these areas would experience a **minor adverse** impact during the summer season.

Thoroughfares

15.6.9 The windiest conditions shown in Figure 15-3 are suitable for leisure walking and so the site is generally suitable as a pedestrian thoroughfare. There is a **negligible** effect expected in the windier zone between the two Proposed buildings and a **minor to moderate beneficial** effect in other areas which are classified as suitable for Standing/Entrance or sitting use.

Balconies

15.6.10 There are balconies located around the development on most elevations and at varying levels above ground. There are recessed balconies, protruding balconies and corner balconies. We understand that these balconies are intended for residents and that these areas would normally be outside the scope of a planning application; however, in order to provide design guidance, our assessment comments on the likely wind conditions in these areas.

15.6.11 The corner balconies are directly exposed to the corner winds that blow around the buildings but most of the balconies have a full-height screen along one of the sides of the balcony which pushes wind around the balcony, creating shelter. Figure 15-4 shows the corner balconies.

Figure 15-4 Sketch-up Model Identifying Corner Balconies

15.6.12 The balconies which overlook the space between the two new buildings, protrude from the façade and would therefore be exposed to northerly winds channelling between the two buildings. However there are partitions/screens part way along the balcony which will push the wind around the balcony thereby creating localised shelter. Figure 15-5 shows the protruding balconies.

Figure 15-5 Sketch-up Model Identifying Protruding Balconies

15.6.13 The inclusion of the partition screens and the corner screens is expected to enhance the local wind microclimate and create an environment for residents where, on relatively calm days and when the balcony is on the downwind side of the building, residents would be able to sit comfortably during the summer. This implies a **negligible** effect.

Mitigation Measures

15.6.14 In the assessment above, it has been assumed that there is no landscaping or planting around the development in order to obtain a set of conservative, i.e. relatively windy, results. Moreover, this is a reasonable assumption when many trees are deciduous and therefore offer only marginal shelter in the windiest winter months.

15.6.15 Planting and other landscape enhancements would increase the shelter compared with the assessment described in the previous section, particularly during the late spring and summer seasons, when the deciduous trees are in full leaf.

15.6.16 Most locations on site are expected to experience a wind microclimate suitable for their intended pedestrian use. However, there are two entrances (E2 and E3) where the expected wind conditions are considered to be windier than desired. Consideration should be given to recessing or screening these entrances to improve the wind microclimate and locally achieve Standing/Entrance conditions throughout the year.

15.6.17 The partition and full-height perimeter screens on the balconies are necessary features to divert wind around and away from the balconies.

15.6.18 If any areas intended for long term outdoor seating or as amenity space (e.g. café seating, benches etc) are located in the thoroughfare between the two new buildings (highlighted yellow in Figure 7) then these would benefit from additional shelter. Suitable perimeter screens or landscape planting (hedges/shrubbery etc) would keep the wind above pedestrian height, locally achieving the desired sitting conditions during the summer season.

15.6.19 No further mitigation is considered necessary in order to achieve the desired wind microclimate within the developed Site.

15.7 Residual Impact Assessment and Conclusions

15.7.1 Taking into account the mitigation measures discussed in the previous section the wind microclimate effects on the development in the Operational Phase is expected to be:

Pedestrian thoroughfares	-	**Moderate Beneficial** to **Negligible**
Entrances	-	**Negligible**
Seating areas	-	**Negligible** (during the summer season)
Balconies	-	**Negligible** (during the summer season)

15.8 Cumulative Impact Assessment

15.8.1 The potential extension to the 70 London Road, Regal House building, immediately to the south of the development will reduce the separation between Regal House and the Twickenham Station site. The effect of this extension on the wind microclimate will be limited to the southern corner of the Twickenham Station building adjacent to Mary's Terrace.

15.8.2 There are entrances in the vicinity of this corner but these have been classified with a wind microclimate that is suitable for standing/entrance use in Figure 15-2. However, the direct exposure to prevailing winds makes this a relatively windy corner and the changes to Regal house are expected to push the wind microclimate into the leisure walking classification. This implies a **minor adverse** effect outside the entrance.

15.8.3 The development of the Royal Mail site which is west of Twickenham Station on the opposite side of London Road is likely to reduce the available open space on that site, adjacent to the London Road. The main effect of this development on the wind microclimate at the Twickenham Station site is to provide additional shelter for a fairly narrow range of wind directions from westerlies to west-north-westerlies. These changes are not expected to alter the overall conclusions of the EIA.

15.9 References

Ref. 15-1: T.V. Lawson, 'Building Aerodynamics', Imperial College Press, © 2001

Ref. 15-2: BREVe2 – A publicly available software implementation of the design wind speed rules of BS6399-2. The program includes terrain and topography information from BRE and Ordnance Survey.

16.1 Introduction

16.1.1 This Chapter of the Environmental Statement (ES) assesses the potential impacts of the proposed development on terrestrial (both analogue and digital) and satellite television and radio reception. Consideration has also been given to the potential impact of the proposed development on mobile telephone signals and emergency service communications. Areas of likely impact are quantified and mitigation measures are proposed where appropriate. The Chapter has been written by Tom Paxton, a specialist electronic interference consultant.

16.1.2 This study is based on information found in the latest version of Rolfe Judd's drawings of the proposed development, the Ordnance Survey 1:10,000 map of the area, the locations of the relevant transmitters and data gathered from a site visit of the predicted shadow zone.

16.2 Planning Policy Context

National Planning Policy

16.2.1 The Office of the Deputy Prime Minister Planning Policy Guidance Note 8 (PPG8) 'Telecommunications' (Ref. 16-1) lays out a policy for the provision, expansion and protection of telecommunication systems. In relation to this development paragraph 36 notes that *"the construction of new buildings…can interfere with broadcast and other telecommunications services, and the possibility of such interference can be a material planning consideration." Paragraph 104 states that "local planning authorities will need to satisfy themselves that the potential for interference has been fully taken into account…*"

Regional Planning Policy

16.2.2 The London Plan (Ref. 16-2) is the statutory strategic planning framework for London. Policy 4B.10 states "*all large-scale buildings including tall buildings should…have an acceptable relationship to…telecommunication networks*."

Local Planning Policy

16.2.3 The adopted planning policy in the London Borough of Richmond-upon-Thames comprises the policies of the Unitary Development Plan 2005 (Ref. 16-3) saved beyond 2008. There are no references to telecommunication interference. Similarly, there are no relevant references in the emerging Local Development Framework (LDF) or the 2009 Core Strategy.

16.3 Assessment Methodology and Significance Criteria

Scope

16.3.1 The potential for the proposed development to cause interference to TV and radio reception has been assessed by a combination of desk-based calculations and an on-site inspection of domestic aerial installations. The assessment has been carried out based on the location of the proposed development, details regarding the proposed design and location with respect to the key radio, TV and satellite transmitters and principles of radio propagation. Principles of radio signal transmission from transmitting to receiving antennas were used to study the impact on radio and TV reception in the area surrounding the proposed development. The study of impacts was based on first applying geometrical optics to identify broadly the areas around the proposed development that are likely to be affected. Then principles of radio propagation were used to narrow down the potential area of impact.

Assessment

16.3.2 The introduction of new structures of significant height and bulk into an environment can cause disruption to the reception of electromagnetic waves. Although this effect relates to both radio and TV signals, TV reception is potentially affected more. This is for two main reasons. The first is that a TV receiving installation (roof-mounted aerial) is static whereas a radio can be moved about to optimise reception. The second is that TV is a visual medium and a reflected signal is represented on the screen as a possibly annoying 'ghost' whereas radio is an auditory medium and as such does not subjectively suffer significantly from reflected signals. The recent introduction of digital terrestrial television (DTT) has provided a transmission system that is largely impervious to the adverse effects of reflections.

16.3.3 Radios can receive signals that have been reflected off buildings perfectly adequately. This is how they are able to operate at ground level in urban environments. There is therefore considered to be no significant risk to radio reception (both analogue and digital) and as such only TV reception will be further considered in this chapter.

16.3.4 Similarly, the reception of mobile telephone signals, wireless networks and emergency service communications should not be compromised unless their transmitting aerials are sited on top of nearby buildings at heights less than those of the proposed development. Should this be the case the affected transmitting aerials may have to be relocated. Following a site visit of the surrounding area no such transmitting aerials were found that could be at risk; therefore these services will not be considered further in this assessment.

16.3.5 There are two main mechanisms whereby new buildings can disrupt terrestrial TV reception. The first is by attenuation. The building obstructs the TV signals and causes a subsequent reduction in quality of reception for those viewers in the 'shadow' area cast by the building. In the case of an analogue TV signal this would manifest itself as either a 'grainy' or 'snowy' picture or else a 'ghost' would appear on the screen. The 'ghost' becomes apparent because the original strong signal is no longer available to mask the weaker reflected one. In the case of DTT the reception does not gradually deteriorate like an analogue signal. It is either good quality or else very rapidly breaks up (an appearance of random blocks on the screen) and then is lost altogether.

16.3.6 The second form of disruption is caused by buildings reflecting the main analogue TV signal and causing this second signal to arrive at domestic aerials in the vicinity a little later than the main signal. This later signal appears on the screen as a 'ghost'. Only if the reflected signal is within about 20 degrees of the direction of the main signal will the domestic aerial be able to pick up sufficient of it to be able to show a 'ghost'. If it is more than 20 degrees then the reflected signal arrives at the side of the domestic aerial and will not be received. As previously mentioned DTT is not liable to interference from reflected signals.

16.3.7 In order to define any areas where TV reception will be at risk, the proposed details of the physical form or mass of the development were superimposed onto a 1:10000 scale map and, by calculation, illuminated by the TV transmitters that serve the area. The shadows subsequently cast have been marked on a map. Then the points of reflection of the signals from the development were calculated to generate areas where 'ghosting' could occur. Calculations were carried out using International Radio Consultative Committee/International Telecommunication Union (CCIR/ITU) criteria, specifically the Recommendation 655 parameters (Ref. 16-4). Predicted TV signal strengths for the areas were then calculated.

16.3.8 Within these theoretical areas of potential interference to TV reception a physical survey of domestic TV aerials was carried out. The type and positions of the aerials gave an indication of the strength and quality of the available signals. The presence and use of cable and satellite services was also noted.

16.3.9 All mitigation measures described in this report are expected to provide TV reception of at least the same quality as that previously enjoyed by any potentially affected households.

Significance Criteria

16.3.10 To determine the significance of the residual impacts to television reception the following criteria have been applied (significance criteria were established by the Radiocommunications Agency (2002) in respect of prioritising populations that suffer loss of TV reception);

Extreme	The proposed scheme is likely to affect reception for more than 1000 dwellings.
Major	The proposed scheme is likely to affect reception for more than 500 and up to 1000 dwellings.
Moderate	The proposed scheme is likely to affect reception for more than 100 and up to 500 dwellings.
Minor	The proposed scheme is likely to affect reception for up to 100 dwellings.
Adverse	The proposed scheme is likely to result in a noticeable deterioration in signal strength or increase in reflection effects.
Negligible	The proposed scheme is likely to result in no noticeable effect on reception.
Beneficial	The proposed scheme is likely to result in a noticeable improvement in signal strength or reduction in reflection effects.

Uncertainty

16.3.11 The assessment has generated a 'worst case' result whereby the area or areas of reduced signal strength or of 'ghosting' have been identified along with the number of dwellings within these contours. However, it cannot be predicted with absolute certainty as to whether or not the signal degradation will be subjectively annoying to the viewers within these contours, because only general assumptions can be made about their receiving systems. An above-average system may well have sufficient signal margin to be able to lose some of that signal without reception being subjectively affected, whereas others may not.

16.3.12 In order to calculate the possible detrimental effects to TV reception it has been assumed that each dwelling will have one main TV set, which is fed by an external roof-mounted aerial of the correct type and connected by a good quality down-lead. Only this main set will be considered. Portable TV sets within the dwelling cannot be considered as it is impossible to make robust assumptions on their location within the dwelling, the signal attenuation due to the walls, the signal gain (if any) of the set-top aerial used and the existing quality of reception.

16.3.13 It is possible to calculate with a good degree of precision the TV shadow that new structures will cast and therefore the dwellings that will be at risk. It is more difficult to construct a model of the various reflecting TV signals that exist at present and will exist after construction that will have the potential to appear on TV screens as 'ghosts' and as such the model represents a worst-case analysis, within which the majority of cases are expected to occur.

16.3.14 Since interference caused by temporary structures during construction such as cranes and scaffolding is difficult to predict and equally difficult to rectify due to its impermanent nature, it has not been considered quantitatively within this assessment.

16.4 Baseline Conditions

16.4.1 Television signals within the vicinity of the site are provided by two transmitters. The Crystal Palace transmitter (analogue BBC1, BBC2, ITV, Ch 4 and DTT-Freeview) is located about 17.9 kilometres (km) to the ESE of the site. The Croydon transmitter, located about 17.5 km away on virtually the same bearing as Crystal Palace, provides the analogue Channel 5 signal. In 2012 all analogue television signals in London will be switched off and all transmitters will only transmit DTT-Freeview. This means that in the future the detrimental effects of 'ghosting' should not cause significant problems. Generally poor terrestrial signal quality in the area is demonstrated by the number of properties using high-gain external aerials, many on tall poles. This is due to a combination of the blocking effects of tall trees, Regal House and Bridge House. Both buildings are very close to the proposed development.

16.4.2 The ground is relatively flat in the shadow area and the housing is in the main 2-storey semi-detached. Cable TV is available throughout, and about 30% of dwellings have satellite dishes on their properties. All dwellings have rooftop terrestrial aerials, with all but two using the Crystal Palace/Croydon signals. These two are using signals from out-of-area transmitters, possibly because local trees are blocking their Crystal Palace/Croydon signals.

Figure 16-1 Site Plan – Current Building Heights

16.5 Site Preparation and Construction Impacts and Mitigation Measures

16.5.1 In general, effects during construction will be similar to, or less marked than, those when the buildings have been completed (see 'Operational Impacts and Mitigation Measures' below). The nature of the impact depends on how much of the proposed structures have been built at the time.

16.5.2 Scaffolding and cranes can be the source of annoying reflections, causing 'ghosting'. The worst case happens when the 'ghosting' changes as the construction cranes swing to and fro. It is difficult to predict reflections during the construction phase because cranes change in height and orientation through time. There will be a small number of viewers who will be transiently affected by the cranes but this will not be a long-term condition.

16.5.3 The impacts of the construction phase are construction phase are considered to be temporary **minor adverse**.

16.5.4 Should any dwellings suffer from the reception of 'ghosting' the easiest mitigation measure would be the provision of a DTT Freeview set-top box. Following mitigation the impacts of the construction phase are considered **negligible.**

16.6 Operational Impacts and Mitigation Measures

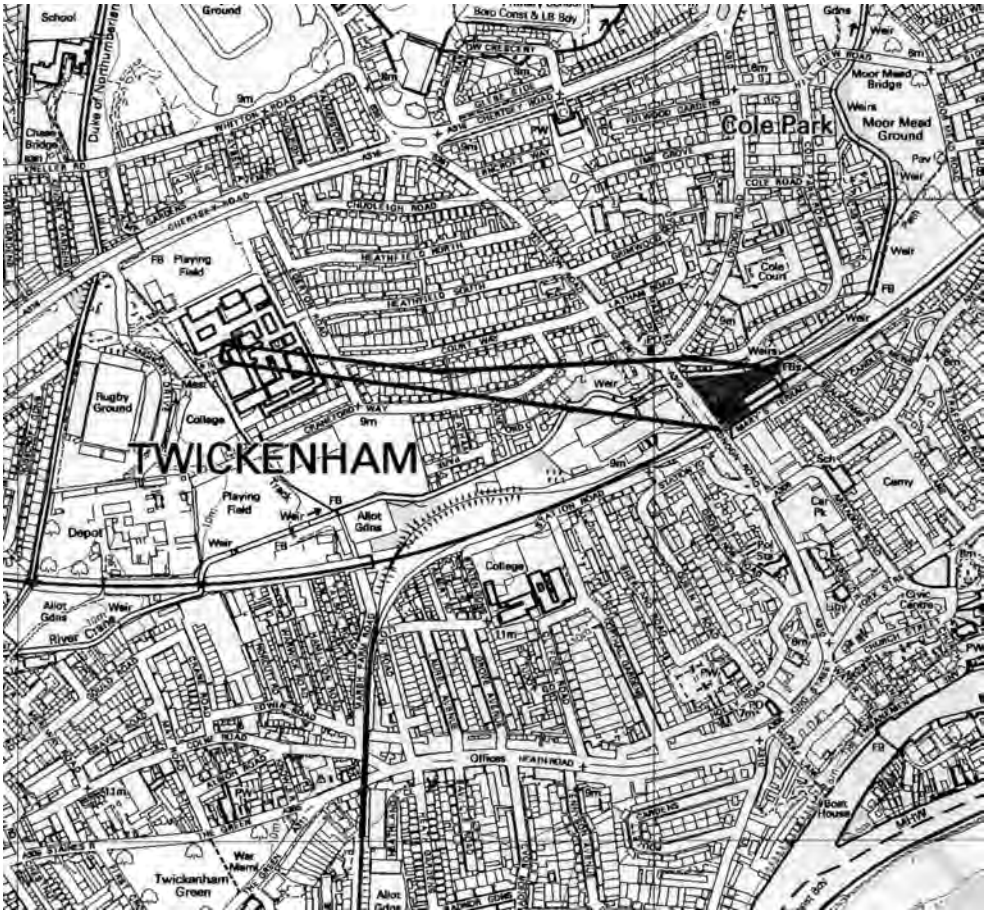
16.6.1 Areas where TV reception has the potential to be affected are in the 'shadow' that the proposed development will cast, which is shown in Figure 16-2. The shadow from the Crystal Palace/Croydon transmitters will lie in lines WNW from the site for approximately 0.8 km. Beyond this distance the loss in TV signal is not considered to be significant. In keeping with a 'worst case' analysis it will be assumed that all dwellings with external aerials are using those aerials for their main source of TV programmes. It could be that they are using cable and/or satellite signals instead and have simply not had their external aerial removed. As a result, the final figures in this report could be more pessimistic than in actual practice. Based on this worst case assumption, there are approximately 90 dwellings that are predicted to experience a reduction in TV signal. Should they be relying on terrestrial signals suitable mitigation measures are available in all cases as set out below in paragraph 16.6.4. Therefore **negligible** residual impacts are expected.

16.6.2 Calculations show that Crystal Palace/Croydon signals will reflect off of the proposed development at such angles that external aerials will not be able to receive them so 'ghosting' is predicted not to be a problem. As has been previously stated, by 2012 all analogue TV signals will cease in London so 'ghosting' will no longer be a potential issue after that point. However, it is noted that the completion date for the development is scheduled to be after 2012.

16.6.3 Domestic satellite dishes point to the south-east. The satellite shadow that this proposed development would cast would be up to 52 metres long to the north-west. There are no dwellings in that area so there is predicted to be no adverse effect to satellite TV reception.

16.6.4 For the aerial systems that will suffer a reduction in TV signals, mitigation measures will include upgrading those aerials by increasing their height and gain or the utilisation of non-subscription satellite services that carry the main TV programmes. This is provided by either the BBC and ITV ('Freesat') or by 'Sky' for a one-off cost. Following the incorporation of mitigation measures the long term impacts of the proposed development are considered **negligible.**

Figure 16-2 The shaded area identifies the development site. The area enclosed by the contour identifies where viewers of the Crystal Palace and Croydon services are at risk of degraded television reception.



16.7 Residual Impact Assessment and Conclusions

16.7.1 Prior to mitigation it is predicted that there will be long term **minor adverse** effects to the reception of terrestrial TV services for up to 90 existing installations. However, mitigation measures are available in all cases.

16.7.2 Given the difficult TV reception that currently exists in the area it is likely that the actual number of dwellings affected will be less than this because some are using cable and/or satellite services and some have above-average aerial installations that will be able to cope with some loss of signal before the subjective picture quality suffers. Following mitigation, impacts to TV reception are considered to be of **negligible** significance.

16.8 Cumulative Impact Assessment

16.8.1 This section assesses the impact of the proposed development in combination with the likely impact to TV reception arising from other developments in the area. Key schemes considered are those located within the predicted shadow as well as those to the ESE that might block the television signals to the proposed development.

16.8.2 Two schemes are predicted to have the potential to generate a cumulative effect and they are the Regal House extension and the Royal Mail scheme. The Regal House extension lies just south of the predicted shadow of the proposed development and therefore will have no cumulative effect. The Royal Mail scheme would create a TV shadow that would largely occupy the same ground as the shadow of the proposed development. Should the Royal Mail scheme be built first then only 17 dwellings would remain uniquely in the shadow of the proposed development.

16.8.3 The Royal Mail Sorting Office site lies west of the proposed development and the impact will need to be assessed through the planning application for the Royal Mail Sorting Office site. Depending on the heights of the proposed buildings the development of the site has the potential to increase the shadow of interference and impact on a number of properties along Craneford Way, Craneford Close and Heatham Park to the west of the Royal Mail site. However, following the incorporation of appropriate mitigation measures, the long term impacts of the proposed development are considered negligible.

16.9 References

Ref. 16-1: ODPM, (2001), 'Planning Policy Guidance Note 8 (PPG 8): Telecommunications'

Ref. 16-2: Greater London Authority, (2008), 'The London Plan – Spatial Development Strategy for Greater London'

Ref. 16-3: London Borough of Richmond-upon-Thames, (2005), 'Unitary Development Plan (saved beyond 2008)'

Ref. 16-4: European Broadcasting Union, (1988), 'Tech.3254-E Planning parameters and methods for terrestrial television broadcasting in the VHF/UHF bands'

17.1 Introduction

17.1.1 This Chapter of the ES assesses the impact of the proposed development in combination with the potential environmental and socio-economic impacts of other developments. This Chapter also considers the residual impacts of the proposed development. This Chapter has been written by Maddox Associates.

17.2 Cumulative Impact

17.2.1 It is a requirement of an EIA to consider the possible combination effects of different types of environmental impacts (eg noise, dust etc) and also the cumulative impacts of other projects likely to overlap in timing with the Development.

Combination Effects

17.2.2 The combination of individual effects from the proposed scheme on a particular receptor was only considered for the construction phase and not for the operational phase of the completed development. This is because the construction works present the greatest possibility of effect interaction and consequently significant adverse effects.

17.2.3 It is considered that the greatest possibility of effect interactions would arise from a combination of air quality, noise and transport-related effects i.e. dust from construction activities and vehicle emissions, noise from plant equipment and vehicle movements. However, due to the relatively short time periods that these activities would be coincide the impacts are considered to be minor/moderate adverse.

17.2.4 As described in *Chapter 6: Site Preparation and Construction*, a Demolition and Construction Method Statement will be produced and Construction Environmental Management Plan (CEMP) implemented through the construction phase to minimise the effects construction activities. A Construction Logistics Plan (CLP) will also be implemented to minimise the potential impacts of construction traffic.

17.2.5 As described there is the potential for some effect interactions to take place during the construction works, however following the implementation of the DCMS, CEMP and CLP, these impacts are anticipate to be negligible and of a temporary nature.

Cumulative Impacts of Other Projects

17.2.6 As detailed in *Chapter 2: EIA Methodology t*he cumulative impacts of the proposed development and a number of schemes in close proximity to the site have been assessed within each technical aspect covered by the EIA.

17.2.7 The London Borough of Richmond upon Thames have requested that the following schemes be included within the cumulative assessment (location shown in Figure 17-1):

- Regal House Extension; and
- Royal Mail Sorting Office.

Figure 17-1 Cumulative Scheme Location

17.2.8 The Regal House Extension (Planning Application reference: 08/3063/FUL) is for the partial demolition of the first floor of Regal House, erection of a part two, part three, part six and part ten storey building at the northern end of the site. The building would accommodate a 111 bedroom hotel with associated bar and restaurant. The building has been designed stepped in height to achieve height levels at Mary's Terrace to the east.

17.2.9 Details relating to the redevelopment of the Royal Mail Sorting Office Site are extremely limited at present. Royal Mail has confirmed that at present there are no proposals sufficiently advanced to enable parameters of development to be set and a full quantitative cumulative assessment undertaken.

17.2.10 As detailed in *Chapter 2: EIA Methodology*, in order to carry out a cumulative assessment for the purposes of this application, the Twickenham Station architects, Rolfe Judd has prepared a block model broadly based on current planning policy and guidance. There is no certainty on the type of development that will come forward within the project construction timeframe. The block model has been based on the professional judgement of Rolfe Judd Architects and project team, instructed by Solum Regeneration to give an indicative view of the scale of development that the site could accommodate. No input has been provided by Royal Mail.

17.2.11 As the use of the site, construction practices or timeframes for development are not available, the cumulative assessment has focused on environmental topics principally influenced by height and massing such as daylight, sunlight and overshadowing, wind microclimate, electronic interference and visual impact when considering the Royal Mail Sorting Office Site.

Development Time Frames

17.2.12 At the time of writing the Regal House extension is scheduled for completion in late 2011. The anticipated timeline for the scheduled commencement of works for the Twickenham Station development is the first quarter of 2011 for the initial podium works, with the construction works are anticipated to take approximately 33 months and will comprise the following key stages:

- Mobilisation;
- Site Clearance;
- Foundations;
- Podium Slab
- Superstructure to Podium;
- New Station
- Superstructure to Residential and Commercial
- Fitting Out
- External Works, Services and Drains and Landscaping
- Handover

17.2.13 As previously noted no timeframes are available for the potential development of the Royal Mail Sorting Office Site.

Potential Cumulative Impacts

Socio Economics

17.2.14 The Socio-economics cumulative impacts associated with the proposed scheme and Regal House Development are:

- Increased employment space and therefore jobs (35 positions in the hotel and associated bar and restaurant in the Local Impact Area – in addition to the 29 jobs identified in this analysis with regards to direct employment in the commercial units on the Twickenham Station site. This gives a total of 64 direct jobs from both developments.
- Subsequent increase in local spend (from both visitors and employees) above that identified in this analysis
- Multiplier effects will in turn increase the number of jobs and GVA supported in the area above that identified in this analysis
- The areas image will also be promoted further and the 'gateway' aspect to Twickenham from the station towards the town centre will be reinforced.

17.2.15 Due to the different use of the two sites there is likely to be an enhancing relationship as opposed to a competing relationship. In addition, the Travelodge will add to the beneficial economic impacts as opposed to increased demand for local social and community infrastructure.

17.2.16 As detailed in *Chapter 2: EIA Methodology*, the proposed use for the Royal Mail Site has not been determined and the cumulative impact cannot be accurately assessed. If the site were to be developed for residential use the cumulative impacts are likely to be beneficial in the provision of private and affordable housing to contribute to meeting the Core Strategy Housing target for residential units.

17.2.17 The impact of the development on the local educational, childcare and healthcare facilities and public open space would need to be assessed through the planning application for the Royal Mail Sorting Office Site and associated S106 contributions agreed for that site.

17.2.18 The Twickenham Station development would have a beneficial impact on any proposals for the Royal Mail site through the provision of improved transport interchange for future users.

Transport

17.2.19 On the basis that the Station development is a car free scheme, there will be no cumulative impacts in terms of the Regal House development. The station will provide improved transport facilities for visitors of the Regal House Travelodge development.

17.2.20 The London Borough of Richmond has produced SPD in respect of the Station and the neighbouring Royal Mail Site. The Transport Statement considers the impacts of the Royal Mail Site coming forward. On the basis that the Twickenham Station development is a car free scheme, there are no highways implications anticipated from the development of the site.

17.2.21 The Transport Statement demonstrates that vehicle and pedestrian access can be provided to the Royal Mail Sorting Office Site to work alongside the Twickenham Station development.

17.2.22 There are no adverse implications associated with the station development as a result of other developments coming forward.

17.2.23 The construction programmes for the proposed development and the Regal House Extension indicate that there is the potential for works to coincide. This has the potential to give rise to adverse impacts. In agreement with the Local Authority further assessments can undertaken and the impact confirmed when a contractor is appointed and detailed method statements and programme information are available.

17.2.24 As detailed within the ES mitigation measures will be agreed through consultation with the Local Authority and clearly set out within the Demolition and Construction Method Statement and through the production of a Construction Logistics Plan (CLP) to identify methods and routes for delivery of construction materials and removal of waste materials.

Air Quality and Noise and Vibration

17.2.25 Through discussions with Regal House contractor, it is presently thought that the Regal House redevelopment will be completed in early 2012 (anticipated to be approximately February 2012). Initial site works for the podium at of the Twickenham Station development are anticipated for Spring 2011.

17.2.26 It is therefore anticipated that the initial phase of the proposed development will coincide with the redevelopment of Regal House extension to the south of the site. If the demolition/construction phases likely to generate dust or give rise to elevated noise and vibration levels of both schemes were to coincide, cumulative air quality and noise and vibration impacts would be likely.

17.2.27 It is not unusual for construction to take place on more than one site and the principle contractor will be required to undertake regular liaison meetings and reviews with neighbouring sites to plan works to minimise unnecessary disruption and implement appropriate mitigation measures to both sites for the period to 2017.

17.2.28 There is not enough information presently available about the proposed Regal House redevelopment or Royal Mail Sorting Office Site to carry out a quantitative cumulative impact assessment. Providing similar mitigation as proposed for Twickenham Station is applied to the other developments the cumulative impacts are considered likely to be minor to moderate adverse.

17.2.29 As described in *Chapter 6: Site Preparation and Construction* of the submitted Environmental Statement, a Demolition and Construction Method Statement will be produced and an Environmental Management Plan (EMP) implemented to minimise the effects of construction and operational activities. A Construction Logistics Plan (CLP) will also be implemented to minimise the potential impacts of construction traffic.

Water

17.2.30 Cumulative impacts to water resources during construction and demolition processes are associated with the generation of sediments and the release into the surface water drainage network, spillage and leakage of oils and fuels, leakage of wet concrete and cement and disturbance of contaminated land and foul drainage. Mitigation measures to manage and control these impacts and reduce the magnitude and significance of any impacts to a minimum are detailed in *Chapter 12: Water Resources* of the Environmental Statement.

17.2.31 As a result of these control measures and the statistical likelihood that a site along the catchment will discharge into receiving surface waters or groundwater at the same time is unlikely, a cumulative impact is considered negligible.

17.2.32 It is possible that foul drainage from consented developments, combined with the proposed development impacts, could result in a moderate adverse impact to any downstream sewage treatment works, if the capacity is limited and assuming all foul drainage is directed to the same treatment plant. Thames Water has a responsibility to accept flows from developments given planning consent in accordance with the Water Industry Act 1991 and no significant impact is anticipated in the long term.

17.2.33 An increase in water supply requirements at the site, coupled with increased requirements at other developments in the vicinity may put pressure on sources of water supply in the area (e.g. river, reservoirs and groundwater supplies), and may lead to a moderate adverse impact to water supply. However, given Thames Water's responsibilities no long term impact is expected and the cumulative impact is considered negligible.

Ground Conditions

17.2.34 Given the site specific nature of the effects relating to ground conditions and the absence of any significant below ground structures in the proposed development there are not considered to be any impacts to be considered with respect to other nearby developments.

Ecology

17.2.35 The Design and Access statement for the Regal House Extension states that the 'site itself has no ecological or biodiversity value as it is hard standing tarmac carpark. The trees and bushes along the boundary between Regal House and residential properties in Cheltenham Avenue and those on London Road will be unaffected by the proposals'. It is considered that through the construction phase of Regal House there is the potential for minor impacts bat and bird nesting and foraging habitat through disturbance from plant equipment and machinery and light spillage. Providing similar mitigation is implemented as detailed in *Chapter 6: Site Preparation and Construction* the noise air quality and light spillage effects of the Regal House extension on ecological receptors are anticipated to be negligible.

17.2.36 The ecological impact of the royal mail site cannot be determined as there is insufficient information available on any proposed development. The future development of the Royal Mail site will need to have regard to the relevant policy and guidance in respect to ecology

17.2.37 The ecological cumulative impact remains the same as the impact of the proposed Development in its own right.

Wind

17.2.38 The potential extension to the 70 London Road, Regal House building, immediately to the south of the development will reduce the separation between Regal House and the Twickenham Station site. The effect of this extension on the wind microclimate will be limited to the southern corner of the Twickenham Station building adjacent to Mary's Terrace.

17.2.39 There are entrances in the vicinity of this corner but these have been classified with a wind microclimate that is suitable for standing/entrance use. However, the direct exposure to prevailing winds makes this a relatively windy corner and the changes to Regal House are expected to push the wind microclimate into the leisure walking classification. This implies a minor adverse effect outside the entrance.

17.2.40 The development of the Royal Mail site which is west of Twickenham Station on the opposite side of London Road is likely to reduce the available open space on that site, adjacent to the London Road. The main effect of this development on the wind microclimate at the Twickenham Station site is to provide additional shelter for a fairly narrow range of wind directions from westerlies to west-north-westerlies. These changes are not expected to alter the overall conclusions of the EIA.

Daylight, Sunlight, Overshadowing and Solar Glare

17.2.41 Due to the moderate height and position of the Regal House scheme relative to the Twickenham Station development site, the cumulative impact on daylight, sunlight and overshadowing is considered to be negligible.

14.8.1 The cumulative impact of the Royal Mail site (based on the assumptions made by Rolfe Judd and the interpretive model heights) relative to the Twickenham Station development site, is considered to be negligible against the nearest residential receptors on Cole Park Road.

14.8.2 With regard to the impact Twickenham Station development will have on the Royal Mail building, it is considered that the development will breach a 25 degree line, however the Royal Mail building footprint is much lower than the development which gives rise to a perception of the development as being higher. As the Royal Mail building is likely to be implemented after the completion of Twickenham Station it is considered that in the design stage the Royal Mail building could be built to suit daylight requirements to ensure BRE target values are met by introducing window glazed areas sufficient for adequate ADF values.

Electronic Interference

17.2.42 For the Regal House development there is no cumulative impact for electronic interference as it lies south of the predicted shadow of the proposed development.

17.2.43 The Royal Mail Sorting Office site lies west of the proposed development and the impact will need to be assessed through the planning application for the Royal Mail Sorting Office site. Depending on the heights of the proposed buildings the development of the site has the potential to increase the shadow of interference and impact on a number of properties along Craneford Way, Craneford Close and Heatham Park to the west of the Royal Mail site. However, following the incorporation of appropriate mitigation measures, the long term impacts of the proposed development are considered negligible.

Townscape and Visual Impact

17.2.44 The Regal House extension has the benefit of full planning permission and information about the development was obtained from the documents submitted as part of the planning application (ref: 08/3063/FUL). This was the basis for incorporation into the computer model from which the photomontages were generated. Photomontage views of the proposed Twickenham Station development with the Regal House extension added are illustrated on Figures in 17-2, 17-3 and 17-4 (*ES Volume II: Townscape and Visual Impact Assessment* contains the full set of verified images).

17.2.45 The Regal House extension has been designed in form, materials and colour similar to those of the existing buildings and thus would appear as a continuation of the original building. In plan, it would extend from the north-west elevation of the existing building to the boundary with Mary's Terrace and north-eastwards to the boundary with a garage court, beyond which are the houses on Mary's Terrace. The area to be occupied by the extension is currently surface car parking at the lower Mary's Terrace street level, bounded by a 1.5m high (approx.) wall to the street. The building is proposed to be stepped in height, the tallest, 10 storey, part along the London Road frontage, stepping down to 3 storeys next to the garage court.

Figure 17-2 View North along London Road

Figure 17-3 View West along Train Tracks

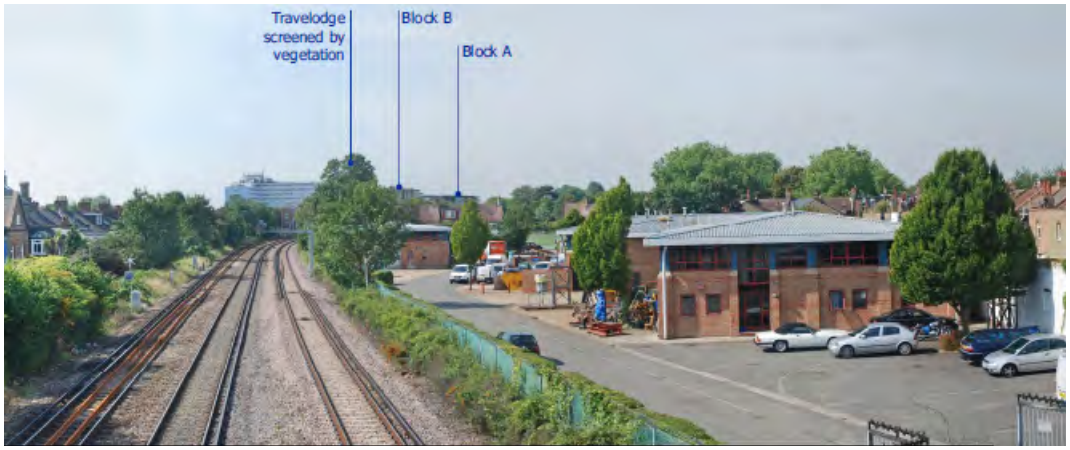


Figure 17-4 View from Cole Park Road

17.2.46 The Royal Mail development is in the very early stages of planning and insufficient information about it was available for detailed illustration and assessment purposes. Architects Rolfe Judd has outlined a possible form for the development taking into consideration current policy and guidance. Royal Mail has been consulted but has had no input into this design solution. The possible scheme indicate a series of development blocks at the lower level of the site, set back from London Road and bridge, larger blocks facing onto London Road and sweeping in a curved frontage to an open area along the River Crane, forming the northern side of the site. Smaller blocks would be arranged in streets and courts, forming a street frontage to railway cottages on Brewery Lane on the southern side of the site. Maximum block height is envisaged to be 5 stories. For the purposes of the assessment, it is assumed that materials and finishes would be consistent with those of the surroundings, including the Twickenham Station development.

17.2.47 The Sustainable Urban Development Study prepared by Turley Associates on behalf of the Council to inform the Core Strategy states that: *"There is an opportunity to create a cluster [of tall buildings] around the station area which would create a landmark and aid the legibility within the local area. Any future tall buildings should not exceed generally nine storeys in height in order not to break the horizon as viewed from the Arcadian view on Richmond Hill. Also a range of heights should be pursued to ensure more interesting and varied skyline".*

17.2.48 Cumulative effects may be defined as:

- *Combined:* townscape and/or visual effects of the Twickenham Station proposal added to those of other developments, e.g. where Twickenham Station could be seen with other similar developments from particular vantage points, either within the same angle of view or in different angles of view from the same point
- *Sequential:* visibility of first one development and later another, at different places as one moves through the area
- *Temporal:* effects accumulating over a period of time on the townscape or visual amenity, from this proposal and other developments.

17.2.49 Construction of the Twickenham Station scheme would commence while the Regal House extension was in progress, which would be completed part way through construction of Block C of the Twickenham Station development. The townscape changes of the two developments would, therefore, be part of a continuum, and unlikely to be perceived as a separate, sequential cumulation of effect or a cumulation of effect over time – except the time period of their construction. Because of their proximity, where the two developments were visible, they would be seen in the same angle of view at any viewpoint. Therefore, the cumulative effects would be the combined effects of the Twickenham Station development in conjunction with the Regal House extension.

17.2.50 It is likely that both these developments would be completed and in operation by the time the Royal Mail Sorting Office Site development commenced. Twickenham Station and Regal House together would effectively screen and separate the Royal Mail Site development from the areas to the east of the station. Cumulative effects in combination with Twickenham Station development may be experienced on London Road and the London Road/Whitton road junction and from the eastern edge of Queen's Road conservation area.

17.2.51 As the Royal Mail Sorting Office Site development would follow completion of the Twickenham Station development, there would be temporal effects. Because of proximity, the Royal Mail Sorting Office Site development would be seen in the same angle of view as the Twickenham Station development. In moving around the area, from east of Twickenham Station development, the Royal Mail Sorting Office Site development would be screened but would come into view as one emerged onto London Road or passed from Mary's Terrace to Station Yard under London Road bridge. There would therefore be sequential visual effects.

Townscape effects

17.2.52 In conjunction with the Twickenham Station development, the Regal House extension would continue the London Road frontage of tall buildings and link the existing Regal House with the tallest part of the Twickenham Station development. Without the Regal House extension a relatively wide gap would remain between the two buildings, which would be partially filled by the extension, leaving only a narrow gap at Mary's Terrace. The openness to the west of the bridge would be retained along the railway lines and Station Yard, but the Royal Mail Sorting Office development would establish a street frontage to the west between the railway and the River Crane The green space proposed along the river Crane west of Coles Bridge would complement the plazas associated with the Twickenham Station development and enhance the value of the new footpath link along the River Crane, linking the areas to east and west of London Road separate from the road network.

17.2.53 The Regal House extension would bring the tall buildings of the town centre closer than the Twickenham Station development to the smaller scale residential area of and surrounding Mary's Terrace. However, the main effect of the Twickenham Station development, of filling part of the open sky which gives a partial sense of openness to the immediate context of the terrace despite the tall boundary wall to the railway immediately opposite, would be not be increased. The orientation and stepping in height of the Twickenham Station development away from Mary's Terrace would be effective in retaining some of that openness. The Royal Mail Sorting Office Site development would not affect this area and there would be no cumulation of effect with it.

17.2.54 The Twickenham Station development would screen the Regal House extension from the Cole Park Road area and there would be no additional effects. As the Royal Mail Sorting Office Site development would follow some time after the Twickenham Station development, it would be screened from the Cole Park Road area, and is likely to be apparent only from the area of the junction of Cole Park Road and London Road. The Royal Mail Sorting Office Site development may be visible from Heatham House. However, the mature vegetation situated within the grounds of Heatham House together with the vegetation situated along the River Crane will provide a screen to the development.

17.2.55 The minor adverse or less effects of the Twickenham Station development on other sensitive receptors such as conservation areas, listed buildings, or public rights of way, would not be increased when assessed in conjunction with the Regal House extension or Royal Mail Sorting Office Site development. The three developments together would create a new townscape character in the centre of Twickenham, forming a gateway between the areas of Twickenham to south and north of the railway and River Crane and accentuating the centre of the town in views from the surrounding area. The varied building heights and open space proposals would help relate the developments to their surroundings and with each other.

17.2.56 During the construction period of the Twickenham Station development, short term major adverse effects were assessed on the immediately surrounding areas. Construction of the Regal House extension would be in progress during the foundation works within the Twickenham Station development and, as noted, would therefore form a continuum and construction of the two developments in conjunction is unlikely to increase the effects assessed, either on the immediate surroundings or further afield. The construction timeframes of the Royal Mail Sorting Office Site development are currently unknown and at present it is considered that it would not occur until after both the Twickenham Station and Regal House developments were in operation, so there would be no cumulation of construction effects in combination. There would be temporal cumulation of construction effects, over a time period beyond the construction of the Twickenham Station development, but not experienced as greater adverse effect, as the RMG development site is separated from the Station site by London Road and bridge, and the effects are likely to be well contained by the site's boundary features.

Visual effects

17.2.57 The beneficial visual effects for people in the immediate surroundings of the Twickenham Station development would be slightly enhanced by the addition of the Regal House extension, in views from east and west, where he gap between the buildings would be reduced by the Regal House extension and they would appear as an integrated cluster. The later addition of the Royal Mail Sorting Office Site development would reinforce enclosure of the street along London Road and the bridge, providing a building frontage to the west side. It would be set back sufficiently to give a spacious quality to the street, while strengthening the visual connection between London Road to the south of the bridge and to the north at its junction with Whitton Road.

17.2.58 There would be no additional adverse visual effects on Cole Park Road residents in conjunction with Regal House extension and Royal Mail Sorting Office Site development, as the Twickenham Station development would completely screen Regal House extension from view and only oblique views from the junction of Cole Park Road and London Road. From Mary's Terrace, Regal House extension the Twickenham Station development would be seen in conjunction only in a narrow framed view along the street, with the Regal House extension to the left and from the Twickenham Station development to the right. The houses are oriented away from the developments and any views available would be oblique. Currently Bridge House is seen above the roofline of Mary's Terrace, which would be replaced by the Regal House extension, stepping down in height towards the houses.

17.2.59 From the Queen's Road-Station Yard area, the RMG development would be seen as a continuation of similar development in the left of the view, beyond the railway.

17.2.60 Any adverse visual impact assessed would not be increased when the impacts of Twickenham Station development is considered cumulatively with those of the other two developments.

Cumulative Impact Summary

17.2.61 The Twickenham Station development has evolved in response to regional and local planning policy for the Site and is designed to respond positively to its site and surroundings.

17.2.62 The design and consultation process has led to a development which will result in an improved transport interchange including increased capacity for the peak movements experienced on Twickenham Stadium event days. This improvement will benefit future developments around the site through improving the quality of facilities at the transport interchange and providing a pedestrian link through to the public open space of Moormead Park.

17.2.63 A full quantitative assessment on the cumulative impacts has not been possible due to the lack of detail currently available for the Royal Mail Sorting Office Site. A broad presumption has been made that if the Royal Mail development is for residential use then the cumulative impacts would be beneficial in providing residential units that will go to meeting the Boroughs housing targets. If the Royal Mail Site included employment uses then it is broadly assumed the cumulative impact would be beneficial due to a rise to new jobs which are predicted to have a positive impact on the area, although this would be dependent on the Use Class of any proposed development. It is understood that any future development on the Royal Mail Site would make their own appropriate S106 contribution to the provision of local community facilities (education, healthcare etc).

17.2.64 The cumulative impacts on air quality, noise and vibration, water resources and ground conditions are difficult to accurately predict due to the lack of information presently available to carry out a quantitative cumulative impact assessment. Providing similar mitigation as proposed for Twickenham Station is applied to the other developments the cumulative impacts are considered likely to be minor to moderate adverse. Details of proposed mitigation measures is set out within the Environmental Statement.

17.2.65 The Twickenham Station Development has the potential for major beneficial effects on the townscape qualities of its London Road context in improvement to the street frontage, including additional street trees, generous public plazas to the two main entrances, an appropriate station approach and frontage, and a footpath link to Moormead Park. This is considered to have a beneficial impact to future developments around the site. Once established, the three developments together would create a new townscape in the centre of Twickenham and, as anticipated in the Sustainable Urban Development Study, would combine in the long term to provide enhanced public realm, pedestrian links and green space.

17.3 Residual Impacts

17.3.1 Residual impacts are defined as those impacts that remain following the implementation of mitigation measures. Mitigation measures for each area of environmental and social impact are discussed in full in the relevant technical chapters. In addition, each technical chapter also contains detailed consideration of both beneficial and adverse residual impacts arising. The significance criteria applied to these impacts are outlined in *Chapter 2: EIA Methodology* and within the individual technical chapters.

17.3.2 The Development has evolved in response to regional and local planning policy for the Site. The design and consultation process has led to a Development which will result in an improved transport interchange including increased capacity for the peak movements experienced on Twickenham Stadium event days.

17.3.3 The development has the potential for major beneficial effects on the townscape qualities of its London Road context in improvement to the street frontage, including additional street trees, generous public plazas to the two main entrances, an appropriate station approach and frontage, and a footpath link to Moor Mead Park. Only localised adverse effects were assessed, on the character of the setting of Cole Park Road and Mary's Terrace which in the Long –Term are considered Negligible.

17.3.4 The proposed development will add 115 residential units to the existing stock, improving the housing stock within the Borough. In addition the Development will give rise to new jobs which are predicted to have a positive impact on the area.

17.3.5 The Environmental Impact Assessment (EIA) has been undertaken in parallel with the design process and measures have already been undertaken to eliminate adverse environmental and social impacts, including revising block location, height and massing to provide an overall scale appropriate to the site's location, and consideration of measures to ensure the ecological features protected.

17.3.6 Full details of the significant impacts identified during the assessment are set out in Chapters 7 to 16 of this ES. Mitigation measures which will be required to reduce the significance of these impacts, the means by which mitigation will be delivered and the residual significant impacts likely to remain are summarised in Tables 17.1 and 17.2.

Table 17.1 Construction Impacts

ES Topic	Key Potential Impacts	Mitigation	Residual Impact	Mitigation Delivery
Socio-Economics	Construction Jobs - Construction investment is anticipated to support 30 permanent jobs directly	.	Minor Beneficial - Temporary	
Transport	Increased number of construction vehicles on local highway network and site Suspension of onsite parking facilities Disruption to transport interchange	Development of a Demolition and Construction Statement to detail: • The times when vehicle movements and deliveries will be allowed; • The proposals to minimise the number of vehicle trips by employees during construction; • The facilities for loading and unloading; • The facilities for parking cars and other vehicles; • Construction vehicle access routes; • Times of construction on site; and • Travel Plan Measures for construction workers, to include: Walking; Cycling; Bus; Rail outside periods of rail closures; and Car Sharing Construction Logistics Plan	Moderate Adverse Impact - Temporary	Planning Condition or Obligation to produce: Demolition and Construction Method Statement (DCMS) Construction Logistics Plan (CLP)

Air Quality	Dust and fume impacts on nearest residents and station users - minor adverse	Erect solid barriers around site. Use water as dust suppressant. Construction traffic to switch off engines when not in use. Vehicle movements on site to be on hard surfacing. Loads entering or leaving site to be covered. Enclose and cover stockpiles. All non-road diesel plant to use ultra low sulphur fuel and to be low emission types or retrofitted with emission controls. Occasionally monitor dust at site boundaries on dry windy days between April and October.	Negligible	Planning Condition or Obligation to produce: DCMS
	General impacts on local air quality - minor adverse	Clean and wheel-wash vehicles as necessary. Minimise idling plant and vehicles. As far as is practicable, minimise construction related traffic.	Negligible	Planning Condition or Obligation to produce: DCMS
	Specific impacts on the railway and railway passengers - minor adverse	Use of sheeting during construction - Protective sheeting in the form of a fan scaffold over the areas below/adjacent to construction activity to project over platforms to catch dust and small debris.	Negligible	Planning Condition or Obligation to produce: DCMS

Noise and Vibration	Noise at nearest residential receptors from demolition, site clearance & construction noise Potentially major adverse for brief periods, principally minor adverse.	Enclosing site in impermeable hoarding; Substitution of noisy plant / activities where possible; The use of "super-silenced" power generation plant at night; Application of Best Practice working methods.	Negligible temporary	Application for Section 61 agreement between principal contractor and Local Authority.
	Demolition, site clearance & construction vibration Minor adverse/Negligible	Appropriate choice of construction methods and piling techniques	Negligible	Planning Condition or Obligation to produce: DCMS / CEMP
Ground Conditions	Disposal of Contaminated Spoil Moderate Adverse	Pre-Treatment of Spoil prior to Disposal. Capping the existing soil with hard cover or topsoil/subsoil, and removal of selected areas of gross contamination, where necessary. Legislative compliance and appropriate disposal of material would result in environmental impacts.	Negligible	Site Waste Management Plan Regulations 2008 Environmental Protection (Duty of Care) Regulations, 1991

Ground Conditions (Cont'd...)	Risks to Site Workers and Public Safety Moderate Adverse	Use of Personal Protective Equipment (PPE) Secure site through hoarding to prevent unauthorised access Implementation of Dust Control Measures – sheeting CEMP to include details of: Personal hygiene, washing and changing procedures; Personal protective equipment, including disposable overalls, gloves and particulate filter masks to be worn; Adoption of dust suppression methods, e.g. water spraying, wheel washing facility for vehicles leaving the Site; Measures to avoid surface water ponding and positive collection and disposal of all on Site runoff; Regular cleaning of all Site roads, access roads and the public highway.	Negligible	Control of Substances Hazardous to Health (COSHH) Regulations 2003 Construction (Design and Management) Regulations 2007 (CDM)
	Risk to Water Resources Moderate Adverse	Use of appropriate piling techniques Requirement to carry out a Foundation Works Risk Assessment and agree the final piling strategy with the EA	Negligible	Foundation Works Risk Assessment

Ground Conditions (Cont'd...)	Exposure of Soil to Leaching Moderate Adverse	Bunding or similar containment measures, to prevent the release of contamination through surface water runoff.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Contamination of Ground during Construction through risk related to material or fuel spillages directly or indirectly to the soil through accidental spillages.	Implementation of measures to minimise risk of accidents Bunding or similar containment measures	Minor adverse	Planning Condition or Obligation to produce: DCMS and CEMP
Water Resources	Impact associated with the release of suspended sediment Moderate Adverse	Site access points which will be regularly cleaned to prevent build up of dust and mud. Earth movement will be controlled to reduce the risk of construction silt combining with the site runoff. Properly contained wheel wash facilities will be used where required, to isolate sediment rich runoff. Removal of silt from site runoff through the use of settlement tanks to allow discharge through the existing surface water sewer without potential impacts downstream.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP

Water Resources (Cont'd...)	Use and storage of hydrocarbon fuels and oils Moderate Adverse	siting of storage areas away from surface water drains and on an impermeable base with an impermeable bund with no outflow and capacity to contain the contents plus an additional 10%. Plant and machinery will be kept away from the drainage system and will have drip trays beneath oil tanks/engines/gearboxes/hydraulics which will be checked and emptied regularly via a licensed waste disposal operator. An emergency spillage action plan will be produced, which site staff will have read and understood, On-site provisions will be made to contain a serious spill or leak through the use of booms, bunding and absorbent material.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Use of concrete and cement products – creation of alkaline wastewater, contamination of drainage channels or surface water Moderate Adverse	Concrete to be pre-mixed and delivered from an off-site source. Any mixing and handling of wet concrete on-site will be undertaken in designated areas, away from any drainage channels or surface water. A designated area will be used for any washing down or equipment cleaning Wastewater will be discharged to the foul drainage system or contained and removed by tanker to a suitable discharge location.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP

Water Resources (Cont'd...)	Disturbance to Groundwater and Disturbance of contaminated land Moderate Adverse	Perimeter walls will be capable of preventing seepage of water during excavation Water arising from excavations will be discharged to the local sewer network via settlement facilities. However restrictions may apply if the water is found to be contaminated Removing, treating or isolating any contamination hotspots under hard standing material Providing a clean subsoil or topsoil capping or covering layer in landscaped areas.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Disturbance of the existing drainage network - re-release of pollutants into the sewerage system Minor Adverse	Identification of all existing utilities and signs will be used to warn of the presence of the drainage system Any damage to the drainage network will be immediately repaired An emergency action plan will be produced to ensure spillages and leakages are immediately contained.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Preferential Pathways	The use of geotextile bunding to isolate and minimise the ingress of surface water runoff to non-decommissioned boreholes Decommissioning of exposed boreholes Isolation of the area around piling operations from surface water until piling is complete	Negligible	-

Water Resources (Cont'd...)	Water Demand and Wastewater Generation Minor Adverse	Use of water efficient fixtures and fittings within the temporary offices in use during construction, and by the avoidance of wastefully using water during site processes.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
Ecology	Effects to Crane Corridor SINC	Footpath to be installed away from the River Crane and associated trees on a disused, hard-standing station platform and through a small section of scrub	Negligible	
	Effect to River Crane and its associated habitats	-	Negligible	
	Light pollution and increased disturbance. Moderate adverse effect within the zone of influence	Artificial lighting kept to a minimum Lighting directed to required areas through appropriate angling and use of directional shields Use of low light columns	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Effects to trees	No trees or deadwood to be removed or adversely affected during development	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP

Ecology (Cont'd)	Effects to Birds/Bats Loss of breeding habitat. Loss of foraging grounds.	No habitats of value to breeding birds to be removed or adversely impacted upon during development.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Potential loss/disturbance to foraging grounds and potential to kill or injure individual stag beetles or other invertebrates. Moderate Adverse	No habitats of value to invertebrates to be removed or adversely impacted upon during development.	Negligible	
Daylight, Sunlight and Overshadowing	Light spillage from demolition and construction of the Development is likely to be at times greater than that of the completed Development, particularly prior to the external cladding being erected. Minor Adverse	Use of Site hoardings will help reduce light spill into the adjacent properties and roadways. Use of directional floodlight controls for any higher positioned luminaries.	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP
	Tall cranes may be present on-site	-	Negligible	Planning Condition or Obligation to produce: DCMS and CEMP

Wind	Site will be initially similar to the existing layout and then gradually approach the wind microclimate of the proposed development. Negligible	-	Negligible	
Electronic Interference	Potential for Ghosting through TV signal interference Minor/Moderate Adverse	Upgrading those aerials by increasing their height and gain or the utilisation of non-subscription satellite services that carry the main TV programmes.	Negligible	
Townscape Impacts	Listed building: Heatham House, its setting: High	-	Moderate adverse	
	Queen's Road and Amyand Park Road Conservation Areas: High	-	Minor adverse/ Negligible	
	Mary's Terrace, buildings of townscape merit: Moderate	-	Major adverse	
	The character of the residential areas to north and south, their residential amenity, setting and tranquillity: High	-	Major/ Moderate adverse	
	The townscape character in the vicinity of London Road bridge: High	-	Major, adverse	

Townscape Impacts (Cont'd...)	The amenity of passengers and others using the railway station: Medium	-	Major adverse	
	The character and setting of the public rights of way crossing the railway: High	-	Minor adverse/ Negligible	
	The character and setting of the cycleway LCN 174 along Mary's Terrace and Amyand Park Road: Medium	-	Negligible	
	The site: Low	-	Major adverse	
Impacts on views and visual amenity	1. Junction of Arragon Road and London Road.	-	Moderate / Major adverse	
	2. Junction of Whitton Road and London Road.	-	Moderate / Major adverse	
	3. Junction of Beauchamp Road and Marys Terrace.	-	Moderate/ Major adverse	
	4. Richmond Hill (long distance).	-	Negligible	

Impacts on views and visual amenity (Cont'd...)	5. Crane Valley – playing fields off Craneford Way	-	Negligible	
	6. Marsh Farm Road – Pedestrian link over the railway line	-	Minor Adverse/ Negligible	
	7. St Margarets – view from railway bridge, St Margarets Road.	-	Negligible	
	8. Cole Park Road	-	Moderate/ Major adverse	
	9. Corner of Cheltenham Avenue, St Mary's School	-	Negligible	
	10. In front of The Albany public house	-	Moderate/ Major adverse	
	11. Moor Mead Park.	-	Negligible	

Table 17.2 Operational Impacts

ES Topic	Key Potential Impacts	Mitigation	Residual Impact	Mitigation Delivery
Socio-Economics	Housing Provision - 115 units	-	Major Beneficial	
	New population spend	-	Moderate Beneficial	
	Council Tax revenue - £224k per annum from 115 additional units.	-	Minor Beneficial	
	Employment creation - 29 direct jobs once operational.	-	Moderate Beneficial	
	GVA (related to commercial units) - The scheme will support £1.1m per annum once operational.	.	Moderate Beneficial	
	Additional Demand on Secondary School capacity	-	Negligible	
	Additional Demand on GP/Health Centre Capacity	-	Negligible	

Socio-Economics (Cont'd...)	Additional Demand on Hospital Capacity	-	Negligible	
	Additional Demand on Dentists	-	Negligible	
	Additional small retail units in the area	-	Negligible	
	Additional Demand on Nursery Places	-	Minor Adverse	S106 Agreement
	Additional Demand on Primary School Places Moderate Adverse	S106 contributions as a mitigation measure	Moderate Adverse	S106 Agreement
	Additional Demand on Quality/provision of Parks and Open Spaces - Playgrounds Minor Adverse	Creation of link to Moormead Recreational Ground and Playground	Minor Adverse	
Transport	Increase in Delivery and Servicing vehicles for the proposed retail and station facilities (approximately 34 per week) - Minor Adverse	Delivery and Servicing Plan sets produced and includes: • Restrictions on loading • Management of deliveries to reduce the number of unnecessary journeys • An agreement with the occupants to use freight operators which follow best practice • Ongoing review of the management plan	Negligible	Planning Condition or Obligation to produce: Delivery and Servicing Plan

Transport (Cont'd...)	Provision of larger concourse area	-	Negligible	
	Provision of a car club space	-	Negligible	
Air Quality	Operational impacts on air quality No significant impact predicted for car-free scheme	-	Negligible	
	Ambient air quality Proposed site users exposed to air quality exceeding current AQOs	-	Minor Adverse/ Negligible	
Noise and Vibration	Ambient Noise Proposed development generally falls within NEC B and C. Minor adverse	Mitigation measures include glazing and acoustic ventilation.	Negligible	Planning Condition or Obligation
	Ambient vibration. Occasional perceptible vibration from fast/heavy trains.	-	Negligible	
	Operational noise and Vibration	-	Negligible	Adherence to requirements of Approved Document E of the Building Regulations 2000.

Ground Conditions	Risk to Future Occupants and Water Resources Moderate Adverse	Hard-surfaced site forming a barrier to break the potential contaminant pathway and prevent atmospheric exposure of contaminants	Negligible	
	Risk to Ecosystems Minor adverse	Landscaped areas would be provided with a clean growth medium to reduce risks of exposure to contaminants in the soil.	Negligible	
	Contamination of Ground by the Completed Development	-	Negligible	
Water Resources	Flood Risk Moderate adverse	Retain current rate of discharge to the existing surface water drainage system during normal storm events, Provision of additional protection to the site for more intense storms Surface water discharge from the site will be restricted to 30l/s. On site storage to accommodate the storm volume of up to a 1:100 year intensity. Including a 30% increase to account for the predicted effects of future climate change.	Minor Adverse	Condition or Obligation

Water Resources (Cont'd...)	Contamination from In-Situ Materials Minor adverse	All drainage/service runs will be surrounded by appropriate granular bedding materials and located above the level of any shallow groundwater.	Negligible	
	Release of oils and chemicals Minor adverse	Hard paved with an impermeable surface and positive drainage system incorporating hydrocarbon interception	Negligible	
	Physical Disturbance of Aquifers	-	Negligible	
	Water Demand Moderate adverse	Detailed discussions with Thames Water to establish existing infrastructure capacity for the development.	Minor Adverse	Water Industry Act 1991
	Wastewater Generation Moderate adverse	Detailed discussions with Thames Water to establish existing infrastructure capacity for the development.	Minor Adverse	Planning Condition
Ecology	Light pollution Moderate Adverse	Artificial lighting kept to a minimum Lighting directed to required areas through appropriate angling and use of directional shields Use of low light columns Tree planting to increase screening No lighting proposed along riverside footpath	Negligible	Planning Condition

Ecology (Cont'd...)	Effect to the integrity of the River Crane and its associated habitats.	The location of the proposed footpath has been specifically chosen so that only a short section of habitats of limited value will be lost	Negligible	Planning Condition
	Effects to Crane Corridor SINC	Footpath to be installed away from the River Crane and associated trees on a disused, hard-standing station platform and through a small section of scrub	Negligible	Planning Condition
	Pedestrian disturbance Minor Adverse	Installation of fenceline to prevent pedestrians straying into adjacent habitats	Negligible	Planning Condition
	Effect of loss of trees.	No trees or deadwood to be removed or adversely affected during development Tree planting proposed within the Site	Negligible	Planning Condition
	Effects to Bats Loss of breeding habitat. Loss of foraging grounds.	Monitoring proposed to determine impacts of development.	Negligible	
	Potential loss/disturbance to foraging grounds and potential to kill or injure individual stag beetles. Potential loss/disturbance to foraging grounds and potential to kill or injure other invertebrates	-	Negligible	Planning Condition

Daylight, Sunlight and Overshadowing	Impact of residential amenity adjacent to site	-	Negligible	
Wind	Pedestrian thoroughfares	-	Minor Beneficial to Negligible	
	Entrance	-	Negligible	
	Seating area Negligible (during the summer season)	-	Negligible	
	Balconies Negligible (during the summer season)	-	Negligible	
Electronic Interference	Signal Degradation Minor Adverse	Upgrading those aerials by increasing their height and gain or the utilisation of non-subscription satellite services that carry the main TV programmes.	Negligible	Planning Condition

Townscape Impacts	Listed building: Heatham House, its setting: High	-	Moderate adverse/ Negligible	
	Queen's Road Conservation Areas: High	-	Minor adverse / Negligible	
	Mary's Terrace, buildings of townscape merit: Moderate	-	Moderate adverse / Negligible	
	Amyand Park Road Conservation Areas: High	-	Negligible or none	
	The character of the residential areas to the north, their setting and tranquillity: High	The effects are likely to be regarded as adverse initially but would be mitigated by the landscape design, the form of the buildings, stepping down in height and presenting residential uses in the parts nearest the existing residential area. Additional planting is proposed along the riverbank to east and west and within the northern plaza, which would be effective in the medium term in providing sufficient separationg to reduce the effect on the setting of the nearest residences to neutral.	Moderate adverse/ Negligible	

Townscape Impacts (Cont'd...)	The character of the residential areas to the south, their setting and tranquillity: High	Development would partly reduce the openness of the townscape context provided by the uninterrupted sky over the railway. In the longer term, the adverse effect would be neutralised.	Moderate adverse / Negligible	
	The openness in the vicinity of London Road bridge, and the sense of contrast in the townscape character to north and south: High	-	Major beneficial	
	The character and setting of the public rights of way crossing the railway: High	-	Minor beneficial to negligible, neutral The footpath link: Moderate, beneficial	
	The amenity of passengers and others using the railway station: Medium	-	Major beneficial	

Townscape Impacts (Cont'd...)	The character and setting of the cycleway LCN 174 along Mary's Terrace and Amyand Park Road: Medium	-	Negligible or none	
	The site: Low	-	Major, beneficial	
Impacts on views and visual amenity	1. Junction of Arragon Road and London Road.	-	Major / Moderate beneficial	
	2. Junction of Whitton Road and London Road.	-	Moderate beneficial	
	3. Junction of Beauchamp Road and Marys Terrace.	It would represent a medium change which might initially be perceived as adverse, but would be neutral in effect in the long term.	Negligible	
	4. Richmond Hill (long distance).	-	Minor beneficial/ Negligible	
	5. Crane Valley – playing fields off Craneford Way	-	Negligible	

Impacts on views and visual amenity (Cont'd...)	6. Marsh Farm Road – Pedestrian link over the railway line	-	Minor beneficial / Negligible	
	7. St Margarets – view from railway bridge, St Margarets Road.	-	Minor beneficial / Negligible	
	8. Cole Park Road	The change in the view would be considerable and is likely to be regarded as an adverse change from the present relative openness. The visual effect would be mitigated by the landscape design, the form of the buildings, stepping down in height, and the additional planting proposed along the riverbank to east and west and within the northern plaza, which would be effective in the medium term in providing sufficient screening to reduce the effect to neutral.	Major to moderate adverse / Negligible	
	9. Corner of Cheltenham Avenue, St Mary's School	-	Negligible	
	10. In front of The Albany public house	-	Moderate to Major beneficial	
	11. Moor Mead Park.	-	Negligible	