Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

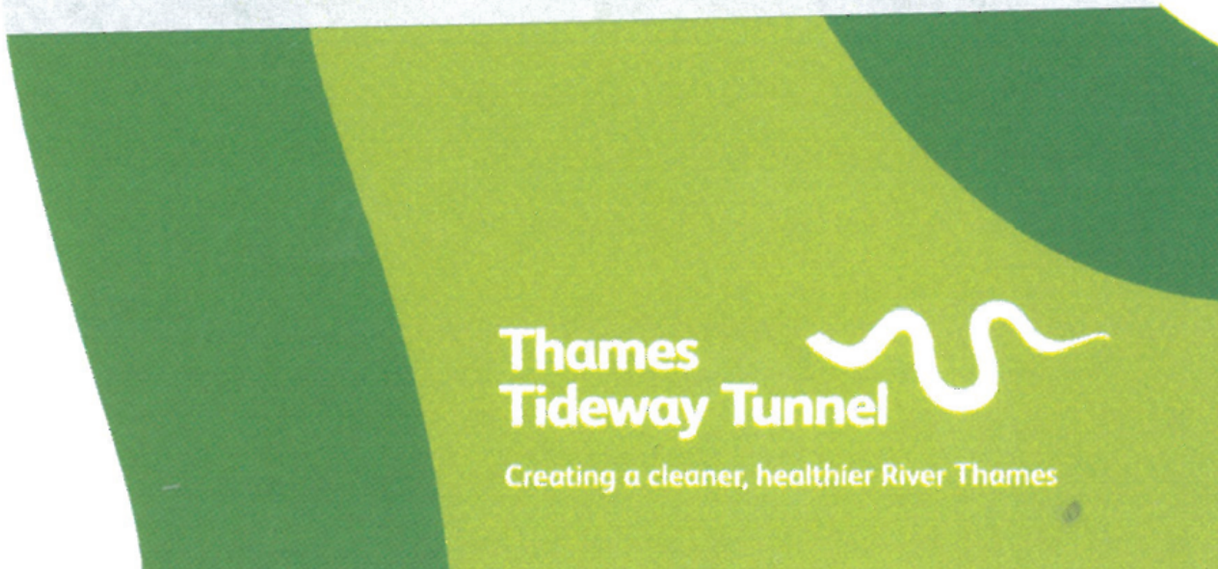
Documents for Certification
September 2014

We, Lindsay Speed and Sarah Fairbrother hereby certify that this is a true copy of the environmental statement referred to in Article 61 (1) (f) of the Thames Water Utilities Limited (Thames Tideway Tunnel) Order 2014.

Lindsay Speed

Sarah Fairbrother

September 2014



Thames Tideway Tunnel
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Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

APFP Regulations 2009: Regulation **5(2)(a)**

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Appendix A: Introduction

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Appendix A: Introduction

A.1 Summary

A.1.1 This document presents the appendices that accompany the *Environmental Statement* Volume 6 Barn Elms site assessment.

A.1.2 Figures associated with the appendices are provided within a separate volume of figures.

A.1.3 For consistency and ease of use Volumes 3 to 27 of the *Environmental Statement* all utilise the same appendices contents and labelling protocol. For these volumes the appendices are as follows:

a. Appendix A: Introduction
b. Appendix B: Air quality and odour
c. Appendix C: Ecology – aquatic
d. Appendix D: Ecology – terrestrial
e. Appendix E: Historic environment
f. Appendix F: Land quality
g. Appendix G: Noise and vibration
h. Appendix H: Socio-economics
i. Appendix I: Townscape and visual
j. Appendix J: Transport
k. Appendix K: Water resources – groundwater
l. Appendix L: Water resources – surface water
m. Appendix M: Water resources – flood risk
n. Appendix N: Development schedule.

A.1.4 Where a topic has not been assessed the associated appendix does not include any supporting information. Also, if a topic has been assessed but does not need to present any supporting information then the appendix is intentionally empty.

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Appendix B: Air quality and odour

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Appendix B: Air quality and odour

B.1 Model verification

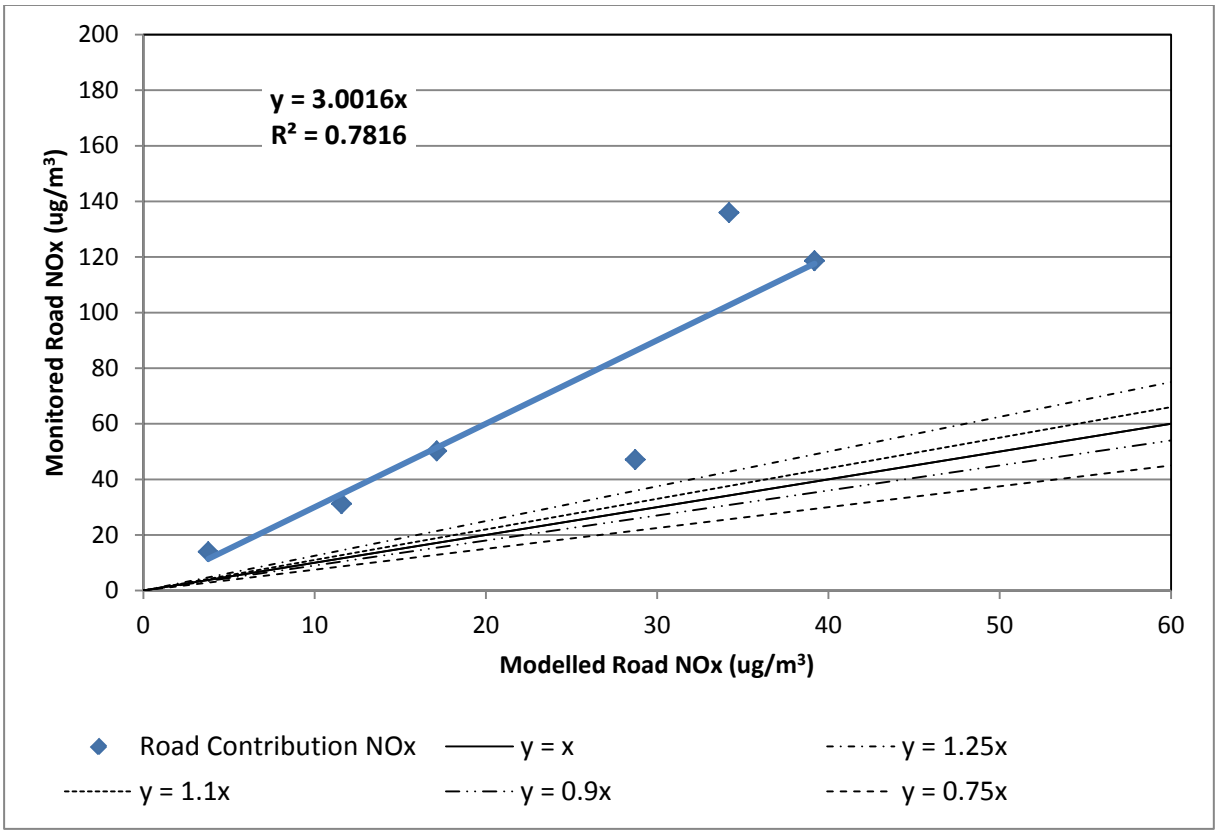
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at four monitoring sites established for this assessment (BELM1–BELM4) and two local authority monitoring sites (RI1 and W5) as shown in Vol 6 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between -12% and 40%. As the model has been optimised and no further improvement of the model was considered feasible (such as reducing vehicle speeds or using different pollutant backgrounds, etc), a model adjustment factor was therefore deemed necessary.

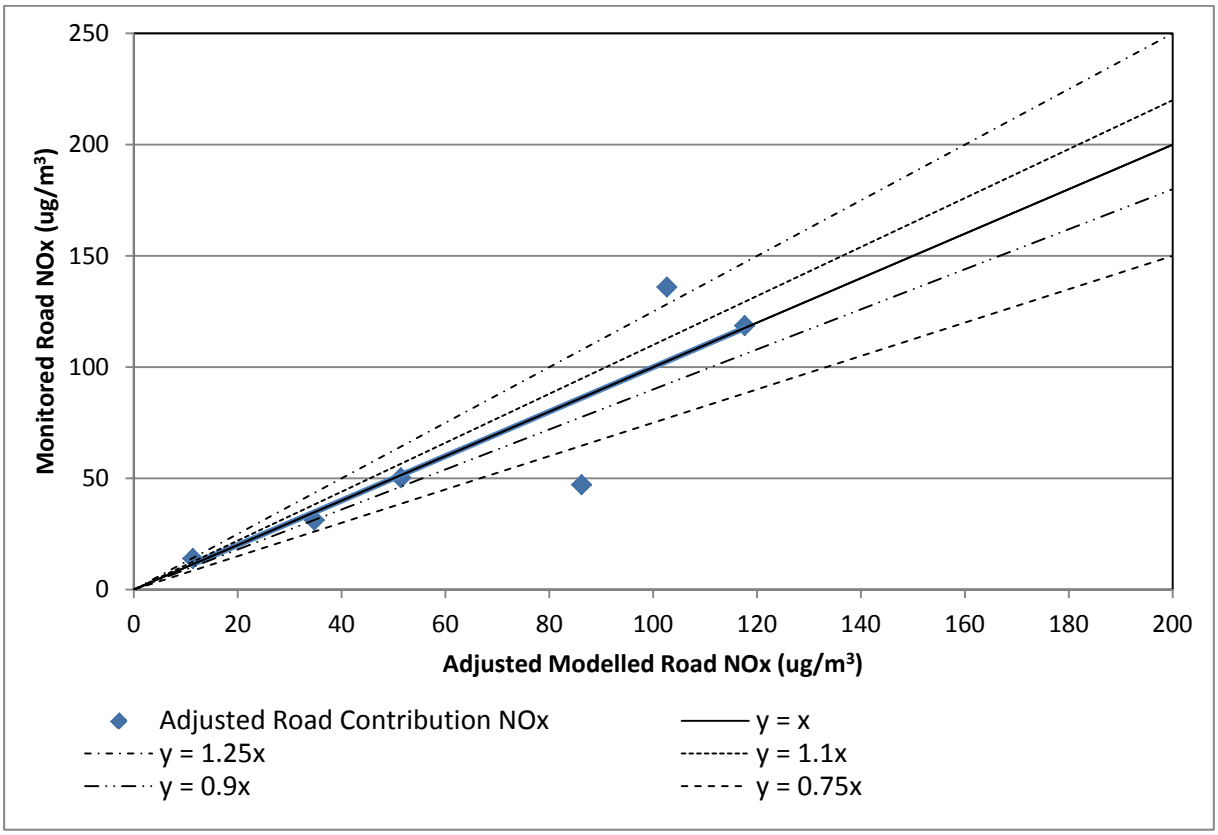
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 6 Plate B.1 below). An adjustment factor of 3.00 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09)[1] and subsequently applied. PM_{10} monitoring data were available from one site (RI1) and were compared with the modelled concentration. An adjustment factor of 2.00 was calculated for adjusting modelled roadside PM_{10} concentrations, in accordance with LAQM.TG(09), and subsequently applied.

B.1.4 Applying the NO_X adjustment factor and then calculating NO_2 concentrations, as shown in Vol 6 Plate B.2, provides better overall agreement between actual and predicted data. The subsequent linear regression calculation for monitored versus modelled total NO_2, as shown in Vol 6 Plate B.3, indicated that four of the six modelled concentrations were within 10% of the measured value and that all six modelled concentrations are within 25% of the modelled value.

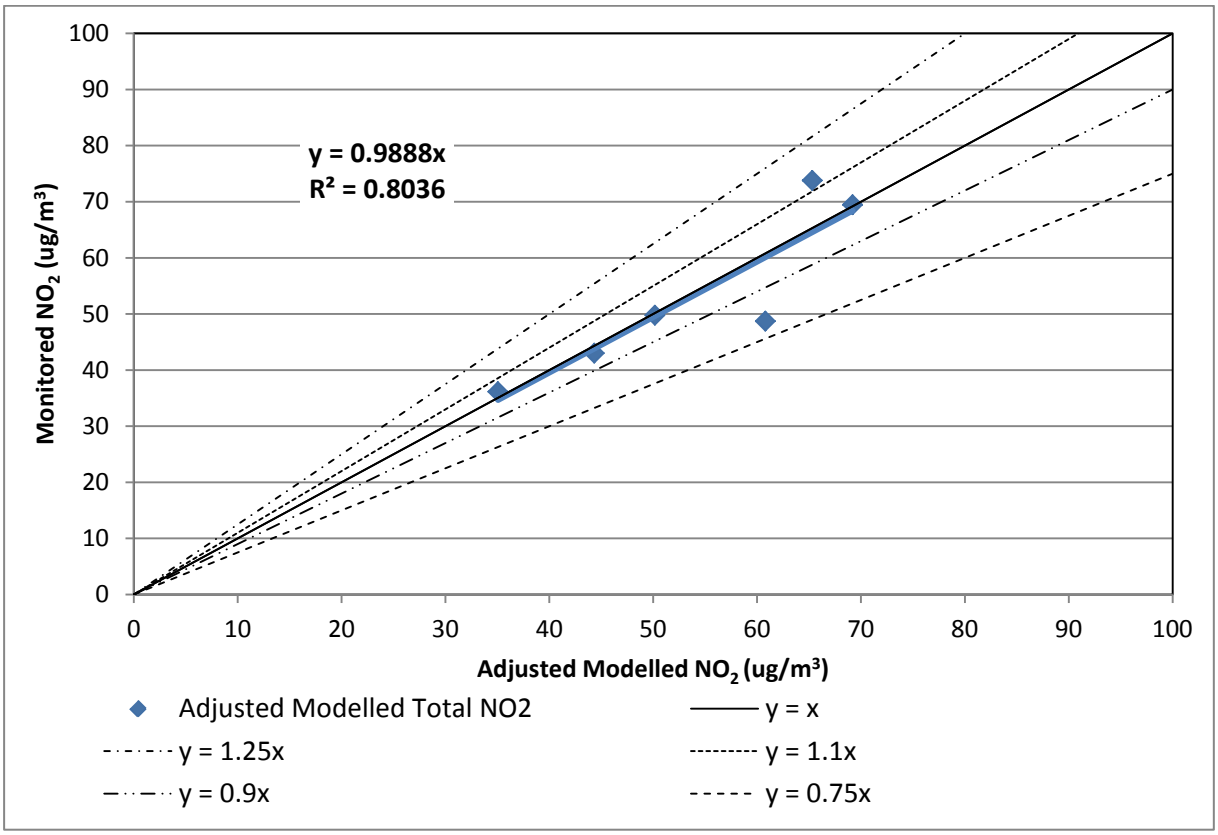
Vol 6 Plate B.1 Air quality - monitored road NO_X vs. modelled road NO_X



Vol 6 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 6 Plate B.3 Air quality – total monitored NO_2 vs. total adjusted modelled NO_2



B.2 Traffic data

B.2.1 The traffic data used in the air quality modelling for the Barn Elms site are shown in Vol 6 Table B.1.

Vol 6 Table B.1 Air quality - traffic data model inputs

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
ATC** 'Indirect'	Castelnau A306	20992	7.5%	30	25.7	1.8%	21374	0	21374	7.5%
TfL Model	Church Road A3003	4174	19.2%	30	29.0	1.8%	4250	0	4250	19.2%
Speed Limit	Elm Grove Road	571	3.7%	30	30.0	1.8%	582	0	582	3.7%
ATC 'direct'	Rocks Lane A306	19153	8.8%	30	25.7	1.8%	19501	10	19511	8.8%
ATC 'direct'	Queen Elizabeth Walk	1303	12.2%	30	15.3	1.8%	1327	10	1337	12.9%
ATC 'Indirect'	Rocks Lane A306	22597	3.7%	30	25.7	1.8%	23009	10	23019	3.7%
TfL Model	Mill Hill Road B349	12096	3.3%	30	18.4	1.8%	12316	0	12326	3.3%
ATC	Rocks Lane	18209	9.5%	30	28.3	1.8%	18540	10	18555	9.6%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
'direct'	A306									
TfL Model	Lower Richmond Road A306	11996	4.5%	30	14.8	1.8%	12214	0	12229	4.5%
ATC 'Indirect'	Upper Richmond Road A205	28585	7.7%	30	28.3	1.8%	29105	26	29149	7.8%
ATC 'Indirect'	Upper Richmond Road A205	25195	6.1%	30	28.3	1.8%	25654	22	25679	6.2%
TfL Model	Queens Ride B306	7114	6.6%	30	38.6	1.8%	7243	0	7254	6.5%
ATC 'Indirect'	Roehampton Lane A306	21659	6.7%	30	28.3	1.8%	22053	2	22055	6.7%
ATC 'direct'	A308 New Kings Road	20060	8.9%	30	20.5	6.9%	21444	0	21478	8.9%
ATC 'Indirect'	A219 Fulham High Street	29012	9.4%	30	20.5	6.9%	31015	0	31030	9.4%
ATC 'Indirect'	A219 Putney Bridge	47956	7.3%	30	20.5	6.9%	51266	0	51297	7.3%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
TfL Model	B306 Lower Richmond Road east of Embankment	27835	4.3%	30	16.9	6.9%	29757	0	29782	4.3%
Speed Limit	Embankment north of Lower Richmond Road	815	0.6%	30	30.0	6.9%	871	0	871	0.6%
TfL Model	B306 Lower Richmond Road west of Embankment	26938	4.3%	30	16.9	6.9%	28797	0	28822	4.3%
Speed Limit	Embankment west of Thames Place	1096	2.8%	30	30.0	6.9%	1172	0	1172	2.8%
TfL Model	B306 Lower Richmond Road west of Thames Place	26422	5.1%	30	16.9	6.9%	28246	0	28271	5.1%
TfL Model	Putney High Street south of Putney Bridge	42409	9.8%	30	14.7	6.9%	45336	0	45342	9.8%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
ATC 'Indirect'	Putney Bridge Road east of Putney High Street	19402	6.5%	30	25.4	6.9%	20742	0	20742	6.5%
ATC 'direct'	Putney Bridge Road east of Deodar Road	18753	9.9%	30	25.4	6.9%	20047	0	20076	9.8%
TfL Model	Putney High Street north of South Circular	20341	12.2%	30	29.4	6.9%	21745	0	21748	12.2%
ATC 'Indirect'	A205 South Circular west of Putney High Street	16190	7.7%	30	25.4	6.9%	17308	0	17311	7.7%
ATC 'Indirect'	A205 South Circular east of Putney High Street	14808	6.1%	30	25.4	6.9%	15830	0	15836	6.1%
TfL Model	Putney High Street south of South Circular	20829	11.9%	30	29.4	6.9%	22267	0	22270	11.9%

** AADT – annual average daily traffic. ** ATC - automatic traffic count.*

B.3 Construction plant emission factors

B.3.1 For the purpose of the assessment, the following listed equipment in Vol 6 Table B.2 at Barn Elms has been modelled for the peak construction year.

Vol 6 Table B.2 Air quality - construction plant assessment model inputs

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Site set up and general site	Ground level behind hoarding	Compressor 250cfm*	1	50	104	8.3×10^{-7}	5.2×10^{-8}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	2.6×10^{-6}	1.6×10^{-7}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	5.4×10^{-7}	3.4×10^{-8}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	1.9×10^{-8}	4.1×10^{-8}
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	2.9×10^{-7}	1.8×10^{-8}
	Ground level behind hoarding	Hiab*** lorry/crane	1	5	56	4.5×10^{-8}	2.8×10^{-9}
	Ground level behind hoarding	Well drilling rig	1	50	403	3.2×10^{-6}	2.0×10^{-7}
Piling	Ground level behind hoarding	100t crawler crane	1	50	240	1.9×10^{-6}	1.2×10^{-7}
	Ground level behind hoarding	25 tonne mobile crane	1	50	275	2.2×10^{-6}	1.4×10^{-7}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Shaft sinking by spray concrete lining	Within excavation	Shotcrete robot	1	20	14	7.2×10^{-7}	6.7×10^{-8}
	Ground level behind hoarding	Concrete deliveries (agitating)	1	80	223	2.9×10^{-6}	1.8×10^{-7}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	7.2×10^{-7}	4.5×10^{-8}
	Ground level behind hoarding	12t excavator	1	80	66	8.5×10^{-7}	5.3×10^{-8}
	Ground level behind hoarding	100t crawler crane	1	80	240	3.1×10^{-6}	1.9×10^{-7}
	Ground level behind hoarding	25t mobile crane	1	20	275	8.8×10^{-7}	5.5×10^{-8}
	Ground level behind hoarding	25t excavator	1	50	125	1.0×10^{-6}	6.3×10^{-8}
	Ground level behind hoarding	400cfm compressor	1	50	104	8.3×10^{-7}	5.2×10^{-8}
Shaft secondary lining	Ground level behind hoarding	100t crawler crane	1	50	240	1.9×10^{-6}	1.2×10^{-7}
	Ground level behind hoarding	Service crane 40t mobile crane	1	25	275	1.1×10^{-6}	6.9×10^{-8}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	7.2×10^{-7}	4.5×10^{-8}
	Ground level behind hoarding	Concrete pump	2	20	223	1.4×10^{-6}	8.9×10^{-8}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Culvert works	Ground level behind hoarding	Service crane – 100t mobile crane	1	50	280	2.2×10^{-6}	1.4×10^{-7}
	Ground level behind hoarding	25t excavator	1	50	125	1.0×10^{-6}	6.3×10^{-8}
	Ground level behind hoarding	Dumper	1	50	81	6.5×10^{-7}	4.1×10^{-8}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	233	7.5×10^{-7}	4.7×10^{-8}
	Ground level behind hoarding	Concrete boom pump	1	20	233	7.5×10^{-7}	4.7×10^{-8}
Drive connection tunnel in spray concrete lining	Within excavation	Shotcrete robot	1	20	14	7.2×10^{-7}	6.7×10^{-8}
	Ground level behind hoarding	Concrete deliveries (agitating)	1	80	223	2.9×10^{-6}	1.8×10^{-7}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	7.2×10^{-7}	4.5×10^{-8}
	Within excavation	Butor tunnel excavator	1	50	30	3.9×10^{-6}	3.6×10^{-7}
	Within excavation	Piccini dumpers	2	50	81	1.3×10^{-6}	8.1×10^{-8}
	Ground level behind hoarding	100t crawler crane	1	50	240	1.9×10^{-6}	1.2×10^{-7}
	Ground level behind hoarding	25t mobile crane	1	20	275	8.8×10^{-7}	5.5×10^{-8}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
	Ground level behind hoarding	25t excavator	1	50	125	1.0×10^{-6}	6.3×10^{-8}
	Ground level behind hoarding	400cfm compressor	1	50	104	8.3×10^{-7}	5.2×10^{-8}

*Note: For the purposes of this assessment, the above listed equipment has been modelled for the peak construction year. The data assumes a 10 hour working day. This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable assumption for the assessment that can be made at this stage. * cfm – cubic feet per minute. ** FLT – fork lift truck.***Hiab – loader crane.*

References

[1] Defra, *Local Air Quality Management - Technical Guidance, LAQM.TG(09)* (2009).

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Appendix C: Ecology - aquatic

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Appendix C: Ecology - aquatic

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Appendix C: Ecology - aquatic

C.1 Introduction

C.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Appendix D: Ecology - terrestrial

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Appendix D: Ecology – terrestrial

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Appendix D: Ecology – terrestrial

D.1 Notable species survey report

Introduction

D.1.39 A Phase 1 Habitat Survey was carried out on 23 November 2010 at the Barn Elms site (see Vol 6 Figure 6.4.2 Phase 1 Habitat Map in separate volume of figures). Based on this, surveys for the following species have been undertaken:

a. otter *(Lutra lutra)* and water vole *(Arvicola amphibius)*

b. badger *(Meles meles)*

c. bats

d. breeding birds

e. wintering birds

f. reptiles

g. great crested newts (*Triturus cristatus*)

h. invertebrates

i. invasive plants.

D.1.40 The purpose of the surveys is to determine the presence or likely absence of these species at and around the site.

D.1.41 This report presents the survey findings. The survey area for each species is described with reference to the habitat types identified during the Phase 1 Habitat Survey as having potential for notable species (paras D.1.43 to D.1.66). The results from the surveys are then presented (paras D.1.67 to D.1.100). The final section provides an interpretation of the results (paras to D.1.101 to D.1.120). Figures referred to in this report are contained within Volume 6 Barn Elms Figures.

D.1.42 Information on legislation, policy and methodology can be found in Volume 2 Environmental assessment methodology of the *Environmental Statement*. Information on site context can be found in Section 3 of this volume.

Survey area

Otter and water vole

D.1.43 Water voles are associated with vegetated river banks where there is a diversity of habitat type and structure, in addition to food plants such as common reed *(Phragmites australis)*. They occupy burrows in the river bank where they shelter and breed. Otters move along watercourses and eat fish and other aquatic animals. They shelter and breed in holts, which can be a hole in the base of a tree or can comprise holes in banks. They also make use of tall bankside vegetation as resting places.

D.1.44 The survey area, as shown in Vol 6 Figure 6.4.3 (see separate volume of figures) includes the Beverley Brook adjacent to the site in the southwest and the River Thames in close proximity to the site to the east, as well as connecting vegetation. These watercourses are considered to provide a potential corridor for the movement of otter (if present) as well as providing possible areas for otter to forage and rest. The bank and associated vegetation along the Beverley Brook has the potential to support foraging and burrowing water vole. The survey also included an area of woodland to the south and west of the proposed site compound, containing several wet areas and a waterbody, where otter may shelter.

Badger

D.1.45 Setts (underground burrows) of badgers are often found within woodlands, dense scrub, and along hedgerow banks, whilst tall ruderal vegetation and grassland, provide habitat where badgers forage for grubs and insects below the surface of the soil. Badgers mark out their territories by creating latrines, usually along existing boundaries such as the edge of a woodland or hedgerow.

D.1.46 The survey area, as shown in Vol 6 Figure 6.4.4 (see separate volume of figures) covers the proposed development site at Barn Elms and connecting linear habitats such as the tall ruderal, trees and scrub line adjacent to Beverley Brook to the south, and adjacent to the River Thames to the east. The survey area also included the northern site boundary, adjacent to the Barn Elms Wetland Centre. The broad-leaved woodland directly to the south and west of the proposed site compound was included in the survey area as this was identified as having potential for a large badger sett to be present. Attention was also given to the playing fields within and adjacent to the site in order to identify potential foraging habitats and paths through the site.

Bats

D.1.47 Bats are associated with a diverse range of habitats, including woodland, scrub, riparian habitats and buildings. They roost in trees and buildings where suitable features are present, and they commute along linear features such as hedgerows, watercourses and tree lines, and forage around vegetation such as scrub, hedgerows, grassland, trees and river corridors.

D.1.48 A two stage bat survey was carried out. The first survey was a remote recording (bat triggering) survey using remote Anabat™ recording devices. Based on the habitat types identified during the Phase 1 Habitat Survey and their potential to support foraging, commuting or roosting bats, three locations were chosen for the installation of the remote recording devices as shown on Vol 6 Figure 6.4.5 (see separate volume of figures). No remote recording or dawn activity surveys were undertaken in the northern part of the site, along the proposed construction access route, as the Phase 1 Habitat Survey identified limited potential for roosting bats and the area had minimal foraging resources.

D.1.49 Location one is on the southern boundary of the site adjacent to the Beverley Brook. The recording device was attached to a tree. This

location was selected to record potential bat activity associated with foraging and commuting along the Beverley Brook and to record the movement of bats entering and leaving the site along this boundary. This device was also positioned to record potential bat activity associated with bat roosts in trees and buildings to the south of the Beverley Brook.

D.1.50 Location two is to the east of the site adjacent to the River Thames. The recording device was attached to a mature tree. This location was selected to gain an understanding of bat activity associated with foraging and commuting along the trees adjacent to the River Thames and along the watercourse, and to identify whether a roost is present within the trees at this location.

D.1.51 Location three is on the eastern boundary of the site along the proposed site access road. The remote recording device was attached to a mature tree. This location was selected to record activity associated with the northern end of the access road, such as foraging and commuting along the trees adjacent to the site to the east.

D.1.52 The bat activity recorded during the remote recording surveys triggered the need for an additional dawn survey (see Vol 2 Methodology for bat triggering criteria). Therefore, a second stage of bat surveying was undertaken, comprising one dawn survey visit by two ecologists to assess the usage of the site and immediate surrounds by bats.

D.1.53 The survey area comprised the proposed development site and the habitats in close proximity that could support commuting, foraging and roosting bats as follows:

a. the amenity grassland area on site
b. the Beverley Brook to the south and the River Thames to the east
c. tree and scrub adjacent to the site to the east
d. buildings across the Beverley Brook to the south
e. tree and scrub along the road adjacent to the London Wetland Centre
f. the woodland to the south and west of the proposed development site (construction compound).

D.1.54 The survey area for the bat activity (dawn) survey, is shown in Vol 6 Figure 6.4.5 (see separate volume of figures).

D.1.55 A bat roost potential survey of trees within and adjacent to the Barn Elms School Sports Centre car park and changing rooms was undertaken, as these trees were identified as potentially being affected by the works on site. The trees included black poplar (*Populus nigra* agg.) and a large London plane (*Platanus x acerifolia*) tree. The survey area is shown in Vol 6 Figure 6.3.5 (see separate volume of figures).

Breeding birds

D.1.56 Breeding birds forage and nest within a range of habitat including grassland, scrub, trees and marginal aquatic habitats. Birds can also nest on and within buildings. The survey area, as shown in Vol 6 Figure 6.4.6

(see separate volume of figures) comprises suitable habitat within 100m of the site boundary as follows:

g. trees, scrub and tall ruderal vegetation along the Beverley Brook adjacent to the site to the south and west, and adjacent to the site and access road to the north and east

h. the woodland to the south and west of the proposed development site

i. the hedgerow adjacent to the London Wetland Centre to the north of the site.

D.1.57 The survey area does not include the site compound at the northwest of the site or habitat immediately adjacent as this is sub-optimal for breeding birds.

Wintering birds

D.1.58 Wintering birds are mainly associated with aquatic habitats such as intertidal mudflats and marshes, marginal vegetation and wetlands, which they use for resting and foraging. Some wintering bird species are also associated with terrestrial habitats such as scrub and grassland, which they use for roosting at high tide or foraging. The survey area, as shown in Vol 6 Figure 6.4.7, includes the proposed development site and habitats in close proximity to the site that have potential for wintering birds as follows:

a. the playing fields that provide potential foraging and resting habitat

b. the foreshore of the River Thames to the east of the site, which has potential for wintering birds to rest and forage on the intertidal mud, silt and gravel

c. the confluence of the Beverley Brook with the River Thames, which provides potential foraging habitat

d. the woodland and associated wet areas to the south and west of the site.

Reptiles

D.1.59 Reptiles are associated with a variety of habitats including open woodland, abandoned and derelict land, large gardens, heathland, grassland, scrub and riparian habitats. Reptiles are usually found where there is a mosaic of these habitats that provide a range of conditions for shelter, foraging and basking. They also require sheltered locations for hibernating in winter, such as piles of wood or stone.

D.1.60 The survey area comprises the tall ruderal, trees, scrub and rough grassland habitat adjacent to the site to the south and east, as shown in Vol 6 Figure 6.4.8 (see separate volume of figures). The amenity grassland on and adjacent to the site, and the area of tall ruderal vegetation and scattered trees to the east of the site and the area of the proposed site compound in the northwest of the site was considered to be sub-optimal as it lacks cover and shelter for reptiles.

Great crested newts

D.1.61 Great crested newts are generally associated with waterbodies with good water quality, submergent vegetation or leaf litter for egg laying and an absence or limited population of fish. To be suitable for breeding the waterbody would need to be connected to suitable terrestrial habitat used for foraging and shelter such as rough grassland, scattered scrub and log or stone piles. Great crested newts associated with a waterbody can move long distances through suitable terrestrial habitat between suitable waterbodies.

D.1.62 A Habitat Suitability Index (HSI) assessment[1] of the waterbody within an area of trees and scrub to the west of the Barn Elms Sports Centre, and to the northwest of the main construction site. No other waterbodies with potential for suitability for great crested newt were identified within 250m of the site.

Invertebrates

D.1.63 Notable and diverse assemblages of invertebrates are associated with a range of habitat types, with many species associated with specific plant species or particular habitat types. Habitats with potential for notable invertebrate species include riparian (bank-side/marginal) vegetation, tall ruderal vegetation, sparsely vegetated areas, dead wood, trees, scrub, and species-rich grasslands.

D.1.64 Habitat within the survey area comprises bank-side vegetation along Beverley Brook to the south of the site, tall ruderal and grassland habitat adjacent to the Scout hut to the east of the site, areas of dead wood adjacent to the Thames Path to the east of the site, and scrub adjacent to the access road into the site, as shown in Vol 6 Figure 6.4.9 (see separate volume of figures).

Invasive plants

D.1.65 Invasive plants that are listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) occur in a wide range of habitats, although they are more often associated with watercourses or wet areas, or within areas of disturbed ground, where material contaminated with seeds and rhizomes (sections of root that can re-grow), may have been imported into the area.

D.1.66 The invasive plants survey area, comprises the proposed development site, and an area within 10m of the proposed development site boundary, as shown on Vol 6 Figure 6.4.10 (see separate volume of figures). The 10m zone beyond the site boundary was surveyed to record any invasive plants present adjacent to the site that could potentially spread onto the site, or that could have roots that extend into the site below ground (e.g. Japanese knotweed (*Fallopia japonica*)).

Results

D.1.67 In this section, the results of the desk study, notable species surveys and the invasive plant survey are presented. The results are then interpreted in paragraphs D.1.101 and D.1.120.

Desk Study

D.1.68 Species data recorded within 500m of the site from 2001 to 2011, as supplied by Greenspace Information for Greater London (GIGL), are summarised in Vol 6 Table D.2.

Vol 6 Table D.1 Terrestrial ecology - species recorded within 500m of the site between 2001 – 2011

Common name	Latin name	Record count
Mammals		
European water vole	*Arvicola amphibius*	92
West european hedgehog	*Erinaceus europaeus*	25
Common pipistrelle	*Pipistrellus pipistrellus*	166
Daubenton's bat	*Myotis daubentonii*	678
Lesser noctule	*Nyctalus leisleri*	35
Nathusius's pipistrelle	*Pipistrellus nathusii*	34
Noctule bat	*Nyctalus noctula*	648
Nyctalus (bat)	*Nyctalus*	22
Pipistrellus sp.	*Pipistrellus sp.*	718
Serotine	*Eptesicus serotinus*	32
Soprano pipistrelle	*Pipistrellus pygmaeus*	966
Unidentified bat	*Myotis sp.*	8
Bats	*Vespertilionidae*	21
Birds		
Tundra swan	*Cygnus columbianus*	4
Whooper swan	*Cygnus cygnus*	157
Lesser white-fronted goose	*Anser erythropus*	3
Greylag goose	*Anser anser*	350
Barnacle goose	*Branta leucopsis*	31
Ruddy shelduck	*Tadorna ferruginea*	1
Northern pintail	*Anas acuta*	392
Garganey	*Anas querquedula*	123
Ferruginous duck	*Aythya nyroca*	1
Greater scaup	*Aythya marila*	20
Common scoter	*Melanitta nigra*	5
Common goldeneye	*Bucephala clangula*	53

Common name	Latin name	Record count
Smew	*Mergellus albellus*	9
Grey partridge	*Perdix perdix*	2
Common quail	*Coturnix coturnix*	6
Diver sp.	*Gavia sp.*	1
Slavonian grebe	*Podiceps auritus*	2
Black-necked grebe	*Podiceps nigricollis*	4
Leach's storm-petrel	*Oceanodroma leucorhoa*	1
Great bittern	*Botaurus stellaris*	91
Black-crowned night heron	*Nycticorax nycticorax*	2
Little egret	*Egretta garzetta*	84
White stork	*Ciconia ciconia*	3
Eurasian spoonbill	*Platalea leucorodia*	1
European honey-buzzard	*Pernis apivorus*	6
Black kite	*Milvus migrans*	2
Red kite	*Milvus milvus*	14
Eurasian marsh harrier	*Circus aeruginosus*	25
Hen harrier	*Circus cyaneus*	4
Montagu's harrier	*Circus pygargus*	1
Northern goshawk	*Accipiter gentilis*	7
Osprey	*Pandion haliaetus*	15
Merlin	*Falco columbarius*	17
Eurasian hobby	*Falco subbuteo*	253
Peregrine falcon	*Falco peregrinus*	220
Spotted crake	*Porzana porzana*	27
Common crane	*Grus grus*	1
Pied avocet	*Recurvirostra avosetta*	82
Eurasian curlew	*Numenius arquata*	84
Little plover	*Charadrius dubius*	475
European golden plover	*Pluvialis apricaria*	21
Northern lapwing	*Vanellus vanellus*	602
Ruff	*Philomachus pugnax*	44
Black-tailed godwit	*Limosa limosa*	98

Common name	Latin name	Record count
Bar-tailed godwit	*Limosa lapponica*	27
Whimbrel	*Numenius phaeopus*	46
Common greenshank	*Tringa nebularia*	170
Green sandpiper	*Tringa ochropus*	165
Wood sandpiper	*Tringa glareola*	36
Arctic skua	*Stercorarius parasiticus*	4
Mediterranean gull	*Larus melanocephalus*	9
Little gull	*Larus minutus*	50
Yellow-legged gull	*Larus michahellis*	1
Caspian gull	*Larus cachinnans*	375
Herring gull	*Larus argentatus*	397
Little tern	*Sternula albifrons*	5
Caspian tern	*Hydroprogne caspia*	1
Black tern	*Chlidonias niger*	20
Sandwich tern	*Sterna sandvicensis*	24
Common tern	*Sterna hirundo*	336
Arctic tern	*Sterna paradisaea*	27
European turtle dove	*Streptopelia turtur*	24
Common cuckoo	*Cuculus canorus*	21
Barn owl	*Tyto alba*	1
Short-eared owl	*Asio flammeus*	19
European nightjar	*Caprimulgus europaeus*	1
Common kingfisher	*Alcedo atthis*	255
Lesser spotted woodpecker	*Dendrocopos minor*	20
Wood lark	*Lullula arborea*	12
Sky lark	*Alauda arvensis*	183
Sand Martin	*Riparia riparia*	391
Tree pipit	*Anthus trivialis*	18
Yellow wagtail	*Motacilla flava*	309
Hedge accentor / Dunnock	*Prunella modularis*	175
Bluethroat	*Luscinia svecica*	5
Black redstart	*Phoenicurus ochruros*	50

Common name	Latin name	Record count
Ring ouzel	*Turdus torquatus*	57
Fieldfare	*Turdus pilaris*	187
Song thrush	*Turdus philomelos*	215
Redwing	*Turdus iliacus*	288
Cetti's warbler	*Cettia cetti*	34
Common grasshopper warbler	*Locustella naevia*	2
Marsh warbler	*Acrocephalus palustris*	7
Wood warbler	*Phylloscopus sibilatrix*	1
Firecrest	*Regulus ignicapilla*	9
Spotted flycatcher	*Muscicapa striata*	34
Bearded tit	*Panurus biarmicus*	6
Marsh tit	*Poecile palustris*	1
Red-backed shrike	*Lanius collurio*	1
Lesser grey shrike	*Lanius minor*	1
Common starling	*Sturnus vulgaris*	340
House sparrow	*Passer domesticus*	198
Eurasian tree sparrow	*Passer montanus*	7
Brambling	*Fringilla montifringilla*	97
European serin	*Serinus serinus*	1
Common linnet	*Carduelis cannabina*	295
Lesser redpoll	*Carduelis cabaret*	3
Common redpoll	*Carduelis flammea*	189
Common crossbill	*Loxia curvirostra*	7
Common bullfinch	*Pyrrhula pyrrhula*	20
Lapland longspur	*Calcarius lapponicus*	6
Snow bunting	*Plectrophenax nivalis*	8
Yellowhammer	*Emberiza citrinella*	15
Ortolan bunting	*Emberiza hortulana*	1
Reed bunting	*Emberiza schoeniclus*	367
Corn bunting	*Emberiza calandra*	1
Amphibians		

Common name	Latin name	Record count
Common frog	*Rana temporaria*	32
Common toad	*Bufo bufo*	2
Invertebrates		
Cinnabar	*Tyria jacobaeae*	1
Ear moth	*Amphipoea oculea*	1
Ero aphana	*Ero aphana*	1
Nymphalis polychloros	*Nymphalis polychloros*	1
Stag beetle	*Lucanus cervus*	38
Oak hook-tip	*Watsonalla binaria*	1
Small heath	*Coenonympha pamphilus*	1
White admiral	*Limenitis camilla*	2
Plants		
Cornflower	*Centaurea cyanus*	9
Divided sedge	*Carex divisa*	6
Lesser calamint	*Clinopodium calamintha*	2
Mistletoe	*Viscum album*	2
Pennyroyal	*Mentha pulegium*	1
Native black poplar	*Populus nigra subsp. betulifolia*	4
Small-flowered catchfly	*Silene gallica*	1
Temminck's stint	*Calidris temminckii*	1
Tower mustard	*Arabis glabra*	2
Woolly willow	*Salix lanata*	2
Autumn squill	*Scilla autumnalis*	2

Otter and water vole survey

D.1.69 An otter and water vole survey was undertaken on 10 October 2011 by experienced ecologists in suitable weather conditions (10-14°C, light breeze, dry on the day of survey with a period of dry weather preceding the survey visit). No observations were made of otters or water voles during the survey. No field signs, such as otter spraint, water vole droppings and footprints of either species, which would be indicative of presence of these species, were recorded. The results are shown on Vol 6 Figure 6.4.3 (see separate volume of figures).

Badger surveys

D.1.70 The badger survey was undertaken on the 22 March 2011 with a follow-up survey on 2 September 2011.

D.1.71 Field observations recorded during the survey indicate that the site and its surrounding areas are currently used by badger for foraging and dispersal. The majority of field signs were recorded along the southern survey area boundary where a belt of ruderal vegetation exists adjacent to the Beverly Brook, as shown on Vol 6 Figure 6.4.4 (see separate volume of figures). One foraging scrape was recorded on the playing fields in the central area of the survey area.

Bat surveys

Bat triggering (remote recording) surveys

D.1.72 The bat triggering (remote recording) surveys were undertaken over three nights between 21 and 23 April 2011 in suitable weather conditions (see Vol 6 Table D.3).

D.1.73 The remote recording surveys recorded six species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pygmaeus)*, Nathusius' pipistrelle (*Pipistrellus nathusii)*, noctule (*Nyctaus nyctalus)*, Leisler's bat *(Nyctalus leisleri)* and serotine *(Eptesicus serotinus)*.

D.1.74 A high number of common pipistrelle and soprano pipistrelle bat passes were recorded. The maximum count in any one night at any one location for common pipistrelle was 904 bat passes, recorded at location one on 21 April 2011. The number of common pipistrelle bat passes was also high on the other two survey nights at location one, with counts of 641 and 580. The counts at locations two and three were similar to each other, ranging from 24 to 73 bat passes in any one night. During the dawn bat activity survey, bats were observed foraging and commuting along vegetation to the south and east of the site adjacent to Beverley Brook as shown on Vol 6 Figure 6.4.5 (see separate volume of figures).

D.1.75 For soprano pipistrelle, the maximum counts were recorded at location three, with 91 bat passes on 22 April 2011 and 170 bat passes on 23 April 2011. All other nights all locations were similar, with between 19 and 56 bat passes recorded.

D.1.76 Two Leisler's bat passes and one serotine bat pass were recorded during the remote recording surveys at location two on 23 April 2011.

D.1.77 Nathusius' pipistrelle bat passes were recorded at all three locations in low numbers ranging from one bat pass in one night to six bat passes in one night.

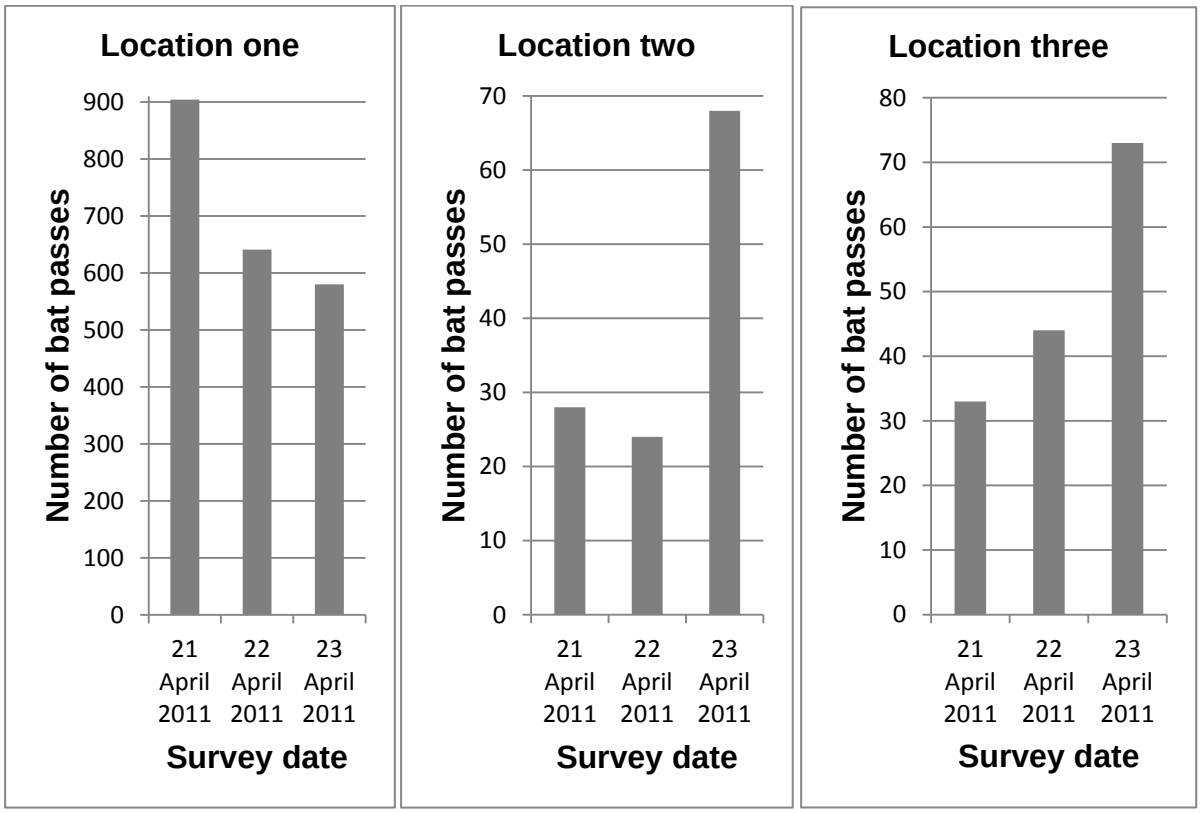
D.1.78 Noctule bat passes were recorded at all three locations in low numbers ranging from one bat pass in one night to five bat passes in one night.

D.1.79 There are three species of pipistrelle bat, each with similar echolocation calls. There were small numbers of pipistrelle bat passes at location one and two that were not possible to identify to species level. Therefore, these could be soprano, common or Nathusius' pipistrelle bats.

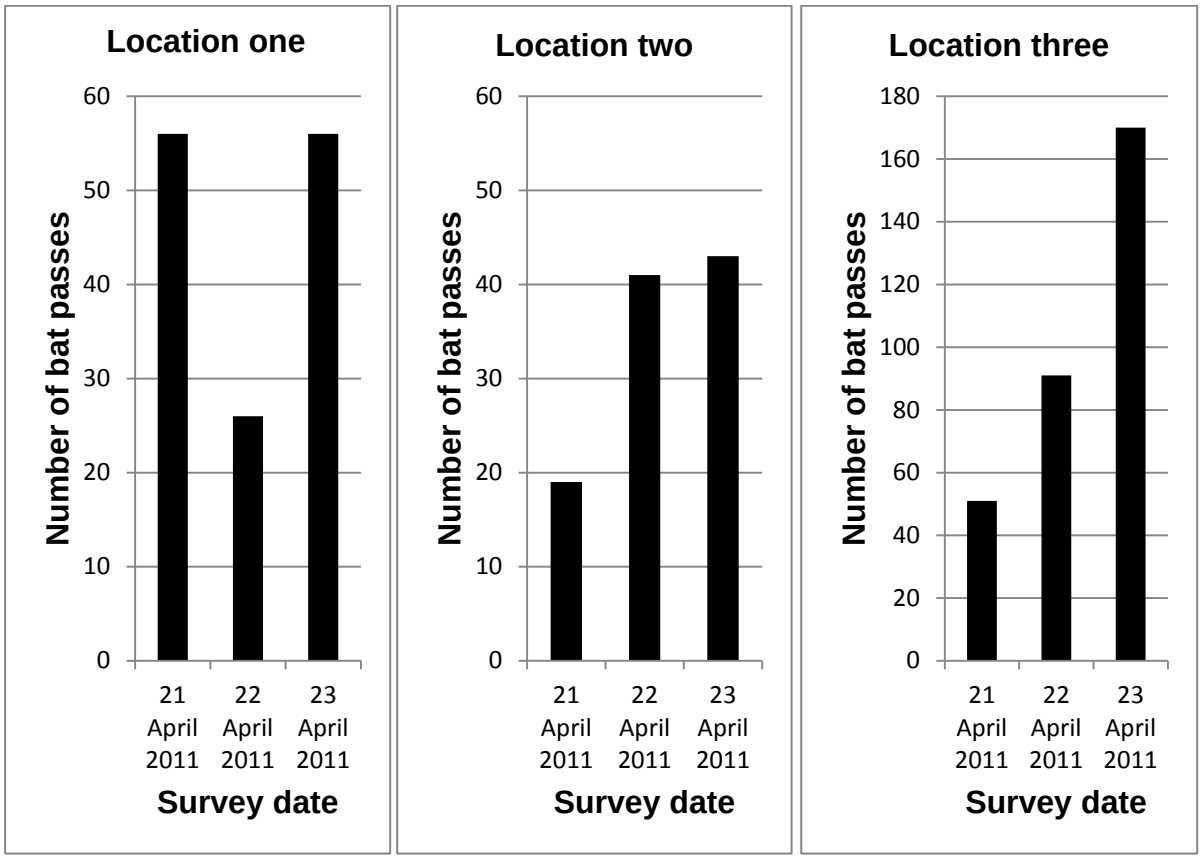
Vol 6 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
21 April 2011	13^0C, light breeze, 100% cloud cover, dry
22 April 2011	14^0C, light breeze, 100% cloud cover, dry
23 April 2011	12^0C, calm, 100% cloud cover, dry

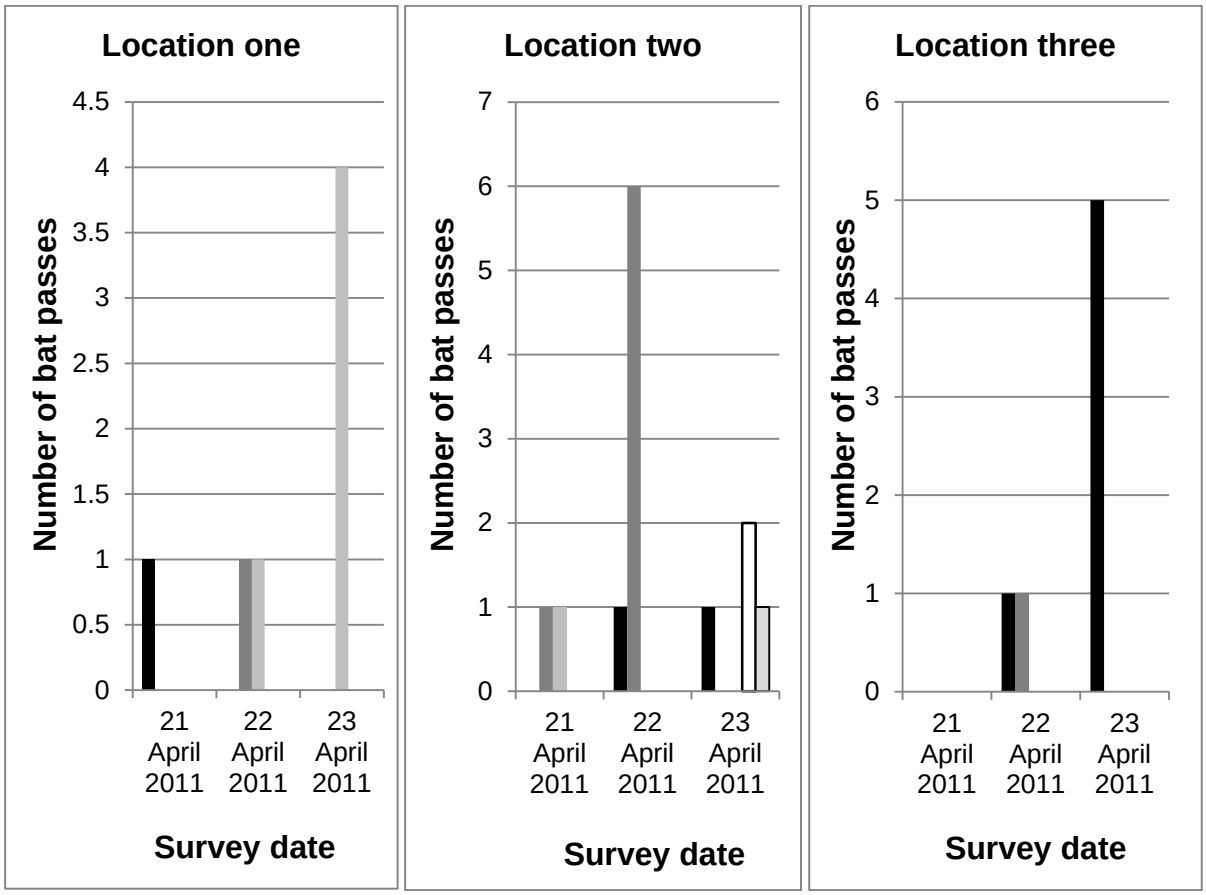
Vol 6 Plate D.1 Terrestrial ecology – common pipistrelle bat passes recorded during remote recording surveys at three locations at Barn Elms site



Vol 6 Plate D.2 Terrestrial ecology – soprano pipistrelle bat passes recorded during remote recording surveys at three locations at Barn Elms site



Vol 6 Plate D.3 Terrestrial ecology –bat passes recorded during remote recording surveys at three locations at Barn Elms site



Bat activity (dawn) surveys

D.1.80 As there were high numbers of bats recorded during the remote recording survey and more than two species were recorded, this triggered the need for a bat activity (dawn) survey to be undertaken (based on bat triggering criteria in Vol 2 Section 6). The bat activity survey was undertaken on 7 June 2011 in suitable weather conditions (12^0C, light breeze, 75% cloud cover, dry). The bat activity survey results are shown on Vol 6 Figure 6.4.6 (see separate volume of figures).

D.1.81 Observations during the activity survey at dawn identified a soprano pipistrelle roost in the Chas Newens Marine Cruise Hire building to the southeast of the site on the opposite side of Beverley Brook. Soprano pipistrelle bats were observed foraging and commuting along the vegetation to the east of the site, adjacent to the River Thames as shown on Vol 6 Figure 6.4.5 (see separate volume of figures).

D.1.82 One noctule bat was seen passing to the west of the site during the dawn activity survey.

D.1.83 A mouse-eared bat species was recorded passing into the playing fields area from the southwest during the dawn activity survey. This is likely to be Daubenton's bat (*Myotis daubentonii*). This species was not recorded on or adjacent to the site.

Bat roost potential survey at Barn Elms School Sports Centre car park

D.1.84 A bat roost potential survey was undertaken of trees within and adjacent to the Barn Elms Sports Centre car park and changing room area of the site on 2 October 2012.

D.1.85 The trees along the northern boundary are mature poplar trees with limited potential for bats. There is potential that the bark may be occasionally used by transient bats. The mature trees to the west of the existing changing rooms are conifers and these are unlikely to support roosting bats. The large mature London plane tree in the south of the car park had no features suitable for bats that could be observed from ground level. However, there is some potential that upper limbs and the main trunk could support roosting bats. The bark and limbs of London plane trees tend not to be suitable for roosting bats as it is generally smooth. It is possible that small numbers of bats such as noctule, common pipistrelle and soprano pipistrelle occasionally use features not visible from ground level.

Breeding bird surveys

D.1.86 Three survey visits were undertaken on 20 April, 17 May and 7 June 2011 in suitable weather conditions (see Vol 6 Table D.1) by an experienced ornithologist (bird specialist). The results of breeding bird survey are shown in Vol 6 Table D.2 and on Vol 6 Figure 6.5.6 (see separate volume of figures).

Vol 6 Table D.1 Terrestrial ecology – breeding bird survey weather conditions

Survey visit	Weather conditions
20 April 2011	16^0C, calm, 10% cloud cover, dry
17 May 2011	12^0C, light breeze, 100% cloud cover, dry
7 June 2011	12^0C, light breeze, 100% cloud cover, dry

D.1.87 A total of 14 bird species and 58 breeding territories (active nests and their surrounding territory) were recorded within the survey area. Species of conservation importance were recorded as follows:

e. The scrub near the Beverley Brook along the south of the survey area provides nest sites and foraging habitat for dunnock (*Prunella modularis*).

f. The trees adjacent to the site to the east, adjacent to the River Thames support nesting habitat for song thrush *(Turdus philomelos*). Song thrush was also observed within scrub along the access road to the north of the site.

g. Mature trees adjacent to the Thames Path and access road to the east of the site supports nesting stock dove (*Columba oenas*).

h. Tall ruderal vegetation adjacent to Beverley Brook provides breeding habitat for mallard (*Anas platyrhynchos*).

Vol 6 Table D.2 Terrestrial ecology - breeding bird territories at Barn Elms

Species name	Latin name	Conservation designation[i]	Estimated number of breeding territories
Mallard	*Anas platyrhynchos*	Amber List	1
Moorhen	*Gallinula chloropus*	Green List	1
Stock dove	*Columba oenas*	Amber List	2
Wood pigeon	*Columba palumbus*	Green List	9
Wren	*Troglodytes troglodytes*	Green List	9
Hedge accentor/ Dunnock	*Prunella modularis*	Amber List UK BAP Priority List	2
Robin	*Erithacus rubecula*	Green List	7
Blackbird	*Turdus merula*	Green List	6
Song thrush	*Turdus philomelos*	Red List UK BAP Priority List	3
Blackcap	*Sylvia atricapilla*	Green List	5
Goldcrest	*Regulus regulus*	Green List	1
Blue tit	*Cyanistes caeruleus*	Green List	6
Carrion Crow	*Corvus corone*	Green List	4
Greenfinch	*Carduelis chloris*	Green List	2

Wintering bird surveys

D.1.88 A total of six survey visits were undertaken at monthly intervals between December 2010 and March 2011, and during October and November 2011 by an experienced ornithologist (bird specialist). The survey visits were undertaken in suitable weather conditions (see Vol 6 Table D.3). The main foraging and resting areas for wintering birds are indicated on

[i] A species that is listed in the following publications:

Batten, L.A., Bibby, C.J., Clement, P., Elliot, G.D. & Porter, R.F. (1990). *Red Data Birds in Britain*. T. & A.D. Poyser, London.

Commission of the European Communities (1979). Council Directive 79/409/EEC on the Conservation of Wild Birds. *Official Journal of European Communities, L103*.

Holliday, M & Rare Breeding Bird Panel (2011). Rare Breeding Birds in the United Kingdom in 2009. *British Birds*, 104, 9, 476-537.

Royal Society for the Protection Birds (2009). *Birds of Conservation Concern 3*. RSPB, Sandy.

United Kingdom Biodiversity Action Plan Steering Group (2011). *United Kingdom Biodiversity Action Plan* http://jncc.defra.gov.uk/page-5163 [10.11].

Vol 6 Figure 6.4.7 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 6 Table D.4.

D.1.89 The northern edge of the proposed development site is in close proximity to the Barn Elms Wetland Centre SSSI. The SSSI supports a wintering bird population of shoveler (*Anas clypeata*) that is of national importance, as well as high bird species diversity. The majority of bird species within the desk study are likely to be associated with the Barn Elms Wetland Centre SSSI.

D.1.90 A total of 15 waterbird[ii] species were recorded within the survey area in close proximity to the site:

a. The foreshore is used for foraging mainly by mallard (*Anas platyrhynchos)*, black-headed gull *(Chroicocephalus ridibundus)*, common gull *(Larus canus*), lesser black-backed gull *(Larus fuscus)* and herring gull *(Larus argentatus).*

b. One common kingfisher *(Alcedo atthis)* was observed flying along the River Thames adjacent to the site.

c. Teal *(Anas crecca)* was recorded foraging on the foreshore adjacent to the site, with aggregations at the confluence of the Beverley Brook with the River Thames.

d. No wintering waterfowl were observed using the site although the amenity grassland area adjacent to the main construction site is likely to be used by foraging Canada goose (*Brenta Canadensis*), an introduced species, and gulls such as black-headed gull (*Chroicocephalus ridibundus*), common gull (*Larus canus*), lesser black-backed gull (*Larus fuscus*) and herring gull (*Larus argentatus*).

D.1.91 Shoveler, which is the wintering species of national importance from the nearby Barn Elms Wetland Centre SSSI, was not recorded on the foreshore.

Vol 6 Table D.3 Terrestrial ecology – wintering bird survey weather conditions

Survey visit	Weather conditions
21 December 2010	0^0C, light north-easterly wind, 100% cloud cover, dry
20 January 2011	5^0C, light westerly wind, 100% cloud cover, dry
18 February 2011	6^0C, light north-easterly wind,100% cloud cover, dry
22 March 2011	14^0C, calm, 90% cloud cover, dry
10 October 2011	20^0C, light westerly wind, 100% cloud cover, dry
9 November 2011	12^0C, light south-easterly wind, 100% cloud cover, dry

[ii] A waterbird is a species which is listed in the Wetland Bird Survey (WeBS) methodology – British Trust for Ornithology, Royal Society for the Protection of Birds, Joint Nature Conservation Committee and Wildfowl and Wetlands Trust.

Vol 6 Table D.4 Terrestrial ecology – species and numbers of wintering waterbirds recorded during monthly wintering bird surveys

Species name	Latin name	Conservation designation[iii]	Monthly wintering waterbird counts					
			21 December 2010	20 January 2011	18 February 2011	22 March 2011	10 October 2011	9 November 2011
Cormorant	*Phalacrocorax carbo*	Green List	3	-	3	4	7	1
Grey heron	*Ardea cinerea*	Green List	2	1	-	1	4	2
Mute swan	*Cygnus olor*	Green List	-	-	-	2	5	-
Greylag goose (feral)	*Anser anser*	Green List	-	-	-	1	-	-
Egyptian goose	*Alopochen aegyptiacus*	Green List	-	-	-	-	1	-
Canada goose	*Branta canadensis*	Green List	27	40	37	8	49	-
Mandarin	Aix galericulata	Green List	-	-	-	2	-	-
Teal	*Anas crecca*	Amber List	21	30	53	18	-	3
Mallard	*Anas platyrhynchos*	Amber List	16	14	17	15	18	15
Moorhen	*Gallinula chloropus*	Green List	1	-	1	2	-	-
Black-headed	*Chroicocephalus*	Amber List	89	30	158	22	84	150

[iii] A species that is listed in the following publications:

Batten, L.A., Bibby, C.J., Clement, P., Elliot, G.D. &Porter, R.F. (1990). *Red Data Birds in Britain*. T. & A.D. Poyser, London.

Commission of the European Communities (1979). Council Directive 79/409/EEC on the Conservation of Wild Birds. *Official Journal of European Communities, L103*.

Holliday, M & Rare Breeding Bird Panel (2011). Rare Breeding Birds in the United Kingdom in 2009. *British Birds*, 104, 9, 476-537.

Royal Society for the Protection Birds (2009). *Birds of Conservation Concern 3*. RSPB, Sandy.

United Kingdom Biodiversity Action Plan Steering Group (2011). *United Kingdom Biodiversity Action Plan* http://jncc.defra.gov.uk/page-5163 [10.11].

Species name	Latin name	Conservation designation[iii]	Monthly wintering waterbird counts					
			21 December 2010	20 January 2011	18 February 2011	22 March 2011	10 October 2011	9 November 2011
gull	*ridibundus*							
Common gull	*Larus canus*	Amber List	2	3	2	-	-	-
Lesser black-backed gull	*Larus fuscus*	Amber List	4	4	5	6	8	2
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	7	1	12	4	10	5
Kingfisher	*Alcedo atthis*	Amber List	-	-	-	1	-	-

Reptile surveys

D.1.92 A total of ten reptile surveys were conducted at an appropriate time of year and during suitable weather conditions (see Vol 6 Table D.5).

D.1.93 No reptiles were recorded during the reptile survey. However, a juvenile grass snake (*Natrix natrix*) has been identified at the Barn Elms Sports Centre by an employee of the centre. A photograph was taken and the identification confirmed by an ecologist.

Vol 6 Table D.5 Terrestrial ecology – reptile survey weather conditions

Date	Weather conditions
20 May 2011	Weather conditions not relevant. Equipment setup (Mat placement)
7 June 2011	17^0C, light breeze, 40% cloud cover, light scattered showers
14 June 2011	19^0C, light breeze, 40% cloud cover, light scattered showers
2 Sept. 2011	20^0C, light breeze, 15% cloud cover, dry
5 Sept.2011	21^0C, light breeze, 25% cloud cover, dry
7 Sept.2011	19^0C, calm, 90% cloud cover, dry
12 Sept. 2011	16^0C, calm, 75% cloud cover, dry
22 Sept. 2011	19^0C, moderate breeze, 90% cloud cover, dry
21 Sept. 2011	22^0C, light breeze, 25% cloud cover, dry
26 Sept.2011	18^0C, light breeze, 90% cloud cover, dry
28 Sept. 2011	20^0C, light breeze, 15% cloud cover, dry

Great crested newt Habitat Suitability Index assessment

D.1.94 An HSI assessment was undertaken as part of the Phase 1 Habitat Survey of the site and immediate surrounds. The following was noted:

a. the waterbody measures approximately 100m by 40m (4000m^2)

b. the waterbody is likely to be permanent given its size

c. the water quality was poor and the water was turbid

d. the waterbody is shaded by surrounding trees and scrub (c. 60% shade)

e. mallard and moorhen were resident on the waterbody, and this may have contributed to the lack of emergent vegetation due to foraging of waterfowl

f. carp and other fish species were observed within the waterbody

g. there are multiple waterbodies to the north of the waterbody within Barn Elms Wetland Centre, although these waterbodies are considered to be undersuitable for great crested newt due to the large

population of waterfowl and the likely large populations of fish (as the waterbody is connected to the River Thames).

h. the terrestrial habitat surrounding the waterbody was good, with connectivity to a range of habitat types such as trees, woodland and scrub

i. there was approximately 10% macrophyte cover on the waterbody at the time of the survey.

D.1.95 Using the information above, the HSI assessment was undertaken (see Vol 6 Table D.6). The overall HSI score was 0.44, which is considered to be poor for great crested newts.

Vol 6 Table D.6 Terrestrial ecology – great crested newt Habitat Suitability Index scores

Factor	HSI Score
Location	1
Pond Permanence	0.9
Water Quality	0.33
Shade (%)	1
Waterfowl	0.01
Fish	0.33
Pond Density	1
Terrestrial Habitat Quality	0.67
Macrophyte Cover (%)	0.4
Final HSI Score	**0.43847064**
Prediction (Likelihood of GCN)	**Poor**

Invertebrate survey

D.1.96 A total of four survey visits were undertaken in suitable weather conditions as shown in Vol 6 Table D.7 by an experienced entomologist (invertebrate specialist).

Vol 6 Table D.7 Terrestrial ecology – invertebrate survey weather conditions

Date	Weather conditions
23 May 2011	10^0C, light breeze, 100% cloud cover, dry
23 June 2011	12^0C, light breeze, no cloud cover, dry
21 July 2011	14^0C, light breeze, 100% cloud cover, dry
19 September 2011	10^0C, light breeze, 25% cloud cover, dry

D.1.97 No notable invertebrate species were recorded on the amenity grassland habitat on site. This habitat lacks structural diversity and plant species diversity, as it is regularly mown. Therefore, it provides poor habitat for invertebrates.

D.1.98 The invertebrate interest recorded during the surveys is predominantly associated with the tall ruderal, scrub vegetation and dead wood on the river banks and the tree lines along the Beverley Brook and the Thames Path, adjacent to the site. The invertebrate assemblage associated with these habitats includes several locally scarce[iv] species dependant on a range of grassland, tall ruderal and scrub plant species. The following five nationally scarce[v] species were also recorded:

j. The beetle *(Drupenatus nasturtii*) associated with water cress *(Rorippa nasturtium-aquaticum)* and found in association with Beverley Brook

k. The yellow-faced bee *(Hylaeus cornutus)* associated with a mosaic of grassland with white umbellifers and scrub, where it nests in plant stems

l. The leaf beetle *(Chrysolina oricalcia)* associated with various white umbellifers (Apiaceae, formerly Umbelliferae)

m. The ivy bark beetle *(Kissophagus hederae)* associated with ivy plants, favouring older branches and trunks where it resides beneath the bark. Ivy is particularly abundant adjacent to the south of the site

n. The drab wood soldier-fly *(Solva marginata)* is associated with loose bark on fallen poplar logs such as the black poplar along the Thames Path adjacent to the site. The wood has to be dead for one or two years to support this species.

D.1.99 The Wildfowl and Wetlands Trust has indicated that there are high numbers of stag beetle *(Lucanus cervus)* in the Barn Elms Playing Fields area. The UK population of stag beetles is concentrated in the London and southeast area. However, no evidence of stag beetles was observed at Barn Elms during the invertebrate surveys.

Invasive plants survey

D.1.100 The invasive plant species survey was undertaken on 22 July 2011. No invasive plants listed on Schedule 9 of the Wildlife and Countryside Act were observed on or within 10m of the site, although Himalayan balsam *(Impatiens glandulifera)* and Japanese knotweed *(Fallopia japonica)* were observed some distance from the site along the Beverley Brook.

[iv] Nationally local - Species which, whilst fairly common, are evidently less widespread than truly common species, but also not qualifying as nationally notable having been recorded from over one hundred, but less than three hundred, ten-kilometre squares of the UK National Grid.

[v] Nationally scarce - Species which are not included within the IUCN threat categories and are estimated to occur in less than 100 hectads of the Ordnance Survey national grid in Great Britain. It should be noted that lower risk (nationally scarce) is not a threat category, but rather an estimate of the extent of distribution of these species.

Interpretation

Otter and water vole

D.1.101 No evidence of otter or water vole was found on or in close proximity to the site. The suitability of the Beverley Brook habitat is likely to be reduced by the presence of the invasive plant species Himalyan balsam *(Impatiens glandulifera)*, which is present along the bank of the Beverley Brook. Himalayan balsam often out-competes other plant species and prevents them from colonising, resulting in a bare open understorey beneath the stands of Himalayan balsam, which is also more vulnerable to erosion. Connectivity between the surveyed stretch of the watercourse and other nearby watercourses that support otter are considered to be poor. Water vole is known to be present upstream along the Beverley Brook. However, this population is separated from the Beverley Brook adjacent to the site by a culverted section, which would limit their passage. These factors may reduce the likelihood of otter and water vole presence in this section of the watercourse.

Badgers

D.1.102 The survey results indicate that badgers currently utilise the site and its immediate surrounds for foraging and dispersal, demonstrated by the presence of areas of disturbed ground (badger scrapes) within the playing fields where badgers have scratched the ground to reveal grubs beneath, and the presence of badger paths entering the playing fields from the south. It is unlikely that a badger sett is present in close proximity to the site. However, badgers are highly mobile and a sett could occur close to the site in the future.

Bats

D.1.103 This survey area is used by a large number of both common and soprano pipistrelle bats as a foraging site. Other bat species such as noctule, Leisler's and Nathusius' pipistrelle are also using the site although much more infrequently. The majority of the activity recorded has been associated with the mature trees located along Beverley Brook to the south of the site.

D.1.104 High numbers of common pipistrelle and soprano pipistrelle bat passes were recorded. The results suggest that the amenity grassland and hardstanding on site does not provide a foraging resource, although bats may commute through the site. The high numbers of bat passes are associated with foraging and commuting activity along vegetation to the south and west of the site adjacent to the Beverley Brook and River Thames.

D.1.105 No common pipistrelle bat roosts were identified during the dawn activity survey on or adjacent to the site, although with remote recording survey records of common pipistrelle close to dusk and dawn, when bats leave and return to their roosts, it is likely that there are common pipistrelle roosts nearby within the wider area.

D.1.106 A small soprano pipistrelle roost was identified within the Chas Newens Marine Cruise Hire building to the south of the site on the opposite bank of

the Beverley Brook. Other soprano pipistrelle roosts are likely to be present nearby within the wider area, particularly given the high numbers of bat passes recorded during the remote recording surveys.

D.1.107 The low number of records of noctule bat, soprano pipistrelle bat, Leisler's bat and Nathusius' pipistrelle bat are likely to be as a result of a few bats foraging adjacent to the site, or commuting through or past the site.

D.1.108 The trees along the northern boundary are mature poplar trees with limited potential for bats. There is potential that the bark may be occasionally used by transient bats. The large mature London plane tree in the south of the car park has some potential that upper limbs and the main trunk could support roosting bats. The bark and limbs of London plane trees tend not to be suitable for roosting bats as it is generally smooth. It is possible that small numbers of bats such as noctule, common pipistrelle and soprano pipistrelle occasionally use features not visible from ground level.

Breeding birds

D.1.109 No birds were recorded nesting within the proposed development site. The trees, scrub and river banks adjacent and in close proximity to the site provide nesting habitat for a range of breeding bird species.

D.1.110 Of the 14 bird species which occupied breeding territories adjacent to the site, none are listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). Four are of nature conservation importance because they are included in the Birds of Conservation Concern Red or Amber List and/or UK BAP Priority Species: mallard (one breeding territory), stock dove (two breeding territories), dunnock (two breeding territories) and song thrush (three breeding territories).

Wintering birds

D.1.111 Of the 15 waterbird species that were recorded within the survey area, seven are of nature conservation importance because they are included in the Birds of Conservation Concern Red or Amber List and/or UK BAP Priority Species: teal, mallard, black-headed gull, common gull, lesser black-backed gull, herring gull and kingfisher.

D.1.112 Shoveler, which is the wintering species of national importance from the nearby Barn Elms Wetland Centre SSSI, was not recorded within the survey area.

D.1.113 The majority of species were recorded in low numbers foraging on the intertidal mudflat within the survey area, the foreshore is used for foraging mainly by ducks and gulls, while the playing fields are used for resting mainly by Canada geese and gulls.

D.1.114 Of particular note are the numbers of teal recorded foraging on the foreshore, particularly at the confluence of the Beverley Brook and River Thames. The foraging resource at this location is likely to be enhanced by the invertebrate resource associated with mudflats at this location.

Reptiles

D.1.115 Reptiles were not recorded on or adjacent to the site, within suitable habitat. Therefore, it is considered unlikely that reptiles are present on or immediately adjacent to the site. However, reptiles may be present in the wider area within suitable habitat, resulting in the occasional reptile visiting the scrub, tall ruderal and grassland areas near to the site.

Great crested newt

D.1.116 As the habitat suitability of the waterbody within 250m of the construction site was considered to be poor and that there were no records of great crested newt identified within the desk study, it is considered unlikely that great crested newts are breeding within this waterbody and present within terrestrial habitat on or in close proximity to the site.

Invertebrates

D.1.117 No notable invertebrate species were recorded on the amenity grassland habitat on site. This habitat lacks structural diversity and plant species diversity, as it is regularly mown. Therefore, it provides poor habitat for invertebrates.

D.1.118 The tall ruderal, scrub vegetation and dead wood on the river banks and the tree lines along Beverley Brook and Thames Path, adjacent and near to the site support several locally scarce[vi] species and five nationally scarce[vii] species.

D.1.119 The Wildfowl and Wetlands Trust has indicated that there are high numbers of stag beetle in the Barn Elms Playing Fields area. This species is protected under Schedule 5 of the Wildlife and Countryside Act 1981 and is a species in significant decline. The UK population of stag beetles is concentrated in the London and south east area. However, no evidence of stag beetles was observed at Barn Elms during the invertebrate surveys. The stag beetle is dependent on dead wood, which is present around the mature native black poplars (*Populus nigra*) on the Thames Path (to the east of the site), and along the banks of Beverley Brook (to the south of the site). Therefore, stag beetle may be present in this area. To confirm presence it would be necessary to undertake a destructive search of dead wood, which could adversely affect the population. As this habitat would not be affected by the proposed works, a destructive search was not undertaken.

Invasive plants

D.1.120 No invasive plants were recorded on or in close proximity to the site. However, Japanese knotweed and Himalayan balsam, which are listed on Schedule 9 of Wildlife and Countryside Act 1981. These species could spread and enter the 10m buffer from the site in the future. Where works

[vi] Nationally local - Species which, whilst fairly common, are evidently less widespread than truly common species, but also not qualifying as nationally notable having been recorded from over one hundred, but less than three hundred, ten-kilometre squares of the UK National Grid.

[vii] Nationally scarce - Species which are not included within the IUCN threat categories and are estimated to occur in less than 100 hectads of the Ordnance Survey national grid in Great Britain. It should be noted that lower risk (nationally scarce) is not a threat category, but rather an estimate of the extent of distribution of these species.

are to be undertaken within 10m of this species, control measures would be required to prevent its spread.

References

[1] Oldham R S., Keeble J., Swan M J S. & Jeffcote M. *Evaluating the suitability of habitat for the Great Crested Newt (Triturus cristatus).* Herpetological Journal 10(4), 143-155 (2000).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix E: Historic environment

APFP Regulations 2009: Regulation **5(2)(a)**

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Environmental Statement

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Appendix E: Historic environment

E.1 Gazetteer of known heritage assets

E.1.1 Details of known heritage assets within the assessment area are provided in Vol 6 Table E.1 below, with their location shown on the historic environment features map (Vol 6 Figure 7.4.1, see separate volume of figures).

E.1.2 All known heritage assets within the assessment area are referred to by a historic environment assessment (HEA) number. Assets within the site are referred to (and labelled in the historic environment features map) with the prefix **1**, eg, **HEA 1A**, **1B**, **1C**. References to assets outside the site but within the assessment area begin with **2** and continue onwards, eg, **HEA 3**, **4**, **5**.

Vol 6 Table E.1 Historic environment – gazetteer of known heritage assets within the site and assessment area

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
1A	Medieval flood defence, Barn Elms playing fields The potentially preserved remains of a medieval foreshore flood defence ditch; part of 'the Great Works' which extended along the curve of the Barnes peninsula from Chiswick church to the Beverley Brook.	---
1B	Barn Elms, North Thames Gas Terminal Evidence of Iron Age occupation, pits and postholes, were discovered at Barn Elms in 1974 during trenching for a gas pipeline by the North Thames Gas Board and excavated by the Wandsworth Historical Society. The features were discovered approximately 80m from the Thames Channel and 25m from the Beverley Brook and consisted of two pits, (one clay lined), and some postholes. The clay lined pit measured c. 1.8m in diameter, was 1.0m deep and contained a mid-Iron Age bronze horse harness ring. Other finds included calcinated flints, burnt daub and potsherds. Earlier, Bronze Age flint-tempered pottery was also discovered.	BEV 1B MLO19103 021013
1C	Barn Elms playing fields The approximate findspot of at least thirteen mid-late Iron Age potin (cast bronze) coins (observed by chance as part of a school project).	SPS I 523450; 176250

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
1D	Barn Elms playing fields The site of an Iron Age settlement. Work on the embankment wall by the Greater London Council revealed Iron Age occupation evidence. Some of the material was identified within a black, burnt layer, the dimensions of which were uncertain due to the small scale of the contractor's trenching. Observations made by the Wandsworth Historical Society (WHS) as part of this 1974 excavation, suggested an Iron Age settlement was likely in this area. Finds included parts of two quern stones and a rotary quernstone (mid–Iron Age), several dozen fragments of coarse pottery (some early Iron Age), and fragments of daub and burnt stones.	BEV IA MLO14976
1E	Barn Elms playing fields (north) The location of 18th century outbuildings (now demolished) associated with Barn Elms manor house (see **HEA 71** below)	---
1F	Barn Elms playing fields (north) The location of 19th century outbuildings (now demolished) associated with Barn Elms manor house (see **HEA 71** below)	---
1G	Barn Elms playing fields (north) The location of former mid-19th century flood gates (now demolished)	---
1H	Barn Elms playing fields (north) The location of former stable buildings or outbuildings dated to the turn of the 20th century (now demolished)	---
2	38-38A Danemere Street, Putney, SW15 An evaluation was carried out at this location by the Museum of London Archaeology Service (MoLAS) in 1996. Natural gravels were overlaid by alluvial sands in the centre and southern parts of the site, associated with an east-west stream channel, the Beverley Brook. This stream channel was in-filled with dumps of late 19th century domestic rubbish and building debris.	DEM96 MLO67192
3	33 Danemere Street, SW15 Trial trenches were dug here by WHS in 1973, which revealed a light scatter of Neolithic flints on a 'mainly Roman site'. Roman pottery and a possible Roman coin were also discovered.	DAN1/73 MLO10464 10480

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
4	30–46 Sefton Street Excavations were carried out here by WHS in 1969 and 1970 which revealed a medieval rubbish pit containing pot sherds. Finds were recovered mainly from two areas of the excavation, at **HEA 4** and **HEA 15**, which is associated, (see below).	SEF I/69 SEF II/70
5	Imperial College Boat Club, 2–3A Holt Villas (formerly), Embankment, Putney, SW15 An evaluation was undertaken on behalf of MoLAS in 1996. The earliest recorded deposits were post-medieval marsh deposits, overlaid with a thick dump containing pottery post-dating 1830, which served either as part of a phase of flood defence and/or as land reclamation for the construction of the buildings on the site. Considerable quantities of post-medieval ceramic building material were found. No other finds dating to other periods were discovered at the site.	ICB96 MLO68384 022325
6	Former Putney Hospital, Lower Richmond Road, SW15 An evaluation was carried out at this location by Thames Valley Archaeological Service (TVAS) in 2007. Natural gravels were overlaid by subsoil and, in two trenches, by modern levelling.	PYH07
7	180 Lower Richmond Road, Putney, SW15 An evaluation was carried out here by Sutton Archaeology Service (SAS) in 2003. Only subsoil was located, above natural sand.	LWP03
8	Thames Channel, between Barn Elms playing fields and Fulham foreshore The location of a subterranean/submarine high pressure gas main, which runs across the southern part of the Barn Elms Playing fields and beneath the Thames channel between Barnes and Fulham.	SZ FEAT CODE 9400
9	19th century pavilions (now demolished), Barn Elms playing fields	---
10	Wharf adjacent to Rowberry Close, Fulham Location of Putney Logboat; unclassified.	MLO75280
11	West bank of the Beverley Brook, Thames foreshore, Barnes The approximate findspot of an early-mid Iron Age human fibula (calf bone), based on an antiquarian observation/find	SPS 523500; 176250

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
12	VOID	
13	Barn Elms playing fields The location of a ceramic bi-conical bead, possibly a spindle whorl and unspecified 'materials' dating to the Mid–Iron Age and Late Bronze Age–Late Iron Age.	MLO40118 021015
14	Thames Foreshore, Putney The find spot of a Neolithic hand-axe.	MLO14610 100075
15	38–46 and 30–46 Sefton Street (SEF I and II) Excavations along 38–46 and 30–46 Sefton Street, carried out in 1969 and 1970 (SEF I and SEF II, see **HEA 4** above), revealed: 38–46 Sefton Street: The find spot of Roman pottery (MLO 10478), post-medieval pottery (MLO 12267), and an early Mesolithic to late Neolithic lithic working site (MLO 14293; see below). 30–46 Sefton Street: The site (SEF I/II) was excavated in 1969–1971 by WHS; it had been disturbed by WWII bombing. The site lies on the floodplain sand and gravel near the present Thames Channel and was interpreted as a 'chipping floor' or lithic extraction/working site (MLO 14293). Evidence for the Mesolithic period was uncovered in the form of artefacts struck from river pebbles. Although it is possible that the site continued into the late Neolithic period, the Mesolithic flints might only represent a field scatter in an area well known for surface finds. Approximately 3000 struck flints were found altogether, mostly dated to the Neolithic period, along with pottery sherds, some of which may have been early medieval in date (Pamela Greenwood pers. comm.). The composition of the remains suggested that the site was purely a manufacturing site; with finished goods transported elsewhere. The only features uncovered were a natural drainage channel and small posthole marks, indicating a lean-to shelter. No signs of settlement were found. It is thought that the site was used over a long period of time, by hunters exploiting nearby heaths. The find of a hearth is mentioned by one source. However, this is not certain.	SEF I/II MLO10478 031192 031349 MLO12267 14293 11009
16	Barnes Common The approximate location of an Iron Age coin, recorded by the Portable Antiquities Scheme (PAS).	CCI-930558

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
17	The London Wetland Centre The find spot of a Saxon buckle.	SMR021048
18	Barn Elms Park The find spot of eight prehistoric (otherwise undated) flint flakes, recovered from the Thames tow path at Barn Elms Park.	MLO26719 106041
19	Barn Elms Foreshore The remains of a medieval (MLO 69861) and a post-medieval (MLO 66275) fish trap dated to c. 1485–1600. The Thames Archaeological Survey described one of the traps as consisting of three posts, c. 0.4m long.	MLO69861 66275; TAS Alpha Survey ID FRM21: A101
20	Festing Road The find spot of a Palaeolithic scraper discovered within road ballast. Probably 'imported' from another location and therefore not in situ.	MLO11902 030801
21	Bishop's Park, Fulham A Grade II registered park. 1884 Bishop Jackson, then Bishop of London, persuaded the Ecclesiastical Commissioners to donate, to the District Board of Works, Bishop's Meadow, a strip of land of c. 2ha situated between the moat, the south-west boundary of the grounds of Fulham Palace, and the River Thames. The meadow was to be laid out as a recreation ground and maintained in perpetuity. Formerly a picturesque osier and grazing ground, by the late C19 the meadow had become a refuse tip and the low-lying land was marshy being regularly flooded by the adjoining River Thames. The offer of land from the Bishop had the proviso that a riverside embankment would be built to prevent further flooding. Bishop Temple enlarged the proposed park by adding further land which increased the total area of the proposed recreation ground to 5ha. In 1889 work started on the wall to be erected along the riverside frontage of the site. The embankment was completed by 1893, the park being formally opened in December of the same year. Soon after the opening of Bishop's Park in 1893 the Vestry, encouraged by the popularity of the new park, bought the house and gardens of Pryor's Bank which occupied the land between the south-east end of Bishop's Park and Putney Bridge. At around the same time the borough was able to	UID5272

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	provide safe access to the park from the nearby Putney railway station when they purchased a small piece of land, John's Place, which ran under the recently constructed Putney Bridge. Pryor's Bank garden was opened in 1900, by which time a further extension to the park was being planned. In 1899 Bishop Jackson had given a further two riverside meadows (c 4ha) to the Vestry in order to extend the park from Bishop's Meadow to the site of Craven Cottage in the north; this extension was opened in 1903. The park continues (2000) as a public open space retaining much of its original design.	
22	Barn Elms Foreshore The Portable Antiquities Scheme (PAS) records the discovery of a late medieval or post-medieval whetstone, discovered as a result of metal detecting on the foreshore.	MLO99965
23	22 Bendemeer Road The find spot of Roman tile and pottery (MLO 10494), medieval pottery (MLO 10513), a WWII air raid shelter (MLO 12016), prehistoric flint flakes (MLO 12035) and post-medieval pottery (MLO 23279).	MLO10494 031315 MLO10513 031374 MLO12016 031485 MLO12035 031543 MLO23279 031484
24	Spring Passage The find spot of Roman pottery, dating to the 3rd century, medieval pottery dating to the 14th century, and of a post-medieval building material dating to the 17th century (MLO 12171).	MLO13097 031284 MLO131160 31352 MLO9594 031390 MLO12171 031389
25	Fulham Palace The location of the post-medieval Fulham Palace moat bridge dating to the early 19th century.	MLO22678 051111
26	Fulham Palace Moat The location of the Fulham Palace moat/enclosure.	MLO19311 050473
27	Fulham Palace Paddock	MLO17335

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	The find spot of unspecified medieval finds dating to the 12th century, and Neolithic find(s), indicating prehistoric occupation of the site.	051007 MLO234440 5100901
28	Barn Elms foreshore The find spot of an early medieval (Saxon) vessel, recorded by the PAS. Discovered during a foreshore survey.	MLO100058
29	Thames channel The approximate location of a post-medieval mount recovered from the Beverley Brook, and recorded by the PAS.	LON-54EB56
30	Thames channel The approximate location of three Roman coins recovered from within the Thames channel, and recorded by the PAS.	PAS-16DF75; PAS-16DAD3; PUBLIC-D8C168
31	Barn Elms foreshore/Thames channel The find spot of three late Iron Age tin coins (MLO 26732), discovered at Barn Elms near the concrete boat slip. Prehistoric (otherwise undated) and Neolithic flint flakes, scrapers, a borer and a core/scraper were also recovered from the foreshore in this approximate location (MLO 26930).	MLO26732 106031 MLO26930 106040
32	Thames channel, Fulham The find spot of a late Neolithic to late Bronze Age leaf–shaped, riveted sword (MLO 10002), a Roman iron sword or 'gladius' used by legionaries of the early Imperial period (1st and 2nd centuries AD) of the 'Mainz' type (MLO 25996) and a legionary Roman sword with a highly decorated scabbard (MLO 26010); perhaps uncovered as a result of dredging.	MLO10002 100124 MLO25996 106086 MLO26010 106100
33	Barn Elms Foreshore Foreshore survey work was undertaken by LARF and Richmond Archaeological Society in 1997 and the Thames Archaeological Survey in 1995. A line of stakes c. 40m long was recorded and interpreted as the remains of a fish trap, consisting of round-wood stakes c. 0.1m in diameter.	MLO69862 022597 MLO66276 022103 TAS Alpha Survey ID FRM21: A102
34	Barn Elms foreshore	MLO69863

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	The location of a prehistoric deposit. The Thames Archaeological Survey describes the deposit as consisting of a mixed orange/black/red sandy deposit with shell inclusions.	022598; TAS Alpha Survey ID FRM21: A103
35	Barn Elms foreshore The location of a deposit of grey/green silt dating from the Roman to later medieval periods.	MLO69924 022638
36	Barn Elms foreshore The location of several post-medieval deposits. The GLHER lists these as 18th century in date. They were identified and described by the Thames Archaeological Survey, carried out in the 1990s which revealed that the deposits had been exposed by a machine cut section. The deposits were variously composed of gravels, clay and sand. One layer (A128) was of blue-green clay and contained organic flecks. The stakes of a timber riverfront defence or bank consolidation was also revealed in the section.	MLO69888–69900; TDP Alpha Survey ID FRM23: A121–A130; A131
37	Allotments northwest of Barnes Common The find spot of Roman pottery.	MLO18997 021044
38	Putney Lower Common The find spot of unspecified prehistoric finds. Possibly recovered as a result of gravel quarrying on Putney Lower Common.	021074
39	Fish pond, Barn Elms playing fields The location of a now filled in fish pond, dating to at least the early 19th century, but potentially first referenced in the mid-17th century.	---
40	Fulham Palace A Grade II* registered park. In 1917 the Warren, the area to the north and north-east of the Palace, was converted into allotments. In 1924 the moat around the site was drained and in c. 1960, St Mark's Secondary School was built in the north-west corner of the Warren. The bishops of London ceased residing at Fulham Palace in 1973. In 1975 Hammersmith and Fulham Borough Council leased the Palace and its grounds from the Church Commissioners for 100 years and in the following year the garden was opened to the public. The Palace grounds including the Warren are protected as a scheduled ancient monument.	UID1029

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
41	Lake, Barn Elms playing fields The location of a lake which came to form part of the Barn Elms manor (part of which survives to the north of the site).	---
42	VOID	
43	Fish/ornamental pond, Barn Elms playing fields The location of a now filled in, small fish pond, dating to at least the early 19th century.	---
44	Barn Elms The find spot of unspecified medieval finds, as listed by the GLHER. No further information.	021106
45	3 bollards at junction with Putney Embankment. Grade II listed.	1065492
46	1940s pavilion (now demolished), Barn Elms playing fields.	---
47	Existing single storey changing pavilion in Barn Elms playing fields	---
48	VOID	
49	VOID	
50	VOID	
51	VOID	
52	VOID	
53	VOID	
54	VOID	
55	London Wetland Centre, north of the site The find spot of a hard consolidation layer composed of scattered chalk blocks.	TAS Alpha Survey ID FRM21: A108
56	Thames foreshore, Hammersmith and Fulham The location of a hard layer of compacted gravel.	TAS Alpha Survey ID FHM05: A106
57	Thames foreshore, Hammersmith and Fulham The location of a sand layer.	TAS Alpha Survey ID FHM05: A105
58	Thames foreshore, Hammersmith and Fulham	TAS Alpha Survey ID

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	The location of a brick river wall/flood defence, blocking access to Craven Cottage Stair. Craven Cottage Stair is of timber, possibly with an associated slipway. Concrete covers the earlier features.	FHM05: A101–A104
59	Thames foreshore, Barnes The location of a possible fish trap, composed of a line of roundwood stakes positioned at an angle to the river.	TAS Alpha Survey ID FWW01: A102
60	Thames foreshore, Hammersmith and Fulham The location of a drain feature and associated splash apron. The drain is composed of a square, cobbled channel between granite curbs.	TAS Alpha Survey ID FHM06: A103
61	Thames foreshore, Hammersmith and Fulham The location of a large, squared timber. Probably driftwood.	TAS Alpha Survey ID FHM06: A104
62	Thames foreshore, Hammersmith and Fulham The location of a timber cofferdam, for the construction of a river wall.	TAS Alpha Survey ID FHM06: A101
63	Thames foreshore, Hammersmith and Fulham The location of a large horizontal timber with metal braces. Possibly a ship's timber, although it is probably driftwood.	TAS Alpha Survey ID FHM06: A105
64	Thames foreshore, Hammersmith and Fulham The location of a paved causeway.	TAS Alpha Survey ID FHM06: A102
65	Thames foreshore, Hammersmith and Fulham The location of a concrete drain/splash apron. Perhaps a drain for the Fulham Palace moat.	TAS Alpha Survey ID FHM07: A111
66	Thames foreshore, Hammersmith and Fulham The location of a peat/organic clay deposit.	TAS Alpha Survey ID FHM06: A106
67	Thames foreshore, Barnes The location of a sand/clay deposit with a high mollusc deposit.	TAS Alpha Survey ID FWW01: A101

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
68	Thames channel, Hammersmith and Fulham The location of an orange/red sandy clay deposit.	TAS Alpha Survey ID FHM07: A112
69	Thames foreshore, Barnes The remains of a fish trap identified during the site walkover survey. It consists of a single, vertical wooden post, standing to a height of c. 0.2m – similar in height and appearance to **HEA 70** below.	---
70	Thames foreshore, Barnes The remains of a fish trap identified during the walkover survey. It consists of two wooden posts, one partially submerged within the foreshore mud, the other standing to a height of c. 0.2m – similar in height and appearance to **HEA 69** above.	---
71	Site of Barn Elms Manor House, Barn Elms playing fields The site of a manor house which existed from at least *c.* 1450 (although it may date to earlier than this) to 1954, when the last mansion building was demolished. The original house was rebuilt in 1694 and two wings were added in 1771.	---
72	Beverley Brook Bridge, tide barrier and flood gate	---
73	Beverley Brook and the Beverley Brook Walk	---
74	Former 19th century coal depot, now HQ for Sea Cadets	---
75	Leaders Gardens and park railings	---
76	Thames foreshore, Barnes Survey work carried out on the Barnes foreshore by the LARF and RAS in 1995 revealed prehistoric deposit layers (including peat layers), one of which contained small branches and wattles (A104); an in situ tree root, trunk and branches (A105–7); animal bones, including those of red deer and orochs (A112), antlers, horns and two skulls (A112), and possible forest remains comprising timber horizontals. Post medieval/modern remains observed included scour caused by an outfall, and railings and gates belonging to the Harrods Depository. Various deposit layers of sand, silt, clay, mud and gravel were observed.	FRM21 A104–107; A112–114; A118; A132–146 MLO66277
77	Thames foreshore, Hammersmith and Fulham A hard black Roman potsherd was recovered from a	MLO 26799

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	foreshore deposit opposite the ESSO petrol depot.	
78	Thames foreshore, Hammersmith and Fulham The location of a sand agradation layer, as located during a TAS survey in 1999.	FHM05 A107
79	Thames foreshore, Hammersmith and Fulham The location of a mud agradation layer, as located during a TAS survey in 1999.	FHM05 A108
80	Thames foreshore, Hammersmith and Fulham The location of a sand and gravel agradation layer, as located during a TAS survey in 1999.	FHM05 A109
81	Thames foreshore, Hammersmith and Fulham The location of a mud agradation layer, as located during a TAS survey in 1999.	FHM05 A110
82	Thames foreshore, Barnes A sand deposit recorded by the TAS in 1999.	FRM21 A147
83	Thames channel The approximate location of a post-medieval tobacco pipe recovered from the Thames channel and recorded by the PAS.	LON-48FB45
84	Thames channel The approximate location of a medieval pot sherd, two Iron Age coins, a post-medieval coin, a post-medieval mount and an early medieval coin recovered from the Thames channel and recorded by the PAS.	LON-3043F4; F9B657; F9B3B4; 8561C6; C68DD3; F932D8
85	Thames channel The approximate location of a Mesolithic flint tool and a post-medieval coin recovered from the Thames channel and recorded by the PAS.	LON-F5F173; SUR-8603A3
86	Thames channel The approximate location of a Roman coin, a post-medieval button and a post-medieval coin recovered from the Thames channel and recorded by the PAS.	LON-83EE32; 2BE528; A6DD03
87	Thames channel The approximate location of a post-medieval button and two post-medieval coins recovered from within the Thames channel and recorded by the PAS.	LON-650585; 643AC1; 63CC55

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
88	Thames channel The approximate locations of a Neolithic axe, a Roman coin and a medieval bone point, recovered from the Thames channel and recorded by the PAS.	LON-27B591; 1A3E53; 1A2B80
89	Beverley Brook confluence, Barnes foreshore The very approximate findspot of an early Iron Age pottery rim sherd with shallow all-over finger-tip decoration, found on the foreshore just upstream of the Beverley Brook.	WHS WM 986-03
90	Southeast of the Beverley Brook confluence, Barnes foreshore The very approximate location (centred on the foreshore opposite Leaders Gardens), of a piled structure running parallel to the Thames alongside the former Beverley eyot, around and downstream of its present mouth. The structure consists of 37 or 38 timber posts to date. Undated bone objects, pottery, an Iron Age ring, the lower half of a quernstone and Iron Age potin (cast bronze) coins have also been recorded as part of recent work carried out by the WHS.	---
91	Barn Elms playing fields (north) The location of Barn Elms Farm to the north of the site, shown on the Ordnance Survey 1st edition map of 1862–1895. Now demolished.	---
92	VOID	
93	Thames foreshore, Barnes The approximate location of a possible fish trap, comprising six wooden posts arranged in two rows (unknown date)	SPS IC 523280; 176820
94	Thames foreshore, Barnes The approximate location of several Bronze and Iron Age artefacts determined by Pamela Greenwood of the WHS, based on a catalogue of antiquarian finds/observations compiled by GF Lawrence in the late 1920s. They include: an Iron Age copper alloy object (possibly an ornament); a mid-Bronze Age copper alloy scabbard chape (metal tip/mounting) ; wooden piles (recorded by Pamela Greenwood based on Lawrence's documented 'pile dwellings' and no longer visible); a male human skull discovered in 1918 (of unknown date) and a human lower jaw bone discovered in 1929; the remains of an early Iron Age iron dagger and scabbard with a bronze front and iron	SPS 523300; 176750

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	back; an iron spearhead; a late Bronze Age socketed sickle with a grooved blade; a late Bronze Age sword; a late Bronze Age/early Iron Age sword; a flint knife made of bone; a mid-late Iron Age potin coin; a mid Bronze Age palstave (axe); a Bronze Age bronze hammer; an undated bead made of antler; a Neolithic flint axe; an Iron Age shield binding; a Bronze plate (possibly an ornament); an Iron Age bronze disc; and a bronze shield fitting. This is also the location of a post-medieval sluice/floodgate.	
95	Thames foreshore, Barnes The approximate findspot of a late Bronze Age cup, recovered from within ballast on the foreshore.	523260; 176750
96	Thames foreshore, Barnes The approximate findspot of a mid-late Iron Age copper-alloy finger-ring with a semi-spiral pattern; possibly of dolphins.	SPS I 523455; 176423
97	Thames foreshore, Barnes The approximate findspot of a mid-late Iron Age potin coin.	SPS I 523456; 176401
98	Thames foreshore, Barnes The approximate findspot of an Iron Age ring.	SPS I 523466; 176391
99	Thames foreshore, Barnes The approximate midpoint of a scatter of mid-late Iron Age potin coin finds, including one half-coin (10 separate coin finds are listed by Pamela Greenwood in her Riverside Archaeology database).	SFS I 523471; 176385
100	Thames foreshore, Barnes The findspot of two mid-late Iron Age potin half-coins.	SPS I 523485; 176359
101	Thames foreshore, Barnes The approximate location of piles, possibly representing a piled structure on the foreshore, based on Lawrence's catalogue of antiquarian finds/observations. Unknown date.	SPS 523470; 176340
102	Thames foreshore, Barnes The approximate findspot of a late Roman (4th century) copper-alloy buckle.	SPS I 523530; 176320
103	Thames foreshore, Barnes	SPS IA

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number/ NGR
	The approximate findspot of a late Bronze Age-early Iron Age pot sherd. Discovered by the WHS pre-1980.	523550; 176300
104	West bank of the Beverley Brook, Thames foreshore, Barnes The findspot of a Roman tegula (roof tile), dated to the 1st century; a late Bronze Age-early Iron Age flint-tempered pottery (jar) sherd from the main body of the vessel; and a rim sherd decorated along the neck with triangle-shaped pendants. Discovered by the WHS in 2011.	SPS I 523525; 176260

E.2 Site location, topography and geology

Site location

E.2.1 The site lies c. 45m to the west of the current River Thames, at the mouth of a tributary valley bounded by the eastern branch of the Beverley Brook. This watercourse runs parallel to the southern boundary of the site, approximately 15m to the south. The confluence of the Thames and the Beverley Brook lies 85m to the east of the site.

Topography

E.2.2 The site is flat, with a very gentle slope down from the southern end of the Barn Elms Playing fields, from 103.2–103.4m ATD (above Tunnel Datum; the equivalent of 3.2–3.4m Ordnance Datum), before rising to 104.4–104.6m ATD at the top of the slope of the Beverley Brook embankment. Levels in the northern part of the site, in the area of the Sports Centre, lie at 103.9m ATD.

Geology

E.2.3 The site is located entirely on alluvium towards the southern edge of the Thames floodplain. The southern part of the site lies at the mouth of the valley of the Beverley Brook, a south bank tributary of the Thames, which cuts through the Kempton Park river terrace[1]. The tributary valley widens from 400m to 800m wide from west to east across the site. The alluvium infilling the valley is typically made up of sand, silt, clay and peat deposits, laid down over the past ten thousand years (the Holocene), which overlie the Shepperton Gravels, deposited by an arctic braided river at the end of the last cold stage.

E.2.4 A cluster of borehole logs are available from the southeast corner of the site, where the main construction works are to be carried out. In addition, two recent geotechnical boreholes have been monitored: one to the north of the boat house adjacent to the eastern access road, c. 380m to the north of the main construction site, and one on Putney Embankment, c.

100m southeast of the site. These boreholes show the variability of the deposit sequence below the site, within the confluence area of the Thames and the Beverley Brook.

E.2.5 Four boreholes from the main permanent works construction area show the level of the ground surface to be 104.0m ATD. In these boreholes, the thickness of made ground varies from 0.75m to 2.0m. The alluvium, where surviving, is sandy clay becoming gravelly toward its base. The thickness of alluvium reflects the irregular surface of the underlying gravel, which varies between c. 101.0m and 102.0m ATD, i.e. 2–3.0m below ground level (mbgl). In one borehole, however, the alluvium appears to be truncated and made ground lies directly over the gravel at 102.0m ATD. Although no levels are yet available, the monitored borehole on Putney Embankment appears to record a deeper alluvial sequence, with 1.5m of modern made ground overlying 1.3m of modern/historic foreshore gravel, which seals a 3.2m sequence of interbedded alluvial clay and peat.

E.2.6 In contrast, the monitored borehole to the north of the boat house recorded a different sequence, with stiff gravelly sandy clay deposits to 5.0m depth, underlying c. 1.3m of modern made ground. It is likely that the gravelly clay represents the late glacial fill of the Beverley Brook. Standing water might have lain within the valley at this time, with inwashes of sand from the surrounding outcrops of Kempton Park Gravels and soliflucted sediment sludged into the valley during episodes of seasonal thaw. As the climate ameliorated, vast quantities of meltwater incised channels through the clayey sediment and gravels were laid down within these channels, which would have had similar characteristics to rivers flowing in arctic regions today. The Shepperton Gravel was deposited at this time in a network of braided, ephemeral channels which left areas of gravel highs and lows. The gravel highs (as recorded in the boreholes on the main construction site) will have remained as islands of drier ground within the confluence area from the prehistoric period onwards, when stream channels and expanding wetland exploited the lower-lying channel areas. By the post medieval period the irregular topography would have levelled-up, as a result of the accumulation of alluvium.

E.2.7 The borehole sequences illustrate the likely variability of sub-surface deposits within the site. The deeper sequence recorded north of the boat house could indicate an abandoned channel (of the Beverley Brook or the Thames) that infilled to become a marginal marshy area, prior to migration of the Thames towards the borehole. It is likely that a number of deep former channels, infilled with Holocene organic deposits, lie within the access roads to the site. Such alluvial sequences will have good potential for dateable palaeoenvironmental reconstructions of the Holocene environment. The main construction site boreholes, however, appear to be located on an island of higher floodplain gravels. The alluvium here is likely to have less potential for environmental remains, but evidence for prehistoric or later exploitation of the floodplain and its mosaic of islands, channels and wetland areas could exist. The borehole from further north, which is also in an area of higher ground within the floodplain, appears to lie on an outcrop of fine-grained Late Pleistocene deposits. These deposits will have potential for reconstructing the late glacial environment

of the Thames and its tributaries. In addition, evidence for prehistoric and later soils and land surfaces might be superimposed.

E.3 Past archaeological investigations within the assessment area

E.3.1 An archaeological investigation was carried out in the southeastern part of the site by the Wandsworth Historical Society (WHS) in 1974 (**HEA 1D**; BEV IA). Despite a limited investigation area, finds of two quern stones, the fragment of another, and a quantity of pottery recovered from within a pit or ditch (not fully excavated) suggest the presence of an Iron Age occupation area within the southeastern corner of the Barn Elms playing fields, in which part of the site lies. This investigation is closely related to **HEA 1B** (BEV I B) also carried out in 1974 by the WHS c. 95m to the south, immediately adjacent to the main construction area and access road, which also revealed evidence of Iron Age occupation, including the remains of pits and postholes and finds of a horse harness ring, burnt flint, daub and pottery. Neither investigation, including plans of the areas excavated, has been published.

E.3.2 Several investigations have also been carried out within the assessment area to the southeast of the site. The WHS has surveyed the Barnes foreshore since the 1970s, and the Thames Archaeological Survey (TAS) undertook walkover, or 'Alpha', surveys during the 1990s. A survey carried out in 1995 by the Richmond Archaeological Survey (as part of the TAS) recorded the remains of a possible medieval or post-medieval fish trap (**HEA 59**) 110m to the east of the site.

E.3.3 Other investigations within the assessment which have yielded significant finds include excavations at Sefton Street (**HEA 4** and **15**), c. 225m and 185m to the south of the site respectively, which revealed decorated Neolithic pottery and a large quantity of struck flints.

E.3.4 In contrast to the numerous archaeological investigations carried out to the south and southeast of the site, no investigations have been carried out in the northern or western parts of the assessment area. Archaeological understanding of this part of the assessment area is therefore more limited.

E.3.5 The results of the investigations indicate activity in the area from the prehistoric period onwards. The results of these investigations, along with other known sites and finds within the assessment area, are discussed by period, below.

E.4 Archaeological and historical background of the site

E.4.1 The following section provides a detailed archaeological and historical background for the site. It should be read alongside Appendix C to Vol 2 Appendix E2, which sets the overall Thames Tideway Tunnel project, and the individual site-specific assessments, within a broader historic environment context (i.e. past landscapes and human activity within such

landscapes). It identifies the main route-wide heritage themes, of which the built and buried heritage assets identified within this assessment form a part.

Prehistoric period (700,000 BC–AD 43)

The prehistoric environment

E.4.2 The floodplains of the Thames and Beverley Brook would have been favoured by prehistoric groups, as they provided a predictable source of food (from hunting and fishing) and water, as well as a means of transport and communication. In prehistory river levels were lower than today and prehistoric soils and landsurfaces developed on areas of high gravel and other deposits left behind by the Ice Age Thames. A parish map dated to 1636 marks a higher gravel surface, or 'eyot', at the then confluence of the Thames and the Beverley Brook in the approximate location of Leaders Gardens (**HEA 75**), c. 100m to the southeast of the site. Throughout all periods, but particularly from the Neolithic onward, islands of higher gravels would have been ideal for farming or more permanent occupation and such areas largely remained beyond the level of inundation when the river was in flood.

E.4.3 The Beverley Brook would have provided a route way through the dense woodlands that cloaked the nearby gravel terraces and through the alder carr (wet woodland), providing links between the Thames and the interior. The wetlands located at the confluence of the Beverley Brook and the Thames would have provided valuable resources of food, water and mud and reeds for the production of pottery and for building materials. Trackways, potentially preserved in waterlogged deposits, particularly peat, may have been used to traverse the wetlands. Survival potential for waterlogged deposits within the assessment area on the Thames foreshore was confirmed by survey work carried out by the LARF and Richmond Archaeological Society in 1995 (**HEA 76**), c. 75m to the northeast of the site, which revealed deposits of prehistoric peat; forest remains, consisting of tree roots, trunk and branches; and animal bones.

E.4.4 The Barn Elms area appears to have been made up of naturally defended islands surrounded by wetlands and stream channels between the Thames and the Beverley Brook, which would have provided conditions similar to those of Iron Age settlements elsewhere in the Thames Valley[2]. The suitability of the topography and geology of the assessment area for prehistoric settlement is reflected by a considerable number of early to late prehistoric features and artefacts (particularly those dated to the Iron Age) uncovered within the vicinity.

Early prehistoric (700,000 BC–2000 BC)

E.4.5 The earliest known find from the assessment area is a Palaeolithic scraper (**HEA 20**), c. 265m to the south, discovered from within road ballast (and therefore probably not *in situ*). Aside from this, no other Palaeolithic finds have been recovered from within the assessment area.

E.4.6 In contrast to the scarcity of Palaeolithic finds, numerous remains dating from the early Mesolithic–late Neolithic were uncovered during

investigations carried out by the WHS at Sefton Street in 1969–70 (**HEA 4** and **15**), c. 185m and 225m to the south of the site, respectively. At the latter site (**HEA 15**) a concentration of struck flints, indicating a 'chipping floor' or lithic extraction site dating from the late Mesolithic–late Neolithic was recorded. Evidence for the Mesolithic period comprised struck river pebbles, although it is unclear whether these represent a surface scatter or *in situ* finds. In terms of the wider context of Mesolithic finds recovered from Wandsworth, it is likely that parts of the foreshore and channel would have lain in dry land in this period and that Mesolithic settlement and activity may have been carried out on present dry land areas adjacent to the Thames[3]. The Portable Antiquities Scheme (PAS) records a Mesolithic flint tool as having been recovered from the Thames channel (**HEA 85**), c. 130m to the east of the site, although this location, as with the PAS finds described below, is very approximate.

E.4.7 Altogether, approximately 3000 struck flints, mostly dated to the late Neolithic period, were discovered at Sefton Street, along with several pottery sherds (although some of the pottery may be early medieval rather than prehistoric; Pamela Greenwood pers. comm.). The GLHER describes the flints as 'very utilitarian' in their makeup, consisting of saws and snapped blades[4], indicating hunting and food preparation activity. Along with flint work, evidence for flint-knapping, axe fragments, and pottery was also uncovered. A scatter of Neolithic flint was also recovered from 33 Danemere Street (**HEA 3**) c. 150m to the south of the site. Finds from the foreshore comprise a Neolithic hand axe (**HEA 14**) recovered 130m to the east of the site, and Neolithic flint flakes, scrapers, a borer and a core/scraper (**HEA 31**) discovered c. 70m to the east. The PAS records the recovery of a Neolithic axe from the Thames channel (**HEA 88**) c. 430m to the southeast of the site. Neolithic finds discovered in Hammersmith on the site of the Fulham Palace Paddock (**HEA 27**), c. 430m to the southeast of the site, also indicate possible settlement on the northern bank of the Thames. A late Neolithic–late Bronze Age leaf-shaped, riveted sword (**HEA 32**) was recovered from the Thames channel close to Fulham, c. 170m to the east of the site, and a Neolithic flint axe (**HEA 94**) was recovered from the foreshore at Barnes, c. 70m to the east.

Later prehistoric (2000BC–AD43)

E.4.8 In contrast to a considerable quantity of Neolithic (and Iron Age) finds, fewer Bronze Age artefacts or features with definitive findspots are known within the assessment area, with very few dating to the early Bronze Age. This may reflect the lack of previous investigation to the north and northeast of the site, where numerous Bronze Age finds are believed to have been recovered. A number of mid-late and late Bronze Age finds (**HEA 94**) have been given an approximate location by Pamela Greenwood of the WHS on a stretch of the Barnes foreshore, c. 70m to the northeast of the site[5]. These include a mid-Bronze Age palstave (axe) and a scabbard mounting: a Bronze Age hammer, socketed sickle, and plate (possibly an ornament); and two late Bronze Age swords (one possibly early Iron Age). A late Bronze Age cup (**HEA 95**) was recovered from within ballast on the foreshore c. 30m to the east of the site.

E.4.9 A discrete cluster of late Bronze Age/early Iron Age pottery sherds was also discovered on the foreshore by the WHS on either side of the Beverley Brook[6] (**HEA 104**), c. 70m to the east of the site. A fine burnished bowl (**HEA 90**) dating to this period was recovered from the foreshore opposite Leaders Gardens at an 'exceptionally' low tide[7], c. 120km to the east of the site. Pottery of this type has also been recovered from the Hammersmith foreshore directly opposite the Beverley Brook[8], and it seems likely that there was activity at the present confluence of the Beverley and the Thames in this period. A ceramic bead, possibly a spindle whorl, and unspecified 'materials' dating to the late Bronze Age–late Iron Age (**HEA 13**) were also recovered from Barn Elms Playing fields, c. 20m to the west of the site.

E.4.10 Evidence for Iron Age activity within the site and assessment area is more comprehensive, as several finds and features have been recorded as part of past investigations. An investigation carried out in the southern part of the site by the WHS in 1974 (**HEA 1D**; BEV I A) uncovered evidence of Iron Age occupation. The investigation comprised a watching brief and limited excavation as part of the Greater London Council (GLC) river defence wall works. Two Iron Age rotary querns and a probable quern fragment; several fragments of pottery dated to the early–mid Iron Age; calcinated bone; burnt flint and a possible salt container were recovered from a black deposit within a large pit or ditch. Other 'stones', potentially quern stones, were observed within the trench but were not recovered. A quantity of pottery was also noted within unmonitored spoil. Within the burnt deposit, the finds formed a distinct concentration[9] and included a lump of iron material, burnt daub, and a large quantity of burnt flint.

E.4.11 A further excavation carried out within the southern part of the site by the WHS in the same year (**HEA 1B**; BEV I B), also revealed Iron Age finds and features indicating occupation. Here, a more extensive excavation was carried out as part of works for the North Thames gas pipeline (**HEA 8**). A large clay-lined pit, measuring 1.8m in diameter and 1.0m deep, and several smaller adjacent pits were excavated. The clay-lined pit contained a mid–Iron Age horse harness ring, calcinated flint, burnt daub and potsherds. Although the finds within this pit suggest a mid–Iron Age date, it is possible that the adjacent features, comprising pits and possible post-holes are of earlier date, as these contained earlier flints and Bronze Age flint-tempered pottery (Pamela Greenwood pers. comm.).

E.4.12 The Iron Age occupation evidence and finds suggest activity and settlement along the current Barnes foreshore in this period, particularly within the area of the former confluence of the Beverley and the Thames. Lawrence describes 'pile dwellings' on the foreshore in the vicinity of the Beverley Brook[10] (**HEA 101**), c. 40m to the east of the site, and the WHS recently recorded a timber-post structure running parallel to the Thames alongside the Beverley Brook eyot (**HEA 90**) c. 160m to the southeast of the site. Later Iron Age 'potin' (cast bronze) coins dating to the late 2nd–1st century BC were discovered close to this structure[11], along with undated bone objects, late Bronze Age–early Iron Age pottery, an Iron Age ring and part of a quern stone. It is possible that the coins and quern stone (and possibly the quern stones discovered within the pits at **HEA 1B**

and **1H**) represent votive offerings. This is supported by numerous other finds of Iron Age potin coins; both within the site, where a chance find of at least thirteen coins was made within the eastern boundary of the site, close to the present foreshore (**HEA 1C**); and the assessment area (including **HEA 84, 97**, **99** and **100**), where at least ten coins were recovered in total. All the coins were discovered on the present foreshore. Two Iron Age rings (**HEA 96** and **98**) were found on the foreshore, c. 70m and 60m to the east of the site respectively. Riverside timber structures were often associated with votive deposition[12] and it is possible that further structures may extend along the foreshore to the north and south beyond the Beverley Brook[13].

E.4.13 Another indication of human occupation was the discovery of an early-mid Iron Age human fibula (calf bone) (**HEA 11**), c. 45m to the east of the site, believed to have been recovered from the west bank of the Beverley Brook. A male human skull discovered in 1918, and a human lower jaw bone discovered in 1929 (**HEA 94**), are also documented with a number of mid-late Bronze Age and Iron Age finds approximately 70m to the northeast of the site[14]. Other Iron Age finds recovered from this section of the foreshore included an early Iron Age dagger and scabbard; a potin coin; a shield binding; a bronze disc and a bronze shield fitting.

E.4.14 There have also been numerous other chance and antiquarian finds of prehistoric artefacts within the assessment area, and more generally, along the Barnes foreshore. At present, the exact locations of these finds are unknown and they are currently being documented by Pamela Greenwood of the WHS. They largely comprise pottery finds but also include: flint artefacts; tools, such as knives, chisels, axes and mattocks, made of flint, antler and stone; swords; scabbards; daggers; plated fittings such as buckles; axeheads and wheel fittings. Unspecified prehistoric finds have also been discovered at Putney Lower Common (**HEA 38**) 400m to the southwest. It is likely that these otherwise unreferenced finds were recovered as a result of gravel quarrying on the Common in the 19th century (Pamela Greenwood pers. comm.). Prehistoric flint flakes were discovered at 22 Bendemeer Road (**HEA 23**) 425m to the southeast of the site. An undated prehistoric deposit (**HEA 34**) containing shell inclusions, was also discovered 370m to the northwest. Eight prehistoric (otherwise undated) flint flakes were recovered from the Thames towpath at Barn Elms Park (**HEA 18**), c. 15m to the east of the site.

Summary

E.4.15 The archaeological evidence suggests that the southern and south-eastern parts of the assessment area were well populated in the Neolithic period with Mesolithic activity indicated by finds of flints to the south of the Beverley Brook, and later Bronze Age activity on the foreshore at the present confluence of the Thames and the Beverley. Evidence for Iron Age activity/occupation is concentrated within Barn Elms playing fields and on the foreshore to the southeast. It is probable that the site lay within a crossing route of the Thames in the Bronze Age and Iron Age periods, and that prehistoric settlement at Barn Elms was part of a large area of continuous occupation within Barnes and Hammersmith. The River

Thames was a major focal point for activity, and this is reflected in numerous finds dating from the Mesolithic to Iron Age discovered within the Thames channel between Barnes and Hammersmith; the stretch of foreshore between Barnes and Putney; and the opposing Hammersmith foreshore.

Roman period (AD 43–410)

E.4.16 The Roman town of *Londinium* was established 9.8km to the northeast of the site in around AD 50. A network of Roman roads has been identified in Putney, 900m to the south of the site. The roads extended from *Londinium* and possibly crossed the Thames at a ford, or other crossing, near Putney Bridge, 850m southeast of the site[15].

E.4.17 The crossing attracted occupation and a settlement grew up between the Beverley Brook and the present Putney High Street/Felsham Road, 650m to the southeast of the site. There are no known Roman finds or features within the site. Roman finds from within the assessment area include pottery recovered from an investigation at Sefton Street (**HEA 15**), 170m to the southwest of the site; pottery and a coin from 33 Danemere Street (**HEA 3**), 160m to the south; tile and pottery from 22 Bendemeer Road (**HEA 23**), 425m to the southeast; Roman pottery dating to the 3rd century from Spring Passage (**HEA 24**), 425m to the southeast; and pottery from allotments to the northwest of Barnes Common (**HEA 37**), 445m to the west.

E.4.18 Roman finds recovered from the Thames channel and recorded by the PAS include a Roman coin (**HEA 86**) discovered c. 235m to the southeast of the site; three coins (**HEA 30**) discovered c. 100m to the east, and a coin (**HEA 88**) c. 430m to the southeast. The WHS have also recorded a 4th century Roman buckle (**HEA 102**) from within the channel and Roman roof tile (**HEA 104**) along the bank of the Beverley, c. 90m and 70m to the east of the site respectively. Within the channel, close to the Hammersmith foreshore, two Roman iron swords or 'gladii' (**HEA 32**; used by legionaries of the 1st and 2nd centuries) were recovered c. 175m to the east of the site, probably as a result of dredging. A sherd of hard, black Roman pottery (**HEA 77**) was also recovered from a foreshore deposit at Hammersmith c. 310m to the northeast of the site.

E.4.19 The site may have lain in marshland prone to flooding throughout this period, and would thus have been unsuitable for settlement, although islands of higher ground are likely to have remained above the expanding wetland. The floodplain probably provided valuable resources of food, water and construction materials, and any evidence of such activity would be located within the alluvium on the site. Travel along the Beverley Brook would have provided a more direct route to the northwest and reduced journey times around the Thames meander, which may explain the scattered finds to the south of the site, along the southern bank of the Brook.

Early medieval (Saxon) period (AD 410–1066)

E.4.20 Following the withdrawal of the Roman army from England in the early 5th century AD the whole country fell into an extended period of socio-

economic decline. In the 9th and 10th centuries, the Saxon Minster system began to be replaced by local parochial organisation, with formal areas of land centred on nucleated settlements served by a parish church. The main evidence of Saxon occupation of the local area is derived from the original Anglo-Saxon place name of 'Berne', meaning 'a barn'[16].

E.4.21 The site fell within the Saxon manor (estate) of Barnes. The earliest record of Barnes dates to the 10th century when King Athelstan granted the single village manor of Barnes to the Dean and Chapter of St. Paul's[17] in AD 924–939. Prior to this, Barnes had been included in the manor of Mortlake to the west. Both manors comprised part of the Brixton Hundred, in the northeastern part of Surrey. This was the most prosperous area within the county, with the largest area of cultivated land[18]. The main settlement in the manor probably grew up in the area of the medieval village, beside the Church of St Mary, 350m to the west of the site. There was probably also a small village at Putney, 900m to the southeast.

E.4.22 The site would have been within marshy ground prone to flooding throughout this period. The land may have been used for rough pasture. The Beverley Brook and the Thames foreshore appear to have been used for fishing and possibly other wetland activities. Medieval and post-medieval fish traps (**HEA 19**) were recorded on the foreshore as part of a TAS survey, c. 40m to the east of the site. Three structures, provisionally identified as fish traps (**HEA 33** and **59**), and identified during surveys carried out by the TAS, c. 35m and 100m to the east of the site respectively, may also date to this period. The WHS also identified a possible fish trap (**HEA 93**) c. 90m to the northeast of the site. Two further fish traps (**HEA 69** and **70**), located 50m and 55m to the east of the site were identified during the site walkover survey. An early Saxon pottery vessel (**HEA 28**) was recorded by the PAS c. 50m to the east of the site. It is possible that some of the pottery previously identified as Neolithic at Sefton Street (**HEA 4** and **15**) may be of early medieval date (Pamela Greenwood pers. comm.). A Saxon buckle was also discovered at the London Wetland Centre, c. 290m to the north of the site.

Later medieval period (AD 1066–1485)

E.4.23 As with the early medieval, throughout this period the site would have been prone to flooding. The main settlements would have been at Putney, 900m to the southeast, and surrounding the parish church of St. Mary at Barnes, 350m to the west of the site (outside the assessment area). The church was built in the early 12th century[19] and would have formed the focus of the settlement. By the 13th century, St. Mary's had been much extended and was described by Lysons in the 18th century as 'one of the most ancient structures in the neighbourhood'[20].

E.4.24 The site continued to lie within open reclaimed land outside these settlements. Attempts were made to drain and reclaim the land, probably to bring it into arable cultivation, through the construction of river walls and drainage ditches. A system of farming large open fields was established in Barnes and Mortlake between the 11th and 13th centuries. Barnes had a basic arrangement of two fields, both of which lay to the west of the current assessment area, with a natural boundary formed by Vine Road in

Barnes Common, 850m to the southwest of the assessment area[21]. Perhaps contemporary with (or following) these developments, large-scale flood defences began to be constructed along the line of the Thames foreshore. These became known as the 'Great Works' and the 'Little Works'.

E.4.25 The Great Works consisted of a single line of drainage ditches and embankments dug parallel to the Thames, which spanned the curve of the Barnes peninsula from Chiswick church to Barn Elms, reaching the Beverley Brook. The Little Works formed a second line of flood defence parallel to the Great Works and was separated from it by a strip of land which varied in width and was used for osier cultivation[22]. Part of the Great Works (**HEA 1A**) survived along the southeastern edge of the site until 1909, and is shown on historic maps. The site potentially preserves below ground remains of this north-south aligned medieval flood defence.

E.4.26 The site of the medieval manor house of Barn Elms (**HEA 71**), lies within the central part of the assessment area, c. 50m to the south of the Sports Centre. In the mid to late-15th century, the manor house was owned by Sir John Say, Chancellor of the Exchequer to King Edward IV[23]. Post-medieval maps (Vol 6 Plate E.1 to Vol 6 Plate E.5) show ponds belonging to the manor (**HEA 39** and **43**), c. 235m to the southwest of the site. These may have originally been natural features which were enlarged and/or deepened in the later medieval period for keeping fish, in order to supplement the diet of the residents of the manor[24]. The ponds to the southwest of the manor house (**HEA 39, 41** and **43**), c. 235m and 430m to the southwest of the site respectively are labelled as 'fish ponds' on Ordnance Survey maps until the 1950s and they may have been used as such in the medieval period.

E.4.27 Further finds dated to this period within the assessment area comprise unspecified medieval finds recovered from Barn Elms (**HEA 44**), c. 295m to the west of the site; and 14th century pottery (**HEA 24**) recovered at Spring Passage, c. 425m to the southeast of the site. The possible Saxon fishtraps mentioned above (**HEA 33, 59, 69** and **70**) may be of later medieval date.

Post-medieval period (AD 1485–present)

E.4.28 Throughout this period, the site lay within reclaimed flood meadows some distance from the nearby settlements of Barnes, Putney and Mortlake. At the beginning of the 17th century there were 150–200 people living in Barnes. Residential buildings were not established in the vicinity of the site on Church Road (leading from the town of Barnes to the Church of St. Mary) until the 17th century[25]. Building material dating to the 17th century was discovered at Spring Passage (**HEA 24**) c. 425m to the southeast of the site, reflecting the spread of housing from nearby Putney.

E.4.29 Within the assessment area, undated post-medieval pottery was recovered from Sefton Street (**HEA 15**), c. 225m to the south of the site, and from 22 Bendemeer Road (**HEA 23**), c. 425m to the southeast. Post-medieval fish traps, (**HEA 19** and **33**), located c. 45m and 40m to the east of the site were observed during surveys on the foreshore, the former was

also observed during the site walkover for this assessment and has been dated to c. 1485–1600. Consolidation dump deposits (**HEA 36**) dating to the 18th century were identified 25m to the east of the site as part of a TAS survey. Attempts to consolidate a stream channel of the Beverley Brook in the 19th century with dumps of domestic rubbish and building debris were recorded at 38–38A Danemere Street (**HEA 2**) 85m to the south of the site. Evidence of 19th century flood defence and/or land reclamation was uncovered at the Imperial College Boat Club (**HEA 5**), 235m to the southeast of the site. The PAS have recorded several post-medieval finds from the Thames channel (**HEA 83**, **84**, **85**, **86**, **87** and **88**).

E.4.30 The site crossed the eastern and northern parts of the grounds belonging to the Barn Elms manor house. The house was rebuilt in 1694 and two wings were added in 1771. It remained in this layout until it was demolished in 1954 for the construction of the current playing fields. Known as 'the Old Manor House', the pre-1694 building was named Barn Elms after the large elm trees which surrounded it[26]. The house and its surrounding farm and woodland are labelled as 'Barn Elms Park' on Ordnance Survey maps. A manorial survey of Barn Elms dated to 1649 described Barn Elms manor (**HEA 71**) as having a large orchard and four fish ponds. The manor was surrounded by a cluster of cottages and outbuildings and has been likened to a hamlet of the village of Barnes[27].

E.4.31 Several landscaped features related to Barn Elms Park fall within the assessment area, to the southwest of the site, including the original southern extent of Barn Elms lake (**HEA 41**) and post-medieval fish ponds (**HEA 39** and **43**), which have subsequently been infilled. The lake (shown on the Tithe and Ordnance Survey maps but not on Rocque's map) and surrounding ponds within Barn Elms Park had reached their full extent by the late 18th century, covering over three acres[28]. In 1827, Castelnau road was constructed by the Company as an approach road between the towns of Barnes and Mortlake and the Hammersmith Bridge which lies 1.3km to the north of the site[29].

E.4.32 The Nicholas Lane estate map dated to 1636 (not reproduced due to limited coverage of the assessment area) shows the mouth of the Beverley Brook split into two streams running either side of the gravel eyot (marked 'Aite' on the map) in the approximate location of Leaders Gardens, c. 160m to the southeast of the site. To the immediate north of the Beverley Brook lies a large area of unmarked open fields in which the site lies. Adjacent to the south bank of the Beverley Brook and east of the present Barnes Common are a number of subdivided fields comprising meadows and grazing land.

E.4.33 Rocque's map of 1741–1745 (Vol 6 Plate E.1) shows the majority of the site within open fields and common to the north and east of the Barn Elms manor house. Orchards and cultivated land/gardens are shown beside the manor house, along with outbuildings (**HEA 1E**) partially situated within the northern part of the site, in the approximate location of the Barn Elms School Sports Centre. The map shows two ponds to the southwest of the house, including a large rectangular pond to the west, and a smaller triangular pond (**HEA 39**) to the south. The ponds are separated by a

large trackway. The Beverley Brook is shown terminating at Barnes Common, c. 250m to the southwest of the site, although it is unlikely that this was the case, and is probably an error. The name Beverley Brook is likely to predate the 16th century and could be named after the beaver[30], an animal now extinct in Britain, hunted for its fur in the past. A conduit was located at Barnes Common in this period which may have provided the manor house with water[31].

E.4.34 The Tithe map of 1837 (not reproduced due to poor map quality) shows the site within an area of open fields to the north and east of Barn Elms manor. The manor house is shown with a large number of outbuildings to the north (in contrast to the more scattered buildings shown on Rocque's map of the previous century). The map shows a lake, which is possibly an extension of the original triangular pond shown on Rocque's map of 1746 and itself originally part of the rectangular pond of the 16th century manor. The features on this map are the same as those on the Ordnance Survey (OS) 1st edition 25" map of 1862 (Vol 6 Plate E.2), described in detail below. Outside the site, along the southern bank of the Beverley Brook, are at least eight 'islands' probably created by artificial ditches for osier cultivation. They do not appear on later maps.

E.4.35 The Ordnance Survey (OS) 1st edition 25" map of 1862 (Vol 6 Plate E.2) shows the site along the eastern edge of open fields within Barn Elms Park. The northern part of the site crosses the riverside path leading to the manor house and is shown lying within an open field belonging to Barn Elms Farm (**HEA 91**), c. 95m to the north of the site. Flood gates are shown marked within the north-eastern corner of the site (**HEA 1G**). The outbuildings shown on Rocque's map (**HEA 1E**) have been demolished and appear to have been replaced by outbuildings and sheds stretched along the western curve of the approach road (**HEA 1F**).

E.4.36 By the early 1820s, the Barn Elms estate and park had been sold to the Hammersmith Bridge Company, although the name 'Barn Elms Park' was retained. The park is shown with a number of formal landscape features, including ponds, a network of paths, tree planting and a kitchen garden. The southern end of a large north-south aligned lake (**HEA 41**) labelled 'Fish Pond' is located to the southwest of the site. This was probably created by joining the rectangular and triangular ponds shown on Rocque's map (see Vol 6 Plate E.1). The map shows a long and narrow pond following the course of the Beverley Brook to the east of the lake (**HEA 39**), along with a small round pond in the south-western part of the site (**HEA 43**). The Tithe Map shows both ponds connected to the lake by narrow channels, but these are not shown on the OS map.

E.4.37 Beyond the Barn Elms Park, at the south-eastern end of the site, a north-south path leads into the park from Putney, and two rectangular pump houses are shown on either side of the path. To the south of the Beverley Brook (outside the site) are the open fields of Barnes Common and Putney Lower Common. The area to the north of Barn Elms Park is mainly occupied by open farmland, with Barn Elms Farm (**HEA 91**), presumably included within the manor lands.

E.4.38 In 1884, the Barn Elms manor house (**HEA 71**) passed to the Ranelagh Club and the park became a famous venue for polo and other sports. The map shows the park cleared of trees to create spaces and buildings for organised games, including tennis and croquet pavilions and two large polo grounds.

E.4.39 The OS 2nd edition 25" map of 1896–1898 (Vol 6 Plate E.3) shows the eastern part of the site lying along the riverbank, at the eastern edge of Barn Elms Park. The former open parkland has been converted into a golf course belonging to the Ranelagh Club. The northern part of the site is shown lying along a boundary between the grounds of Barn Elms Farm and a field or orchard lying to the north of the riverside path leading to the manor house. The floodgates (**HEA 1G**) shown on the OS 1st edition map are now shown as an area of higher ground, bounded by a ditch. There is no change to the layout of the main manor house buildings, although several of the former outbuildings (**HEA 1F**) appear to have been demolished and rebuilt. The ponds (**HEA 39** and **43**) and the lake (**HEA 41**) are labelled as 'Fish Ponds'. An attempt to manage the water flow within the large pond (**HEA 39**) is evident by two sluices marked at either end of the pond.

E.4.40 The urbanisation of the wider area began to the northwest and west of the site, as housing spread beyond Castelnau with the construction of smaller, more densely packed terraced houses. In this area, new streets such as Elm Grove Lane, to the west of the site, were constructed with houses and gardens built back-to-back along narrower streets. Within the wider assessment area to the southeast, terraced housing has spread from Putney to the line of the parish boundary between Putney and Barnes. Residential and industrial buildings have also spread eastwards, towards the riverfront. This includes the buildings which now house the headquarters of the Sea Cadet Corps (**HEA 74**), 65m to the east of the site (Vol 6 Plate E.11). These buildings, and the wharf and yard beside the outflow of the Beverley Brook, are labelled 'Board of Works Yard' and were probably used as a coal depot.

E.4.41 The OS 3rd edition 25" map of 1909–1920 (Vol 6 Plate E.4) shows the two pump houses formerly occupying the south-eastern end of the site have been removed, whilst a new rectangular building and tank have been constructed further to the west, close to the northern bank of the Beverley Brook. In the northern part of the site, the mid-19th century outbuildings (**HEA 1F**) appear to have been rebuilt or converted into smaller, subdivided buildings, possibly stables for polo ponies. New stables or outbuildings have also been constructed to the east of these (**HEA 1H**). The floodgates (**HEA 1G**) are no longer marked on the map, and the flood defences to the east of the site, along the river bank, appear to have been reinforced by the construction of a river wall alongside the earlier series of banks and ditches. Barn Elms Farm (**HEA 91**), to the north of the site, has been demolished. Within the assessment area to the southwest, the larger pond (**HEA 39**) has been infilled so that it is now a third of its former size. The smaller pond, (**HEA 43**), has again been connected to the lake by a stream, with a number of footbridges spanning it. The map shows a

small park named Leaders Gardens (**HEA 75**) 95m to the southeast of the site.

E.4.42 The London County Council (LCC) Bomb Damage Maps of 1939–1945 show no significant damage within or in the immediate vicinity of the site.

E.4.43 The OS 25" map of 1947–1972 (Vol 6 Plate E.5) shows a number of small rectangular buildings constructed to the east of the existing tank in the southeastern part of the site; perhaps utility sheds for maintenance of the park grounds . In the northern part of the site and assessment area, parts of the Barn Elms manor house and outbuildings (**HEA 1F**) are marked 'ruin' or 'ruins'. Within the assessment area, a Corporation Yard has been constructed immediately to the southeast of the Beverley Brook, which curves from its confluence with the Thames to the flood gates at the park entrance. To the southwest of the site, a pavilion on the eastern bank of the larger pond (**HEA 39**) has been removed and replaced with two smaller buildings. The smaller pond (**HEA 43**) no longer has a building on its eastern bank, and the stream which formerly connected it to the lake has been filled in. By 1972, the site lay within the Barn Elms Playing fields and Barn Elms Schools Sports Centre.

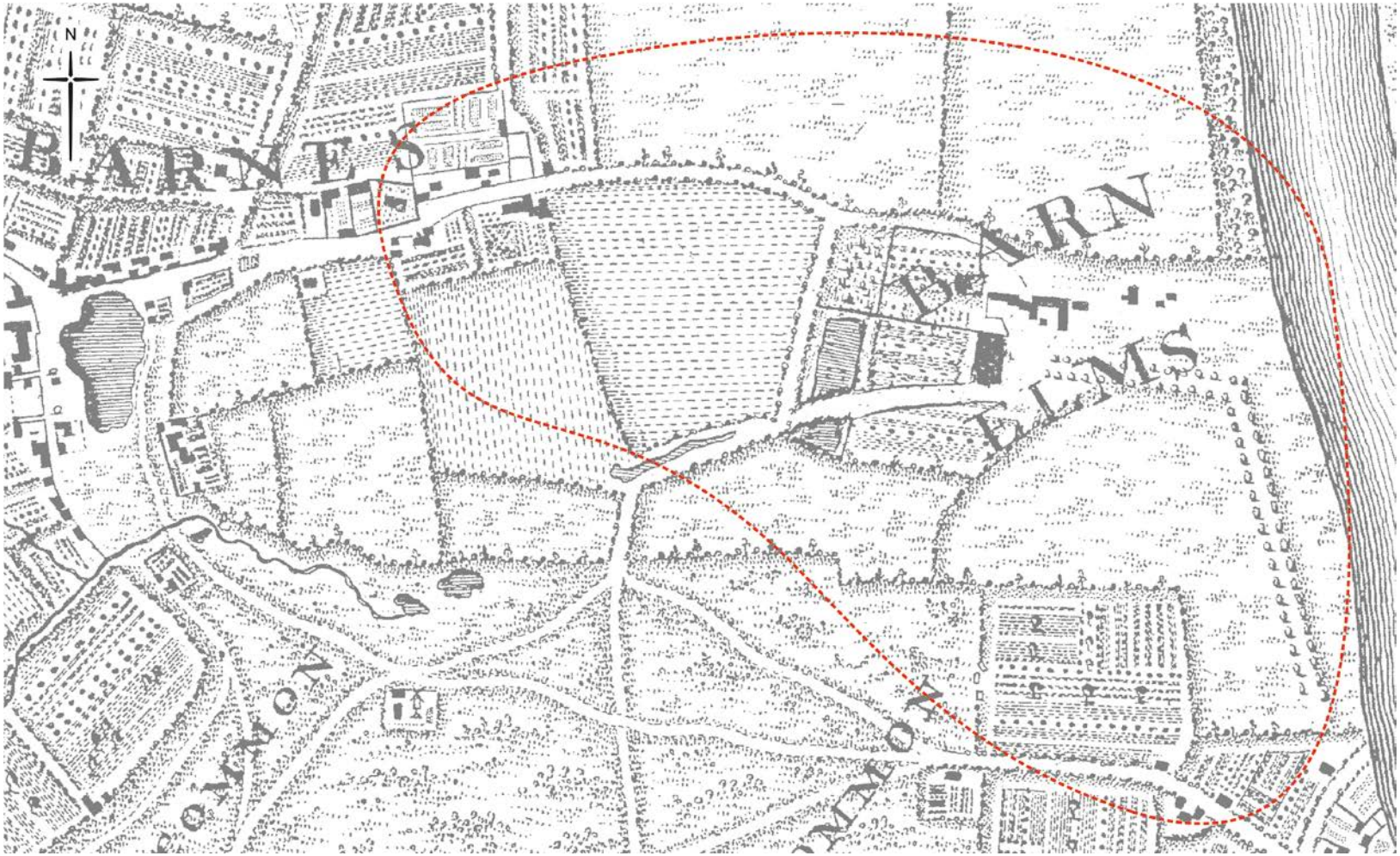
E.4.44 The OS 1:1250 map of 1948–1991 (Vol 6 Plate E.6) shows further changes to the site, including the removal of all former structures. New areas used for sports are marked on the map within the eastern and northern boundaries of the site, and the Barn Elms Schools Sports Centre, in the northern part of the site, has been constructed. Within the wider assessment area, the ponds have been infilled and the approach road and outbuildings attached to the former Barn Elms manor house (demolished in 1954) has been cleared. The path leading from Ranelagh Gardens (at the southern end of Rocks Lane), has also been cleared.

The current site

E.4.45 The site currently lies along the eastern and north-eastern boundary of the Barn Elms playing fields and includes the Barn Elms School Sports Centre main buildings. The north-eastern part of the site is bounded by Queen Elizabeth Walk to the north, and runs east-west towards the riverbank. As well as the Sports Centre buildings, this part of the site is also currently occupied by sports and track facilities. The south-eastern part of the site lies at the western end of the Beverley Brook walk and contains a wire-fenced field boundary. The eastern part of the site, adjacent to the Thames foreshore, lies along the eastern edge of the Barn Elms playing fields, and are bounded by a scout hut, boat house and the riverbank. Vol 6 Plate E.7 provides a general photographic shot looking south across the playing fields. Vol 6 Plate E.8 to Vol 6 Plate E.10 shows the mouth of the Beverley Brook and foreshore at low tide.

E.5 Plates

Vol 6 Plate E.1 Historic environment - Rocque's map of 1741–1745



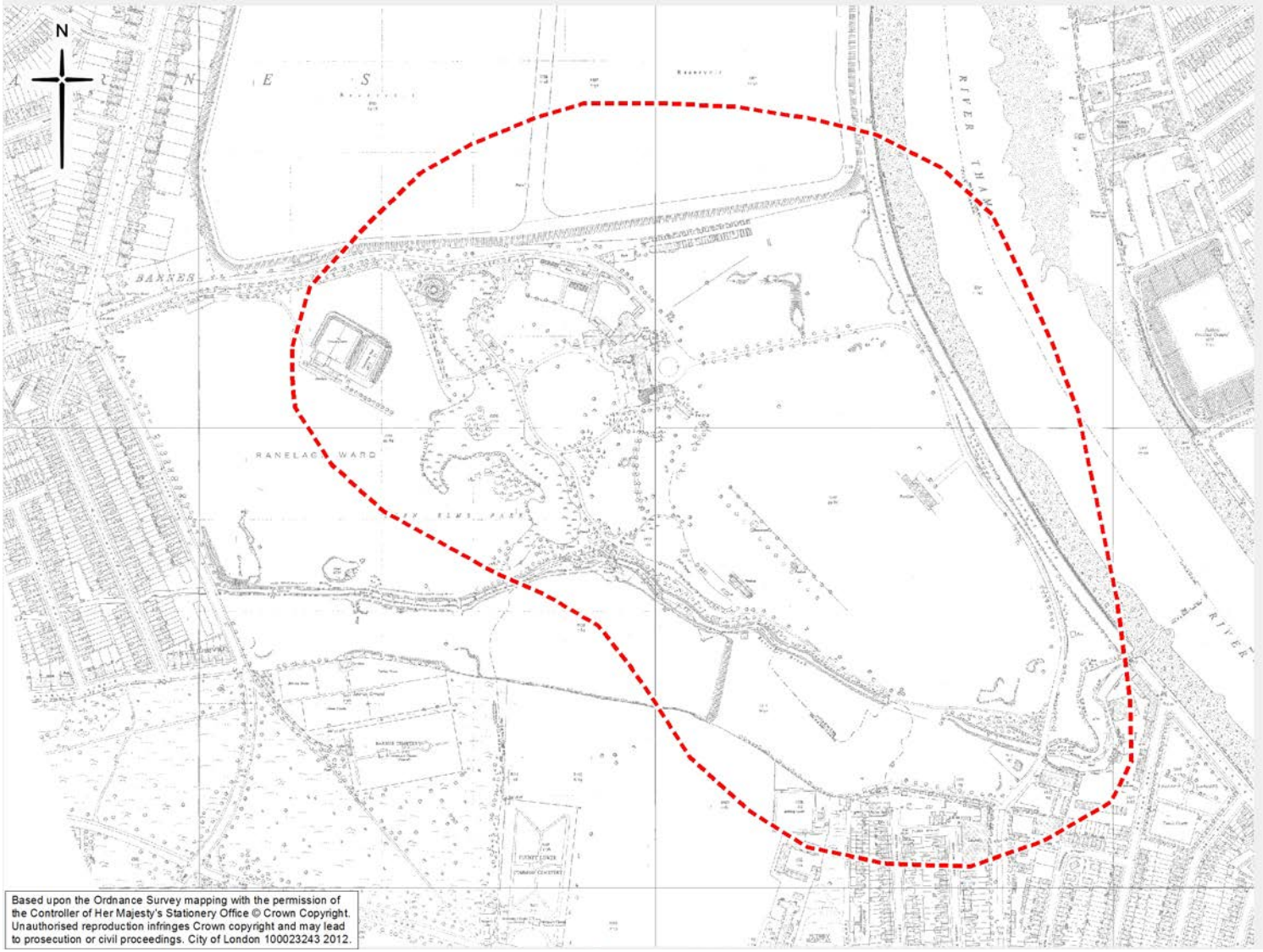
The map does not show the Beverley Brook continuing towards its confluence with the Thames

Vol 6 Plate E.2 Historic environment - Ordnance Survey 1st edition 25” scale map of 1862 (not to scale)

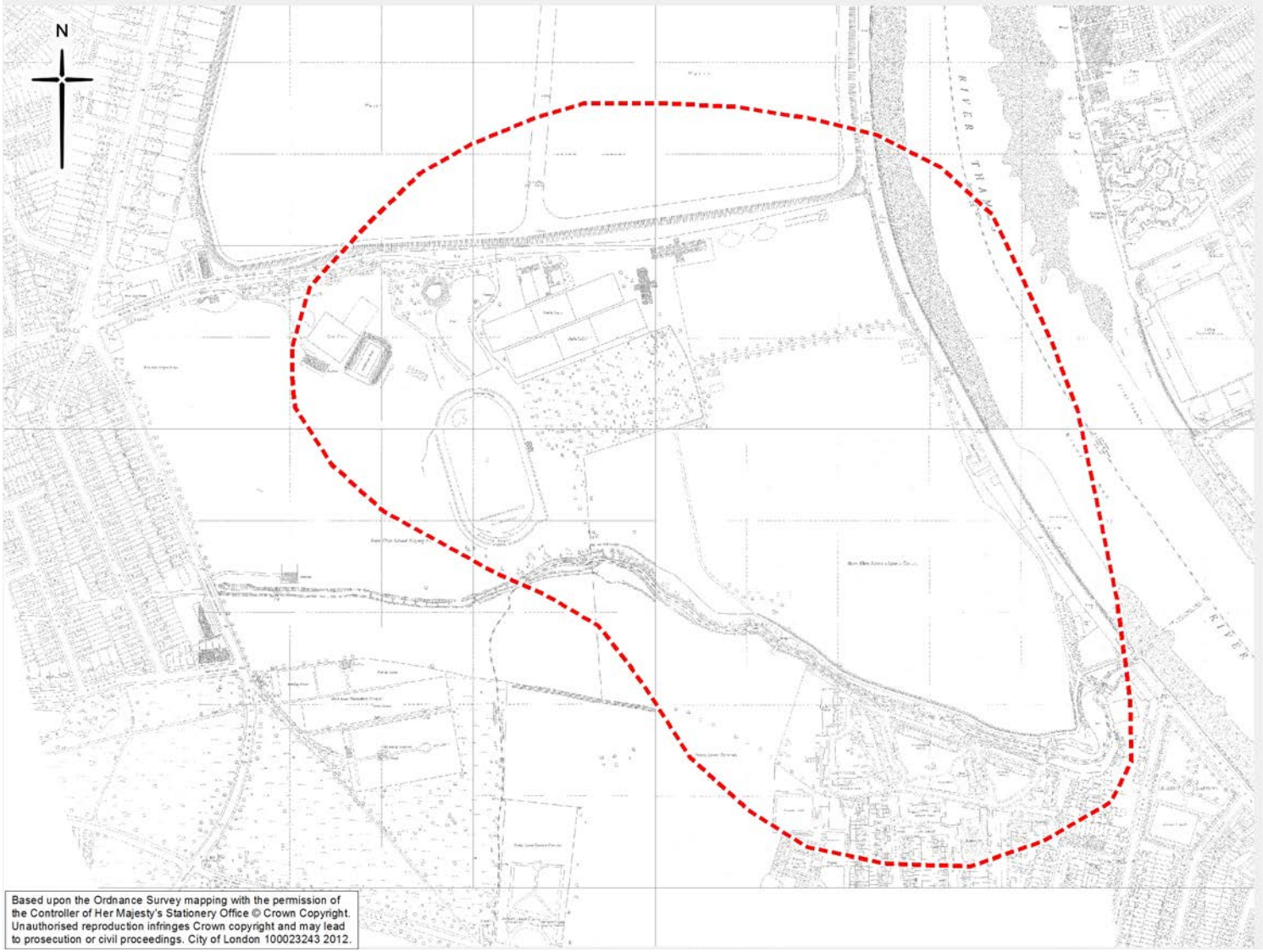
Vol 6 Plate E.3 Historic environment - Ordnance Survey 2nd edition 25” scale map of 1896–98 (not to scale)

Vol 6 Plate E.4 Historic environment - Ordnance Survey 3rd edition 25” scale map of 1909–1920 (not to scale)

Vol 6 Plate E.5 Historic environment - Ordnance Survey revised edition 25” scale map 1947–1972 (not to scale)



Vol 6 Plate E.6 Historic environment - Ordnance Survey 1:1250 map of 1948-1991 (not to scale)



Vol 6 Plate E.7 Historic environment - Barn Elms Playing fields

Looking south towards the area of the site; standard lens; MOLA: 18th April 2011

Vol 6 Plate E.8 Historic environment - The mouth of the Beverley Brook and tide barrier

Looking west from the Thames foreshore at low tide; standard lens; MOLA; 18th April 2011

Vol 6 Plate E.9 Historic environment – foreshore adjacent to the east of the site

Looking north; standard lens; MOLA; 18th April 2011

Vol 6 Plate E.10 Historic environment – the mouth of the Beverley Brook

Looking west; standard lens; MOLA; 18th April 2011

Vol 6 Plate E.11 Historic environment - The former 19th century coal depot buildings, now a Sea Cadets HQ

Looking south from the Thames path; standard lens; MOLA; 18th April 2011

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix F: Land quality

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 6 appendices: Barn Elms site assessment

Appendix F: Land quality

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Appendix F: Land quality

F.1 Baseline report

F.1.1 Baseline data is sourced from:

a. walkover survey

b. the Landmark Information Group database, including historic maps and environmental records

c. stakeholder consultation

d. the initial results from a preliminary intrusive ground investigation.

Site walkover

F.1.2 A site walkover was undertaken on 24th November 2010.

F.1.3 The aim of the walkover survey was to inspect the condition of the site and surrounding areas in order to identify evidence of historical or ongoing contamination sources, as well as any nearby sensitive receptors.

F.1.4 No potential contamination sources were identified on-site during the survey.

F.1.5 Detailed site walkover notes are provided in Vol 6 Table F.1 below.

Vol 6 Table F.1 Land quality - site walkover report

Item (Site Ref: PRD2X, Barn Elms)		Details
Date of walkover	24th November 2010	
Site location and access	The main construction site is located within the southern part of the Barn Elms Sports Centre Playing Fields, with a haul road situated along the eastern and northern boundary of the playing field.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	Relatively flat grass covered sports fields. It was observed that the sports field is at a slightly lower level than the surrounding land. This could be attributed to previous levelling activities on the sports field to make the area flat or construction of raised banks along the Thames and Beverley Brook for flood protection.
Neighbouring site use (in particular note	North	Further grass covered sports fields form the land immediately to the north of the site. A rowing boat house and

Item (Site Ref: PRD2X, Barn Elms)		Details
any potentially contaminative activities or sensitive receptors)		Scout Hut are located within these fields.
	South	Residential properties located on Horne Way/Stockhurst Close (on the opposite side of Beverley Brook). In addition to a metal shelter housing a possible piece of former gas or electrical apparatus.
	East	The River Thames is situated to the east of the site and the Beverley Brook watercourse and sluice gates which lead to the Thames and combined sewer overflow (CSO) site located to the southeast.
	West	Sports fields and leisure buildings/facilities.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	Sports centre buildings present within the haul road area of the site on the northern of the sports field. Outside of the sports field on the sites southern boundary a piece of redundant pipe work in a metal shelter, possibly representing a former gas or electrical apparatus.
Surfacing	Record type and condition	Parkland – hard surfaced pathway through grassland and mature trees of the park.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	Heavily vegetated with mature trees around the boundary of the sports field, site itself is amenity grassland.
Services	Evidence of buried services?	None observed
Fuels or chemicals on-site	Types/ quantities?	None observed
	Tanks (above ground or below ground)	None observed
	Containment systems (eg, bund, drainage interceptors). Record condition and standing	None observed

Item (Site Ref: PRD2X, Barn Elms)		Details
	liquids	
	Refill points located inside bunds or on impermeable surfaces etc?	None observed
Vehicle servicing or refuelling onsite	Record locations, tanks and inspection pits etc.	None observed
Waste generated/ stored onsite	Adequate storage and security? Fly tipping?	No contaminating wastes, grassland only.
Surface water	Record on-site or nearby standing water	Beverley Brook follows the boundary of the site along its south and south eastern edge. Situated along the eastern edge of the site are sluice gates which lead to the Thames and existing CSO site.
Site drainage	Is the site drained, if so to where? Evidence of flooding?	None observed
Evidence of previous site investigations	Eg trial pits, borehole covers.	None observed
Evidence of land contamination	Evidence of discoloured ground, seepage of liquids, strong odours?	None observed
Summary of potential contamination sources		None
Any other comments	Eg access restrictions/ limitations	Site observed through chain link fencing.

Review of historical contamination sources

F.1.6 Historical mapping (dated between 1896 and 1988) was reviewed to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.7 Vol 6 Table F.2 tabulates the potentially contaminating land-uses, inferred dates of operation and typical contaminants associated with the land-uses

in question. Potential contaminants are sourced from CLR8: *Potential contaminants for the assessment of land* (Defra and EA, 2002)[1] and former Department of the Environment industry profiles (Department of the Environment , 2011)[2].

F.1.8 All dates are approximate, where no other information is available the dates relate to when the items first appeared and disappeared from the mapping rather than actual dates of construction, operation or demolition.

F.1.9 Items listed in Vol 6 Table F.2 below are also shown on Vol 6 Figure F.1.1 (see separate volume of figures). In addition, figures illustrating the historical environment of the site and surrounding area are provided in Vol 6 Appendix E.

Vol 6 Table F.2 Land quality – potentially contaminating land-uses

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
On-site			
None			
Off-site			
1	Laundry (80m south)	c1896-c1983	Heavy metals, arsenic, free cyanide, volatile organic compounds (VOCs) such as chloroform and tetrachloroethane, various solvents, fluorocarbon 113, asbestos, polychlorinated biphenyls (PCBs), aromatic hydrocarbons; chlorinated aliphatic hydrocarbons, nitrates and sulphates
2	(a) Board of Works yard (30m southeast)	c1896	Oil/fuel hydrocarbons, aromatic hydrocarbons, polyaromatic hydrocarbons (PAHs), chlorinated aliphatic hydrocarbons, organolead compounds, solvents, heavy metals and asbestos
	(b) Wandsworth Borough Council depot (30m southeast)	c1914-c1919	
	(c) Wharf (30m southeast)	c1920	
	(d) Corporation Yard (30m southeast)	c1951-c1988	
3	Electrical substation x2 (115m south and 110m southwest)	c1951-c1983	Oils, PCBs
4	Electrical	c1952-c1983	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	substation (85m southeast)		
5	Works (70m south)	c1964-c1983	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphur, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
6	Putney hospital (210m southwest)	c1964-present	Pathogens, radioactive substances, heavy metals, oil/fuel hydrocarbons

On-site

F.1.10 The historical mapping shows the site to have had no major previous contaminative uses, having been parkland/recreation grounds since prior to the publication of the earliest map reviewed.

F.1.11 The only features previously identified on-site were an unspecified tank and two small rectangular structures during the 1950s; these structures are believed to be stables/outbuildings and the tank an above ground water storage facility associated with the stables.

Off-site

F.1.12 The 250m assessment area has identified that historically the site has been dominated by green space including polo fields and cricket grounds, with an area of residential properties/medical facilities and pockets of industrial activities situated towards the south and southeast of the site.

Geology

F.1.13 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 6 Table F.3 below.

Vol 6 Table F.3 Land quality - anticipated site geology

Geological unit / strata	Description	Approximate depth below ground level (m)
Made Ground	Dark brown slightly sandy clay - dark orange brown sandy slightly gravelly clay. Gravel is angular to subrounded, fine and medium of flint with brick and glass fragments (<20mm).	0.00 – 2.00
River Terrace Deposits	Medium dense brown sandy gravel - medium dense brown slightly silty gravelly sand. Gravel is subangular to rounded fine to coarse of brown and	2.00 – 7.00

Geological unit / strata	Description	Approximate depth below ground level (m)
	black flint.	
London Clay Formation	Firm and stiff fissured brown slightly gravelly clay becoming very stiff fissured dark greyish brown silty clay.	7.00 - 51.00

Unexploded ordnance

F.1.14 During World Wars I and II, the London area was subject to bombing. In some cases bombs failed to detonate on impact. During construction works Unexploded Ordnance (UXO) are sometimes encountered and require safe disposal.

F.1.15 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited Vol 6 Appendix F.3).

F.1.16 The assessment covered two areas within the Barn Elms site (Area A – main work area and Area B – secondary work area). The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.17 The report identifies that there were no high explosive bomb strikes within the boundaries of both Area A and B. However, three bomb strikes were recorded within 100m of the buffered site boundary. The report also identifies that given the lack of development within the Barn Elms site, it is unlikely that the previous works would have removed UXO items.

F.1.18 Taking into account the findings of this study and the known extent of the proposed works, it is considered that there is an overall low to medium threat from UXO within both areas.

F.1.19 In addition to the above, the local authority highlighted that there was a V1 rocket strike at the junction of the River Thames and Beverley Brook.

Thames Tideway Tunnel ground investigation data

F.1.20 This section summarises the ground investigation undertaken by the Thames Tideway Tunnel project.

F.1.21 Boreholes were drilled at the Barn Elms site and within the immediate vicinity as part of the project-wide ground investigation, shown on Vol 6 Figure F.1.2 (see separate volume of figures).

F.1.22 Vol 6 Figure F.1.2 (see separate volume of figures) also identifies a number of other boreholes excavated in vicinity of the site, these are not considered relevant to the contamination status of the site, either due to their distance from the proposed shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination testing

F.1.23 Soil contamination testing of three samples of Made Ground and four samples of River Terrace Deposits (RTD) at four locations (borehole

SA1115, PR1113, SR1116 and SR1114). The testing comprised a variety of common contaminants including heavy metals PAHs, and TPH.

F.1.24 The results have been compared against human health screening values (Defra/Environment Agency, 2009)[3], (Land Quality Management/Chartered Institute of Environmental Health, 2009)[4] and show no exceedances of light industrial/commercial land use or the more stringent domestic gardens land use.

F.1.25 See Volume 2 Environmental assessment methodology for full guidance on the criteria used.

Soil gas testing

F.1.26 Four rounds of gas monitoring were undertaken within borehole SA1115 (which had a response zone in the RTD). The monitoring recorded maximum percentage volume of methane at <0.1%, maximum percentage volume of carbon dioxide at 4.3% (recorded on one occasion) and lowest recorded percentage volume of oxygen at 15.0%.

F.1.27 Gas monitoring installations in boreholes PR1113 and SR1114 were all screened below the groundwater level. Groundwater remained above the response zones so no soil gas testing results were available for wells screened above or across the water level at these positions.

F.1.28 No soil gas testing results were available for borehole SR1116.

Groundwater contamination data

F.1.29 Samples of groundwater were taken from the River Terrace Deposits within borehole (SA1115). The samples showed only relatively minor exceedances of nitrates when compared with screening values detailed within the Water Supply (Water Quality) Regulations (2000). No other elevated determinands were recorded. Refer to Section 13 Water resources – groundwater of this volume for further information.

Third party ground investigation data

F.1.30 No third party ground investigation data was available to review for the Barn Elms site.

Other environmental records

F.1.31 Details of environmental records (hazard and waste sites) in the vicinity of the site held by the Environment Agency (EA) and other bodies have been obtained from the Landmark Information Group and are presented in Vol 6 Table F.4.

F.1.32 The location of these records is shown on Vol 6 Figure F.1.3 (see separate volume of figures).

Vol 6 Table F.4 Land quality - hazard and waste sites

Item	On-site	Within 250m of site boundary
Active integrated pollution prevention and control	0	0

Item	On-site	Within 250m of site boundary
Control of major accident hazard sites	0	0
Historical landfill site	0	0
LA pollution prevention and control	0	0
Licensed waste management facility	0	0
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	0	There are areas present within 250m classified as past potential contaminated industrial uses.
Pollution incident to controlled water*	0	1
Registered waste transfer site	0	0
Registered waste treatment or disposal site	0	0

**Does not include regular CSO discharges*

F.1.33 Inspection of the data has identified no on-site hazard and waste sites at the Barn Elms site.

F.1.34 Within 250m of the Barn Elms site there are a small number of areas recorded as being of past potential contaminating industrial use. The closest to the site being located to the south and could be attributed to the former yard and Wandsworth Borough Council Depot, as shown on Vol 6 Figure F.1.1 (see separate volume of figures). Contaminants associated with these types of previous land-use are identified in Vol 6 Table F.2.

Land quality data from local authority

F.1.35 As part of the consultation process, both London Borough (LB) Richmond upon Thames and LB of Wandsworth were contacted. However, the LB Richmond upon Thames held no geo-environmental site investigation reports either on or adjacent to the Barn Elms site.

F.1.36 LB Wandsworth searches concluded that it is unlikely that there is an issue of any major land contamination within the area of concern, although there may be minor very localised areas impacted by contaminants in the site of the old council depot (located approximately 30m southeast from the proposed Thames Tideway Tunnel construction area).

F.1.37 A number of high explosive bombs are recorded to have fallen to the south of the area during the Second World War, including a V1 rocket at the junction of the Beverley Brook and the River Thames.

F.1.38 No other information from intrusive surveys at the site was provided by the council. The response from the council is provided in full in Section F.2.

Summary of contamination sources

F.1.39 Following the review of the baseline data, the following sources of on-site contamination are limited to the potential for UXO.

F.1.40 The site and immediate surrounding area do not appear to have been subject to potentially substantial contaminative historical or current land-uses. The site is currently used as a sports field.

F.1.41 The only feature previously identified on-site (at the drop shaft location) was an unspecified tank and two small rectangular structures in the 1950s. These structures are believed to be stables/outbuildings and the tank, an above ground water storage facility associated with the stables, and may therefore be discounted as potential contamination sources.

F.1.42 A cover of Made Ground has been recorded. Whilst Made Ground can contain elevated concentrations of contaminants, this is highly dependent upon its composition and source. The Made Ground encountered in boreholes at the Barn Elms site was described as a clay soils with no visual or olfactory evidence of contamination (eg hydrocarbon odours). In addition, laboratory testing of samples of the Made Ground (and underlying River Terrace Deposits) has recorded the soils to be essentially uncontaminated.

F.2 Local authority consultation

WANDSWORTH COUNCIL
Technical Services Department
Environmental Services & Community Safety Division
PO Box 47095
London SW18 9AQ

Please ask for/reply to: Roy Fox
Telephone: 020 8871 7874
Fax: 020 8871 7661
Email:rfox@wandsworth.gov.uk
Minicom: 020 8871 8403

Our Ref: SR155945
Your ref:
Date: 09 May 2011

Lorna Brooks
Mott MacDonald Ltd
8-10 Sydenham Road
Croydon, CR0 2EE

Dear Ms Brooks

Re: Barn Elms site, London, SW15

I refer to your e-mail enquiry regarding the potential for land contamination at the above site. In order to respond to you I have examined our environmental data for the area, including historical mapping, aerial photographs, geological, hydrogeological and other environmental data, our premises database, the London Fire Brigade petroleum records and the Planning Register. The following points summarise our information relating to the site.

- The 1868 OS mapping shows the area to consist of park land where the current sports pitches are located. Farms were adjoining to the north and acoss the Beverley Brook to the south. A large fish pond was located in the north western part of the search area.
- The 1896 OS mapping shows some streets of terraced housing to have been laid out to the south and southeast of the area of concern. A small Council Depot is in place alongside the borough boundary, which follows the Beverley Brook, at the junction with the River Thames. A laundry is sited in the south, centered at grid reference 523342, 176061. The sports fields are a golf course at this time.
- By the 1916 mapping most of the area to the south is laid out as per the current residential pattern of streets. Boat houses are in place along the River Thames. The Council depot and small laundry are still in operation. Putney Hospital has been constructed to the south west of the area. An additional fish pond is located in the western part of the area, close to the earlier pond. A large, unspecified 'tank' is located at 523364, 176181, unassociated with any structures.
- Changes from the previous map epoch that are shown on the 1930s mapping is a factory making deodorant toilet blocks situated to the east of the laundry (523427, 176065). Adjacent to the factory is a garage possibly for parking and/or repairs. The laundry had an underground petroleum tank installed in 1923. It was solid filled with concrete at a later date unknown to us. The fish pond in the south west has been extended in a long narrow strip following the Beverley Brook eastwards. The Council depot has a travelling crane along the

creek, suggesting that it was used for the receipt of bulk materials, such as stone and building materials.

- The 1947 mapping shows the site of the laundry to have been enlarged. The factory (at 38 Danemere Street) is now being used to manufacture exhibition stands. The isolated tank is still shown. The Council yard is still in operation. No significant changes to this layout occurred until the redevelopment of the factory site to residential use in 1993 – to the area known as 'Waters Place'. The factory site had an underground petrol storage tank installed in 1954, used until 1962 when it was decommissioned by filling with water. The laundry was redeveloped to residential use in 2003, with land conditions (minor localized contamination) managed by RSK ENSR Ltd. It is unlikely that this would have affected land to the north of the Beverley Brook. It is not known when the fishponds were infilled or with what materials.
- The land in the area has alluvium as superficial deposits overlying a London Clay solid geology. The alluvium is classified as a minor aquifer but no abstractions are taken from it.
- Our premises database does not contain any events that may indicate that there is polluted land at the site, such as discoloration of soils or malodours.
- A number of high explosive bombs are recorded to have fallen to the south of the area during the Second World War, including a V1 rocket at approximately the junction of the Beverley Brook and the River Thames.

Based on the information within our possession we conclude that it is unlikely that there is an issue of any significant land contamination within the area of concern although there may be minor very localized areas impacted by contaminants in the site of the old Council depot.

I trust that this information is useful to you. If you would like to discuss any matter raised in this letter, please do not hesitate to contact me. I acknowledge the payment of the fee payable for carrying out this search. A receipt for the payment is being sent to you by our administration team (including five other search areas).

Yours sincerely,

R G Fox
Area Environmental Health Officer
Environmental Services and Community Safety Division

F.3 Detailed Unexploded Ordnance (UXO) risk assessment

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PRD2X – Barn Elms
Document Number: 336-RG-TPI-PRD2X-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R10_V1.0
Date: 12th June 2012

Originator: Max Chainey (29th May 2012)
Quality Review: Lisa Askham (8th June 2012)
Released by: Lee Gooderham (12th June 2012)

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EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as Work Area PRD2X, located at National Grid Reference "523200, 176400". For the purposes of this report, the Site has been divided into **AREA A** (Main Work Area) and **AREA B** (Secondary Work Area).
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • **AREA A** is situated on what was predominantly an undeveloped "recreational ground" that was in use during World War Two (WWII). **AREA B** overlaps *Rock's Lane.* Both **AREA A and B** would have had a moderate to high footfall given that they were regularly in use. • Numerous WWII bombing targets have been identified on and around **AREA A and B**, including "water works", a "pumping station", "works", railway infrastructure and "wharves". • The areas are located between the *Barnes Metropolitan Borough* and *Wandsworth Metropolitan Borough*, which experienced a bombing density of 87 High Explosive (HE) bombs and 160 HE bombs per 1,000 acres respectively. • No HE bomb strikes occurred within the boundary of **AREA A or B**. Three bomb strikes were recorded within 100m of the buffered Site boundary. • Bomb damage was not recorded within **AREA A or B**, however there were no structures present to evidence damage. • Given the lack of development that has occurred within **AREA A and B**, it is unlikely that previous works would have removed Unexploded Ordnance (UXO) items. However, it is also likely that any UXO that fell in either area would have been observed, reported and made safe during WWII. The risk assessment and risk mitigation outlined below are based on the indicative engineering drawings and proposed works provided by *Thames Water*, and therefore it should be noted that any changes to the engineering drawings or proposed works may affect the risk assessment.
Potential Threat Source	The threat is predominately posed primarily by WWII *German* HE bombs, with a secondary threat from Incendiary Bombs (IBs) and *British* Anti-Aircraft Artillery (AAA) projectiles.
Risk Pathway	Given the type of munitions that might be present on Site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.
Risk Level	**AREA A** **LOW/MEDIUM** | **AREA B** **LOW/MEDIUM**
Recommended Risk Mitigation	**The following actions are recommended before undertaking any activity on the Study Site:** **BOTH AREAS** **1. Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site to plan for and guide upon the actions to be carried out in the event of a suspected or real UXO discovery. **2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement.

ASSESSMENT METHODOLOGY	
Approach	6 Alpha Associates are independent, specialist risk management consultants and the UXO related risk on the Site has been assessed using the process advocated by both the *Construction Industry Research & Information Association* (CIRIA) best practice guide (C681) and by the *Health & Safety Executive* (HSE). Therefore, any risk levels identified in the assessments are objective, quantifiable and not simply designed to generate "follow on survey or contracting work"; any mitigation solution is recommended *only* because it delivers the Client a risk reduced to As Low As Reasonably Practicable (ALARP) at best value. Potential UXO hazards have been identified through investigation of Local and National archives covering the Site, *Ministry of Defence* (MoD) archives, local historical sources, historical mapping as well as contemporaneous aerial photography (as and if, it is available). Potential hazards have only been recorded if there is specific information that could reasonably place them within the boundaries of the Site. Key source material is referenced within this document, whilst data of lesser relevance (which may have been properly considered and discounted by 6 Alpha), is available upon request. The assessment of UXO risk is a measure of ***probability*** *of encounter* and ***consequence*** *of encounter*; the former being a function of the identified hazard and proposed development methodology; the latter being a function of the type of hazard and the proximity of personnel (and/or other "sensitive receptors"), to the hazard at the moment of encounter. Should a measurable UXO risk be identified, the methods of mitigation recommended are reasonably and sufficiently robust to reduce these to As Low As Reasonably Practicable (ALARP). We believe that the adoption of the legal ALARP principle is a key factor in efficiently and effectively ameliorating UXO risks. It also provides a ready means for assessing the Client's tolerability of UXO risk. In essence the principle states that if the cost of reducing a risk significantly outweighs the benefit, then the risk may be considered tolerable. Clearly this does not mean that there is no requirement for UXO risk mitigation, but any mitigation must demonstrate that it is beneficial. Any additional mitigation that delivers diminishing benefits **and** that consume disproportionate time, money and effort are considered *de minimis* and thus unnecessary. Because of this principle unexploded bomb (UXB) risks will rarely be reduced to zero (nor need they be).
Important Notes	Although this report is up to date and accurate, our databases are continually being populated as and when additional information becomes available. Nonetheless, 6 Alpha have exercised all reasonable care, skill and due diligence in providing this service and producing this report. The assessment levels are based upon our professional opinion and have been supported by our interpretation of historical records and third party data sources. Wherever possible, 6 Alpha has sought to corroborate and to verify the accuracy of all data we have employed, but we are not accountable for any inherent errors that may be contained in third party data sets (e.g. National Archive or other library sources), and over which 6 Alpha can exercise no control. The intention of this report is to provide the Client with a concise summary of the risks posed to the site investigation and construction works. The background risk has been established in a Threat & Preliminary Risk Assessment Report that will be provided separately. Whilst this document may be used in isolation, an overarching report is available that outlines the procedures, details and methodologies used to assess the UXO risk to this project.

STAGE ONE – SITE LOCATION AND DESCRIPTION

Study Site	The Client has specified the Study Site as Work Area PRD2X. The Site is located at National Grid Reference 523200, 176400. For the purposes of this study, a 50m assessment radius will be applied to the work area to provide flexibility should it need to be relocated. Additionally, the Site has been divided into **AREAS A and B** for the purpose of this report. See *Figures 1* and *2* for the Site location and area divisions.
Location Description ***(Figure 3)***	The Work Area is situated to the southwest of the *City of London* between *Barnes Metropolitan Borough* and *Wandsworth Metropolitan Borough*. Current aerial photography has identified the following within each area: **AREA A:** Predominantly "recreation ground" with "hard-standing" and structures to the north. **AREA B:** A small area of a public highway identified as *Rock's Lane*.
Proposed Engineering Works	*Thames Water* have specified a summary of the proposed engineering works including working draft plans with drawing no's. 100-DA-CNS-PRD2X-244105_AJ; 100-DA-CNS-PRD2X-244106_AG; and 100-DA-CVL-PRD2X-344020_AH. These works have been divided between **AREAS A and B**, however where not explicitly stated, 6 Alpha has made an assumption of which area the work will be carried out. **Area A** • Construction of a 6m internal diameter shaft, approximately 40m deep. • Construction of a permanent hard standing area to facilitate operational use with a permanent vehicle access to the north via the existing boat house access road. • A connection culvert linking the existing Combined Sewer Overflow (CSO) sewer to the CSO shaft. • A 2.2m diameter connection tunnel to convey flows from the CSO shaft to the main Thames Tunnel. • Valve and filter chambers. • Installation, maintenance and removal of a suitable temporary construction working area to facilitate the construction of the above. The construction site will include storage areas for shaft and connection tunnel lining materials, material handling facilities, grout batching and silo facilities, stockyard and spares storage facilities. The site will also contain a power supply for the operation and an area for vehicle parking. The main construction area would be located in the south of the site in the area adjacent to *Beverly Brook*. The site would require the formation of a temporary vehicle access route west along the *Beverly Brook* alignment across the playing fields to *Rocks Lane*. Temporary overhead crane facilities would be required during construction.
Ground Conditions	Thames Water have indicated the following ground conditions for the Work Areas as:

Site Geology	Depth Below Ground Level (m)	Thickness (m)
Made Ground	0.00	2.00
Alluvium	2.00	7.00
London Clay	9.00	Not proven

It is important to establish the ground conditions within this report to determine both the maximum bomb penetration depth (BPD) and the potential for other types of munitions to be buried on this Site.

STAGE TWO – REVIEW OF HISTORICAL DATASETS	
Sources of Information Consulted	The following primary information sources have been used in order to establish the background UXO threat: 1. Home Office WWII Bomb Census Maps; 2. WWII & post-WWII Aerial Photography; 3. Official Abandoned Bomb Register; 4. National Archives in Kew; 5. Internet based research; 6. Historic UXO information provided by 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.
Site History and Use	According to the County Series (CS) & Ordnance Survey (OS) historical mapping, the following site history can be recorded immediately prior to and post-WWII: **1938 CS mapping** **AREA A** is located on "recreation ground" labelled as a "golf course" and "polo ground", with "stables" located to the north of the Site. **AREA B** is located on *Rock's Lane.* **1948 OS mapping** No noticeable or significant changes have occurred within the areas.
1945 Aerial Photography ***(Figure 4)***	**AREA A and B:** The 1945 aerial photography confirms the landscape of the Work Area, however it is not possible to infer what damage may have occurred on the Site given the lack of structures present within the area.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	**AREA A:** *West Middlesex Water Works* is adjacent to this area and was a primary *Luftwaffe* bombing target. **BOTH AREAS:** *Hammersmith Pumping Station and Reservoir* located 900m to the north of the areas was also a primary bombing target. "Opportunistic" targets include a "petroleum wharf", "works", a "factory", *Barnes Station* and railway infrastructure all within 1,000m of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate the following: **AREA A:** No bomb strikes. **AREA B:** No bomb strikes. No bomb strikes occurred within the buffered boundary, however three HE bomb strikes were recorded within 100m of the buffered boundary. Furthermore, a V1 landed 150m to the southwest of **AREA A**.
WWII Bomb Damage ***(Figure 7)***	*London County Council (LCC)* bomb damage maps indicate the following: **AREA A:** No bomb damage. **AREA B:** No bomb damage. No bomb damage was recorded within the buffered Site boundary. Bomb damage was typically only recorded for building structures and not for damage sustained by "land" features. This may explain the lack of damage recorded within and around **AREA A**, as no significant building structures are present.
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located between the *Barnes Metropolitan Borough* and *Wandsworth Metropolitan Borough,* which recorded 87 HE bombs and 160 HE bombs per 1,000 acres respectively. This figure does not include incendiary devices, as they were often released in such large numbers that they were seldom recorded.
Abandoned Bombs	The Official Abandoned Bomb Register records one 50kg HE bomb and one 500kg HE bomb, located approximately 800m to the northeast and 700m to the east of the buffered Site boundary respectively. Additionally, one abandoned HE bomb of unknown size is located 900m to the north of the Site.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	**AREA A:** Yes; the area was predominantly "recreational ground" used for various sports. **AREA B:** No; the area was situated on made ground on a "public highway".
Is there a reason to suspect that the immediate area was a bombing target during WWII?	**AREA A:** Yes; this area lies immediately adjacent to *West Middlesex Water Works*, which was a primary bombing target. **BOTH AREAS:** Yes; there are numerous bombing targets within and around the buffered Site boundary, including many industrial areas, "works", numerous "wharves" and railway infrastructure.
Is there firm evidence that ordnance landed on Site?	**AREA A:** No. **AREA B:** No; given that the area is located on *Rock's Lane* it is very likely any ordnance landing at this location would have been evidenced.
Is there evidence of damage sustained on Site?	**AREA A:** No; this area was predominantly undeveloped "recreational ground", and damage to landscape was not recorded on the *LCC* bomb damage maps. **AREA B:** No; damage to public highways was not recorded on the *LCC* bomb damage maps.
Is there any reason to suspect that military training may have occurred at this location?	**BOTH AREAS:** No; there is no evidence to suggest that military training occurred within either of the areas.
Would an UXB entry hole have been observed and reported during WWII?	**AREA A:** Likely; the area covers "recreational ground" for various sports including golf, polo and tennis, thus providing a moderate footfall to this open area. As *Barnes Metropolitan Borough* experienced a relatively low bomb density for *London*, it is likely that an UXO entry hole would have been observed and reported. **AREA B:** Yes; the land was fully developed for a "public highway" and an UXB entry hole would have been witnessed.
What is the expected UXO contamination?	**BOTH AREAS:** The most likely source of UXO contamination is from *German* aerial delivered ordnance, which ranges from small incendiary bombs through to large HE bombs (of which the latter forms the principal threat).
Would previous earthworks have removed the potential for UXO to be present?	**AREA A:** Unlikely; the area remains "recreational ground" for a school, and has not been developed in any significant way. The structures in the north of the area have remained, however the made ground appears to have been created post-WWII at this location. **AREA B:** No; no significant earthworks have occurred at this location.

STAGE FOUR – RISK ASSESSMENT		
Threat Items	The threat is predominately posed by WWII *German* HE bombs and IBs. Additionally, *British* AAA projectiles may also be present. However, AAA does not have the potential for deep burial, and thus is unlikely to be encountered at depths greater than 1m bgl.	
Maximum Penetration	Considering the general ground conditions (highlighted in Stage 1) within **AREA A**, the most likely Bomb Penetration Depth (BPD) for a 250kg bomb is assessed to be a maximum of 8m bgl. As the boundary of **AREA B** overlaps with a public highway, the BPD will likely be reduced due to the made ground. Whilst the *Luftwaffe* used larger bombs, their deployment was so few and only used against notable targets, to use them within this risk assessment would not be justified. Additionally, smaller items such as *German* IBs and *British* AAA projectiles would have a significantly reduced penetration capability and would not be expected to be encountered at depths greater than 1m.	
Risk Pathway	Intrusive engineering activities are likely to be in the form of excavations. Although for the purposes of this report 6 Alpha will use a range of generic construction activities for the risk assessment.	
Consequence	**Potential consequences of UXO initiation**	1. Kill and/or critically injure personnel 2. Severe damage to plant and equipment 3. Blast damage to nearby buildings 4. Rupture and damage underground services
	Potential consequences of UXO discovery	1. Delay the project 2. Disruption to local community/infrastructure 3. Incurring of additional costs
Site Activities	A number of construction methodologies have been identified for analysis on this Site. There is a large amount of variation in the probability of encountering, or initiating items of UXO when conducting different activities on Site. Additionally the consequences of initiating UXO vary greatly depending on how the item of UXO was initiated on Site.	

STAGE FOUR – RISK ASSESSMENT (…continued)

UXO RISK CALCULATION TABLE

Risk Rating Calculation	6 Alpha's Semi-Quantitative Risk Assessment identifies the Risk Rating posed by the most probable threat items when conducting a number of different construction activities on the Site. Risk Rating is determined by calculating the probability of encountering UXO and the consequences of initiating it.

Activity	AREA A		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	1x1=1	3x2=6	1x6=6
Tunnelling	1x2=2	1x1=1	2x1=2
Shaft Installation	1x2=2	1x2=2	2x2=4
Open Excavations	1x2=2	2x2=4	2x4=8

Activity	AREA B		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	1x1=1	3x2=6	1x6=6

Abbreviations – Site History (SH), Engineering Methodology (EM), Probability (P), Depth (D), Consequence (C), Proximity to Sensitive Receptors (PSR) and Risk Rating (RR).

STAGE FIVE – RECOMMENDED RISK MITIGATION MEASURES WITH RESULTING RISK RATING	
If a geophysical survey is required are the ground conditions an issue?	**Non-Intrusive Methods of Mitigation** – The suitability for an effective non-intrusive method of mitigation is largely dependent on the depth (2m for this Site) and composition of made ground, as any magnetometer results are highly likely to be affected by ferro-magnetic contamination due to previous construction activities within the Study Site location. **Intrusive Methods of Mitigation** – Intrusive magnetometry is expected to be possible on this Site, however deep excavation of made ground is required prior to the use of this methodology. It should be noted that ferro-contamination of any made ground/fill material, particularly at the fill layer, is likely to adversely affect detection capability of the equipment.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'		
Activity	**Risk Mitigation Measures**	**Final Risk Rating**
ALL AREAS	**The following actions are recommended before undertaking any activity on the Study Site:** 1. **Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site to plan for and guide upon the actions to be carried out in the event of a suspected or real UXO discovery. 2. **UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a general briefing on the identification of UXB, what actions they should take to keep people and equipment away from the hazard and to alert site management.	ALARP
This assessment has been conducted based on the information provided by the Client, should the proposed works change then 6 Alpha should be re-engaged to refine this risk assessment.		

Report Figures

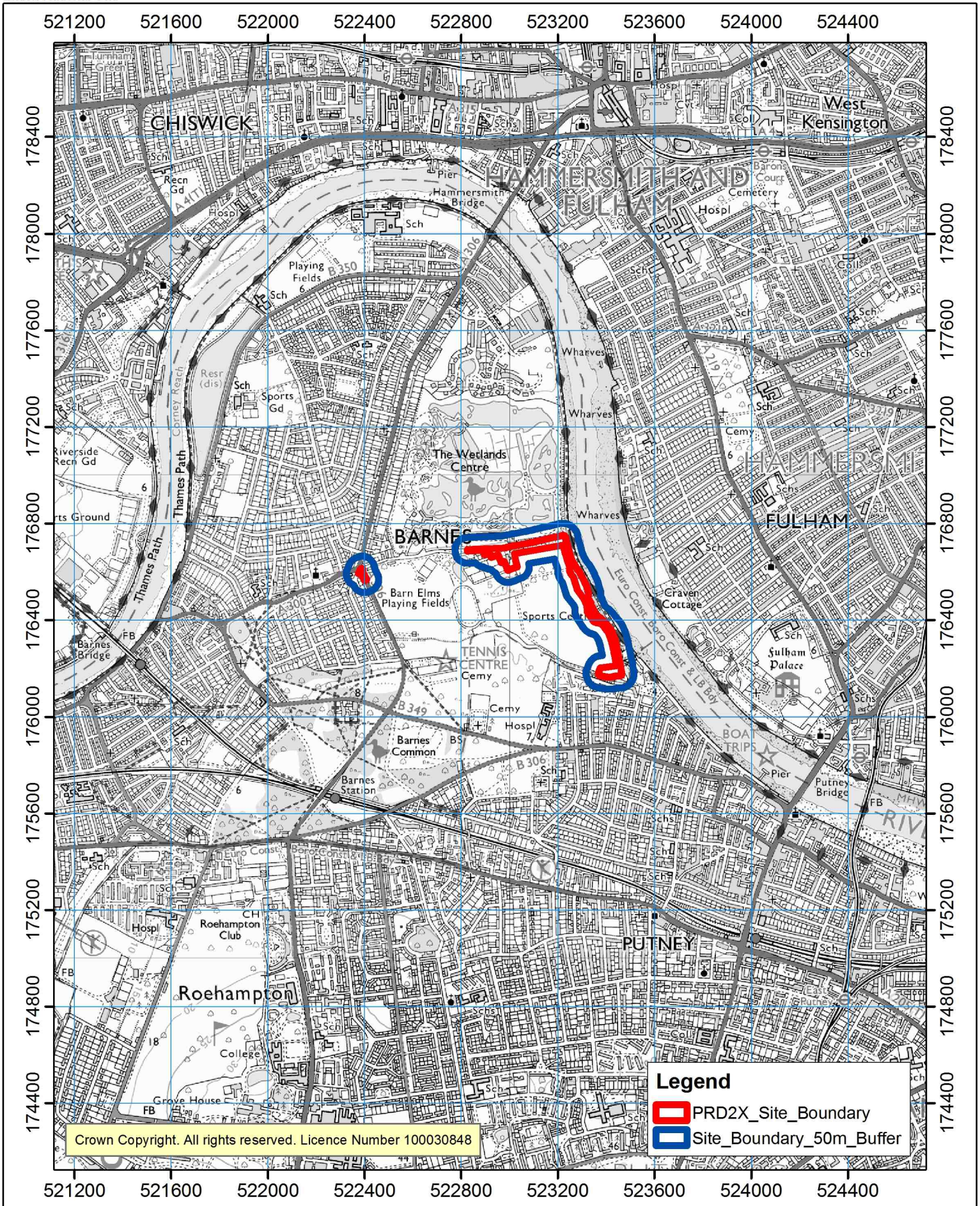
Figure One

Site Location

Thames Tideway Tunnel - Work Area PRD2X
Site Location

Figure 1

British National Grid



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0203 371 3900

0 100 200 400 600 800 1,000 Meters

N

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Drawn By: Dominique René
Checked by: Lee Gooderham
Date: 17th May 2012

Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PRD2X Site Boundary

Figure 2

British National Grid

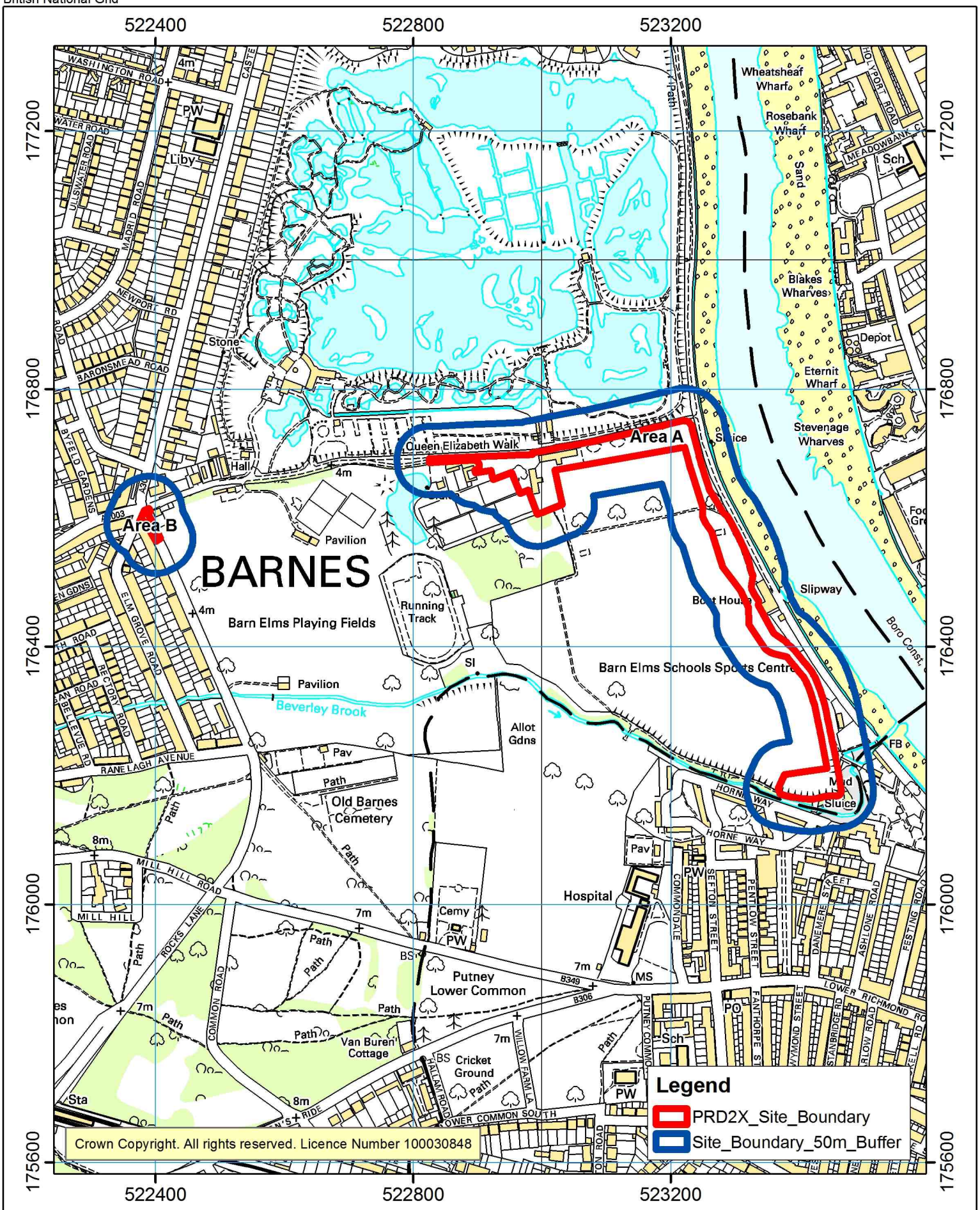

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Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PRD2X
Current Aerial Photography

Figure 3

British National Grid

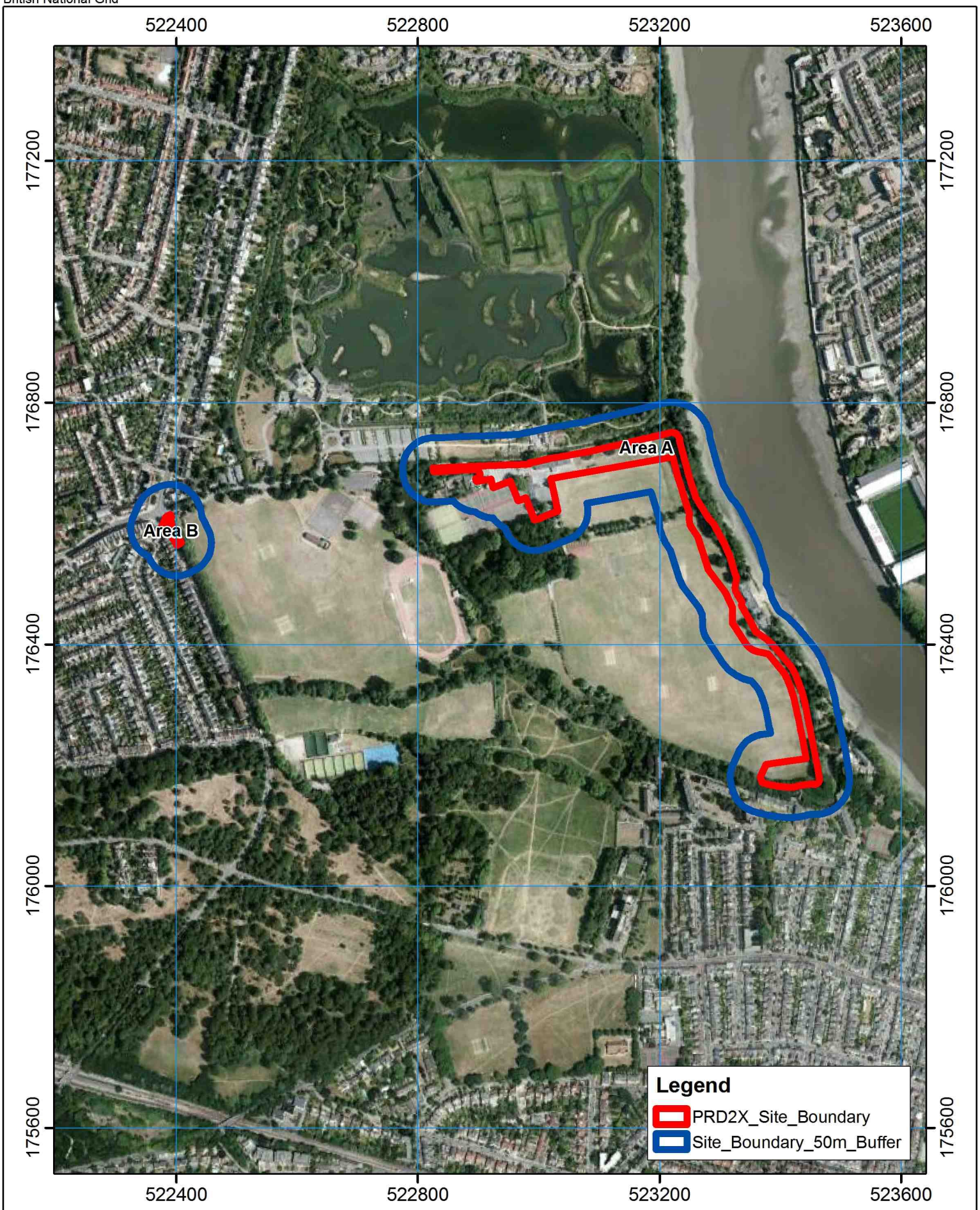

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PRD2X
1945 Aerial Photography

Figure 4

British National Grid

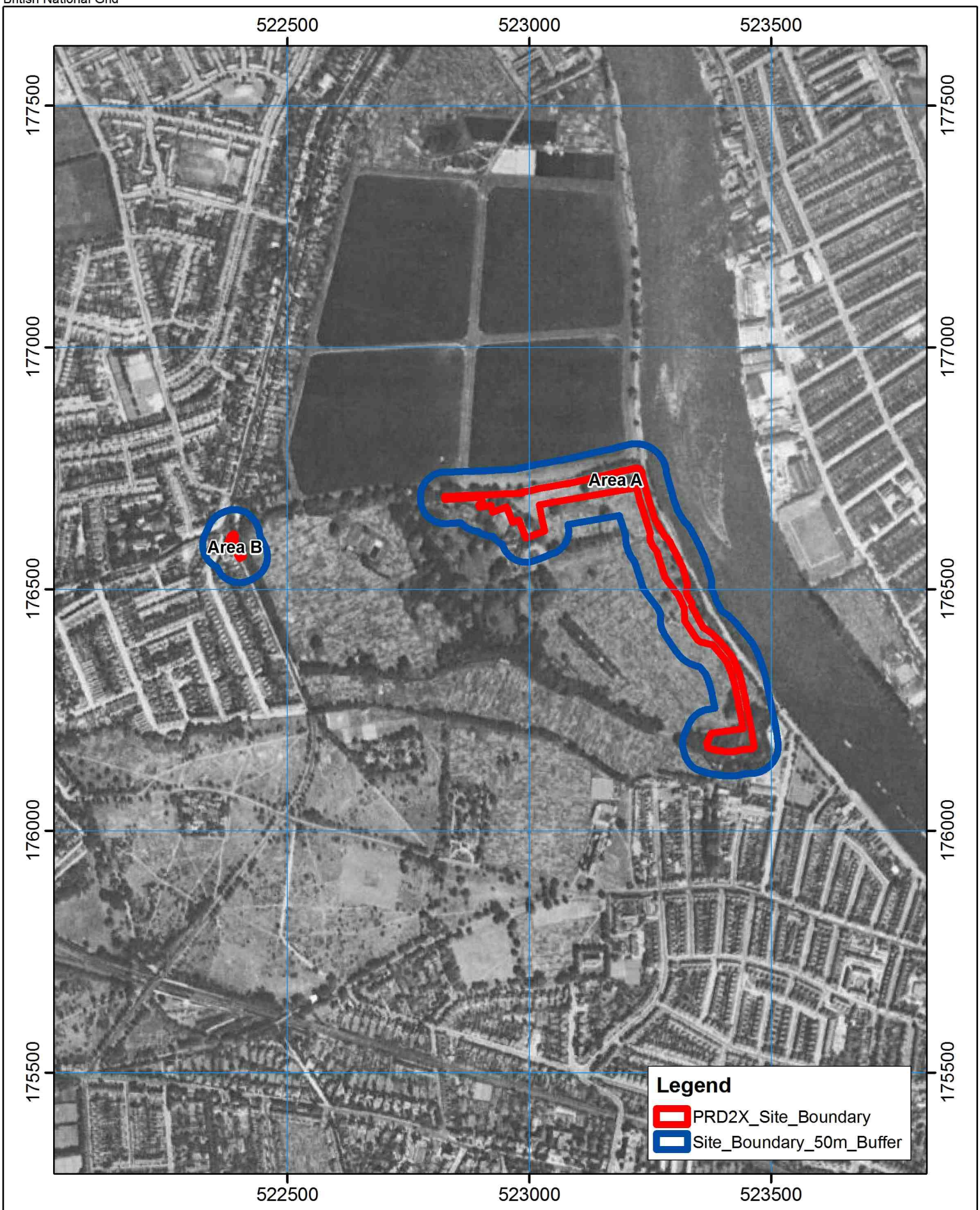

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Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PRD2X
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid

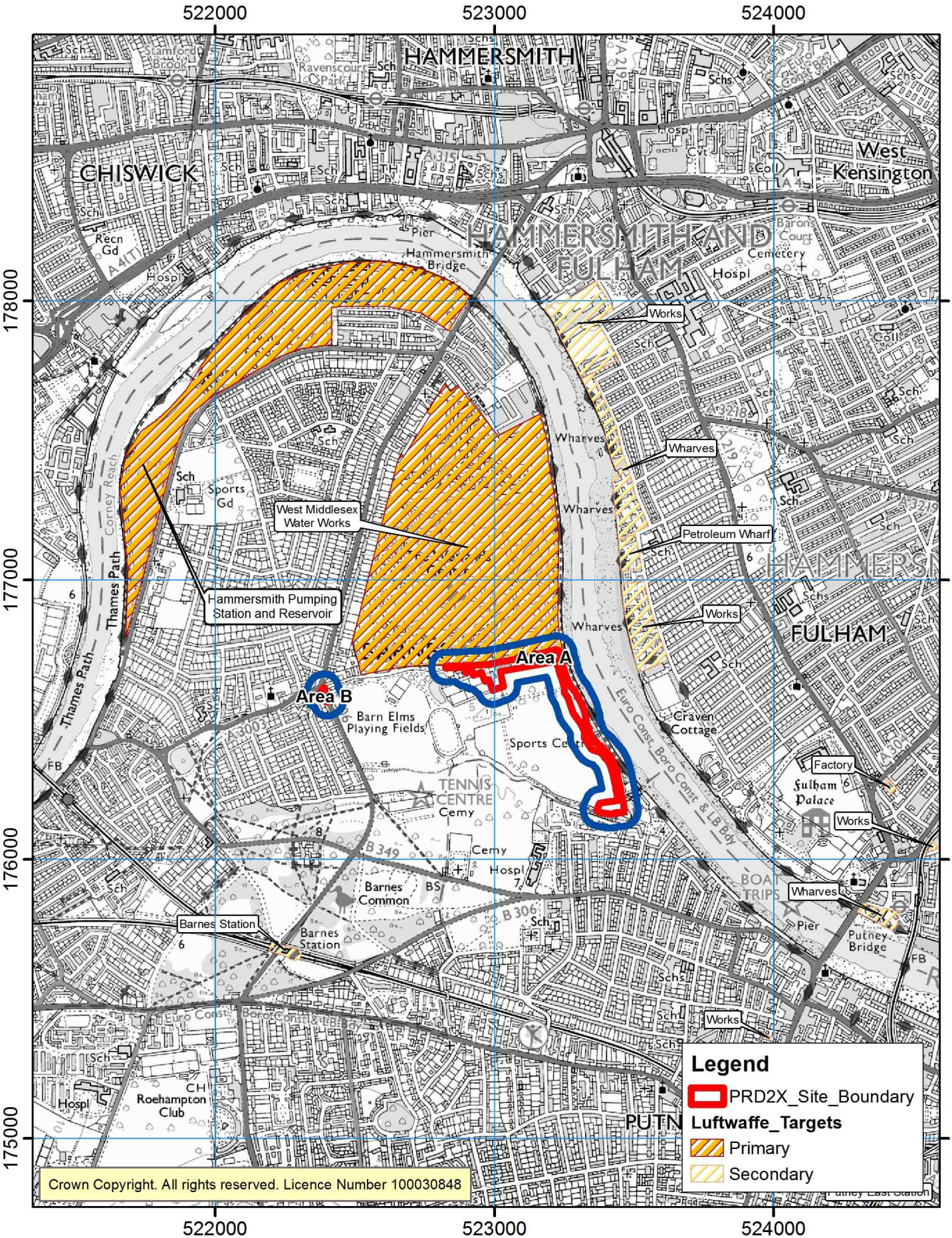

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Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PRD2X
WWII High Explosive Bomb Strikes

Figure 6

British National Grid

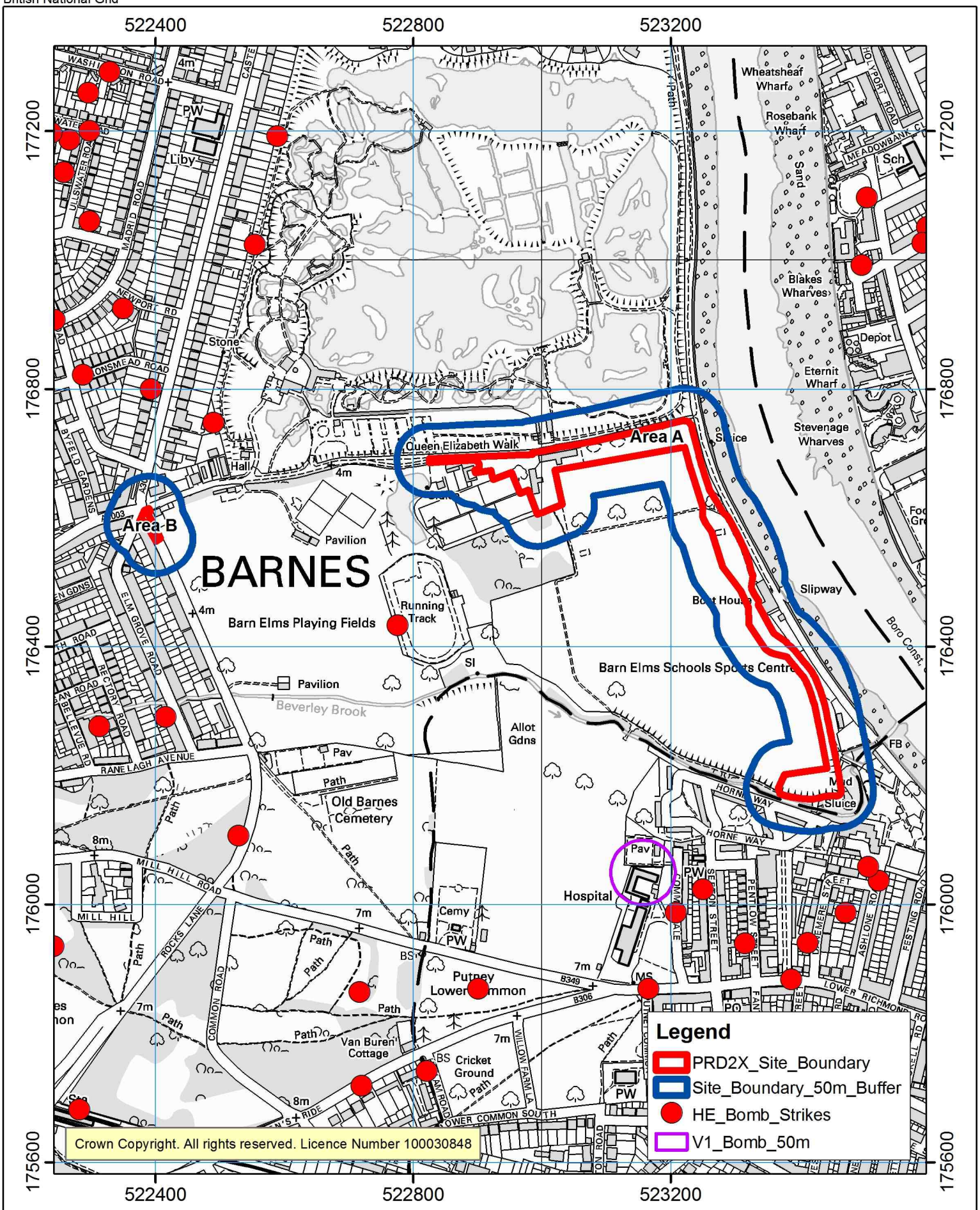

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Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PRD2X
London County Council Bomb Damage Map

Figure 7

British National Grid

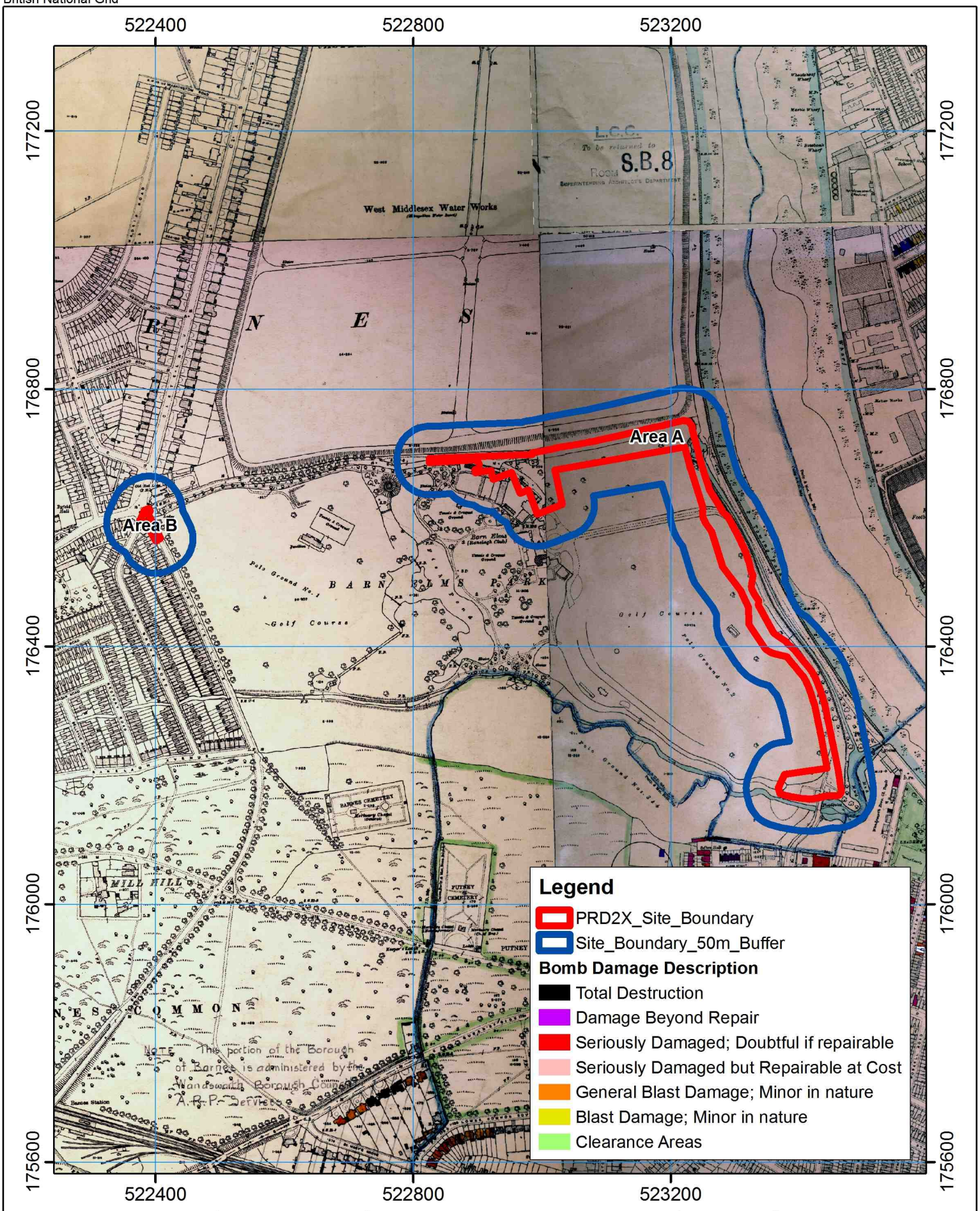

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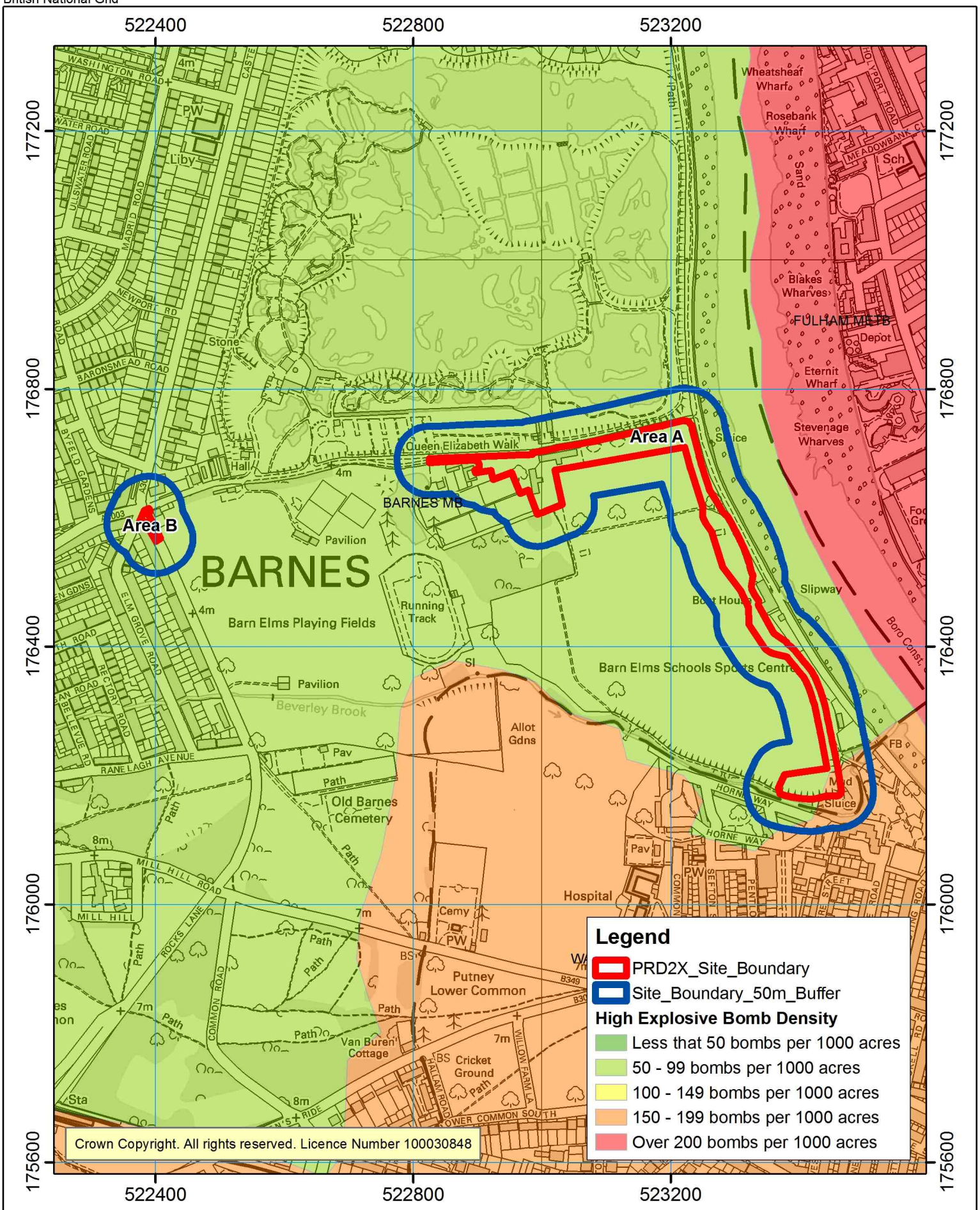
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PRD2X
WWII High Explosive Bomb Density

Figure 8

British National Grid



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References

[1] Department for the Environment, Food and Rural Affairs and The Environment Agency, *CLR8: Potential Contaminants for the assessment of land,* Environment Agency (2002).

[2] Department of the Environment. *Industry Profiles* (various). Available at: http://www.environment-agency.gov.uk/research/planning/33708.aspx. Accessed 25th March 2011.

[3] Defra/Environment Agency. *Soil Guideline Values* (2009).

[4] Land Quality Management/Chartered Institute of Environmental Health. *Generic Assessment Criteria for Human Health Risk Assessment*, 2nd Edition (2009).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix G: Noise and vibration

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel

Environmental Statement

Volume 6 Appendices: Barn Elms site assessment

Appendix G: Noise and vibration

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Appendix G: Noise and vibration

G.1 Baseline noise survey

Introduction

G.1.1 As described in Volume 2 Environmental assessment methodology Section 9, the purpose of the noise survey has been to determine representative ambient and background noise levels at a number of different types of noise sensitive receptor.

G.1.2 The nearest identified noise sensitive receptors to Barn Elms are the high rise residential buildings on Horne Way located south of the proposed development in the London Borough of Wandsworth, on the opposite side of Beverley Brook. Non-residential noise sensitive receptors that have been assessed include the Scout Hut located to the east of the site across the Beverley Brook, the Barn Elms Boathouse and the Barn Elms Schools Sports Centre.

Survey methodology

G.1.3 The London Boroughs of Richmond and Wandsworth have been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys.

G.1.4 A baseline noise survey was completed on 24th through 26th July, 2011. The baseline survey comprised short term attended measurements taken during the daytime, evening and night-time. Continuous unattended monitoring was also completed over a four day period (22nd-25th July, 2011) at one location.

G.1.5 Short term attended noise monitoring was completed at two locations. Measurements were undertaken during the interpeak periods of 10:00-12:00, 14:00-16:00, 20:00-22:00 and 00:00-04:00 on a typical weekday, and 14:00-18:00 and 00:00-04:00 on a typical weekend day, so that the baseline data is representative of the quieter periods where any disturbance from construction would be most noticeable.

G.1.6 Vol 6 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 6 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial number(s)	Laboratory calibration date
Attended baseline survey: 24th-26th July, 2011				
Hand-held analyser(s)	2250	Brüel & Kjær	2580156	30/05/2010
½ " microphone(s)	4950	Brüel & Kjær	2585972	30/05/2010
B&K sound calibrator(s)	4231	Brüel & Kjær	2619375	12/01/2011*
Continuous unattended monitoring: 22nd - 25th July, 2011				
Hand-held analyser(s)	2250	Brüel & Kjær	2590440 2626210	15/03/2011 20/12/2010
½ " microphone(s)	4189 4950	Brüel & Kjær Brüel & Kjær	2589639 2621186	15/03/2011 20/12/2010
B&K sound calibrator(s)	4231	Brüel & Kjær	2445811	14/10/2010*

** Hand-held analyser(s), ½ " microphone(s) and calibrator(s) valid for one year from the date listed*

G.1.7 Prior to and on completion of the surveys, the sound level meters and microphone calibration was checked using a Brüel and Kjær sound level meter calibrator. On-site calibration checks were performed before and after all measurements with no significant deviation being observed. The sound level meters and calibrators have valid laboratory calibration certificates.

G.1.8 For the attended measurements, the sound level meters were tripod-mounted with the microphone approximately 1.3m above ground level. A windshield was fitted over the microphone at all times during the survey period to minimise the effects of any wind induced noise.

G.1.9 For the unattended measurements, the environmental cases used for the continuous data logging were locked to avoid any potential tampering. The microphones were tripod-mounted approximately 1.3m above ground level. Windshields with bird spikes were fitted over the microphones at all times during the survey period to minimise the effects of any wind induced noise, and also to prevent birds from perching on the equipment.

G.1.10 The prevailing weather conditions observed during the attended baseline survey are described in Vol 6 Table G.2.

G.1.11 Contemporary weather data recorded at Heathrow Airport (EGLL) has been summarised in Vol 6 Table G.3. This is deemed to be representative of the prevailing weather conditions for the continuous unattended monitoring kit.

Vol 6 Table G.2 Noise – weather conditions during baseline noise surveys

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Baseline survey – 24th July, 2011 (daytime, 14:00-18:00)				
Maximum: 1.9-2.9 Average: 0.3-0.9	NW; W	21-26	No	Warm, sunny, and dry
Baseline survey – 25th July, 2011 (night-time, 00:00-04:00)				
Maximum: 0-1.4 Average: 0-0.8	NW; W	12-15	No	Scattered cloud, calm and dry
Baseline survey – 25th July, 2011 (evening, 20:00-22:00)				
Maximum: 1.0-1.8 Average: 0.3-0.6	ENE	20-21	No	Cloudy with sunny spells, dry and breezy
Baseline survey – 26th July, 2011 (night-time, 00:00-04:00)				
Maximum: 0.5-2.1 Average: 0.2-0.7	ENE; NE	16-18	No	Overcast, dry, light breeze
Baseline survey – 26th July, 2011 (daytime, 10:00-12:00)				
Maximum: 0.7-2.5 Average: 0.3-1.1	Variable	18-20	No	Overcast, dry, light breeze
Baseline survey – 26th July, 2011 (daytime, 14:00-16:00)				
Maximum: 0.7-2.2 Average: 0-0.8	Northerly	19-21	No	Overcast, dry, light breeze

Vol 6 Table G.3 Noise – contemporary weather data for Heathrow Airport

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation	Description
Friday 22nd July, 2011 (15:00 onwards)[1]				
1.6-3.6	N; NE	16-20	No	Cloudy, dry and breezy
Saturday 23rd July, 2011[2]				
1-5.7	Variable (Predominantly NW)	11-19	Yes (Light rain at midnight and again at 6AM)	Cloudy and dry for majority of day, breezy
Sunday 24th July, 2011[3]				
2-5.1	Variable (Predominantly W and WNW)	10-23	No	Mainly clear, dry and breezy
Monday 25th July, 2011(until 14:00)[4]				
2.6-4.6	Variable (Predominantly W; WNW and NW)	10-22	No	Cloudy dry and breezy

1 http://www.wunderground.com/history/airport/EGLL/2011/7/22/DailyHistory.html
2 http://www.wunderground.com/history/airport/EGLL/2011/7/23/DailyHistory.html
3 http://www.wunderground.com/history/airport/EGLL/2011/7/24/DailyHistory.html
4 http://www.wunderground.com/history/airport/EGLL/2011/7/25/DailyHistory.html

Measurement locations

G.1.12 Vol 6 Table G.4 details the measurement locations which are also presented in Vol 6 Figure G.1 (see separate volume of figures), and shown in Vol 6 Plate G.1 to Vol 6 Plate G.3.

Vol 6 Table G.4 Noise – measurement locations

Measurement location number	Description	Co-ordinates	
		X	Y
BEL01	On public footpath along Embankment, in front of Sea Cadet Corps HQ	523535	176244
BEL02	On public footpath adjacent to Horne Way, in front of Huntingford House	523271	176175
BEL03	On private grassland opposite Wandsworth Boat House	523337	176460

Results

G.1.13 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 6 Table G.5 to Vol 6 Table G.8.

G.1.14 A review has been undertaken of the unattended measurements, which confirms that the attended measurements were undertaken over periods with typical ambient and background noise levels.

Vol 6 Table G.5 Noise – sampled noise survey results BEL01

Location Detail: BEL01, on public footpath along Embankment, in front of Sea Cadet Corps HQ						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	84	56	53-62	60	63*	65
Evening (20.00-22.00)	80	47	50-51	50	53*	55
Night (00.00-04.00)	77	40	42-48	46	49*	50
Weekend day (14.00-18.00)	82	58	60-62	61	64*	65
Weekend night (00.00-04.00)	71	40	41-43	42	45*	45

** An approximation of the averaged ambient façade noise level has been obtained by adding 3dB to the calculated averaged ambient free-field level*

Vol 6 Table G.6 Noise – sampled noise survey results BEL02

Location Detail: BEL02, on public footpath adjacent to Horne Way, in front of Huntingford House						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	80	50	46-59	57	60*	60
Evening (20.00-22.00)	74	42	44-46	45	48*	50
Night (00.00-04.00)	71	33	32-42	38	41*	40
Weekend day (14.00-18.00)	75	56	55-60	58	61*	60
Weekend night (00.00-04.00)	52	37	36-41	38	41*	40

** An approximation of the averaged ambient façade noise level has been obtained by adding 3dB to the calculated averaged ambient free-field level*

Vol 6 Table G.7 Noise – continuously logged noise survey results BEL03

Location Detail: BEL03, within Barn Elms playing fields opposite Wandsworth boat house							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Period noise level (dB(A) façade*)**		
		L_{AFmax}	**L_{A90}**	**L_{Aeq}**	**L_{AFmax}**	**L_{A90}**	**L_{Aeq}**
Weekday	07.00-08.00	75	44	57	78	47	60
	08.00-18.00	93	46	63	96	49	66
	18.00-19.00	76	42	58	79	45	61
	19.00-22.00	82	43	57	85	46	60
	22.00-07.00	79	31	53	82	34	56
Saturday	07.00-08.00	78	43	58	81	46	61
	08.00-13.00	87	44	60	90	47	63
	13.00-14.00	76	44	58	79	47	61
	14.00-22.00	87	43	58	90	46	61
	22.00-07.00	76	39	52	79	42	55
Sunday	07.00-21.00	82	44	58	85	47	61
	21.00-07.00	83	32	53	86	35	56

** An approximation of the averaged ambient façade noise level has been obtained by adding 3dB to the calculated averaged ambient free-field level*

Vol 6 Table G.8 Noise – Noise measurements by haul route (for road-based traffic assessment)

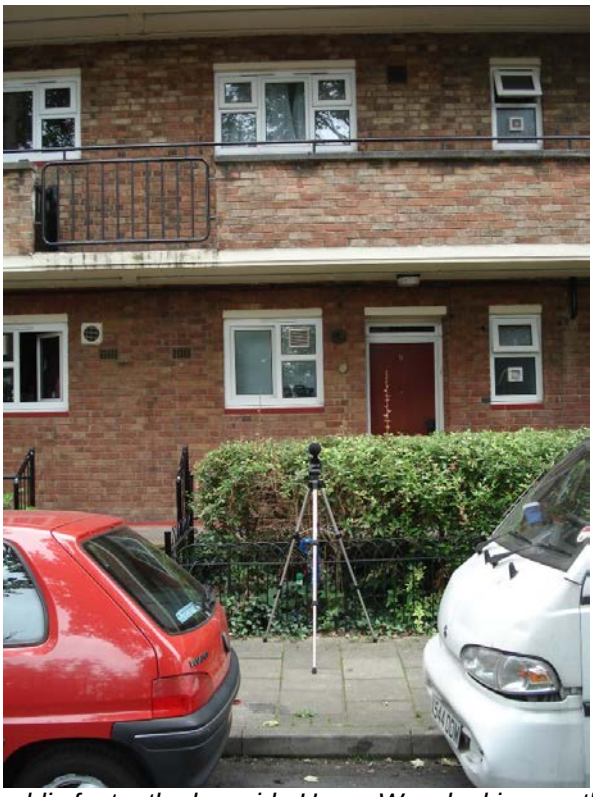
Sensitive receptor locations	**Measurement location**	**Measurement period**	**Noise level (dBLAeq, facade)**
Queen Elizabeth Walk	BEL03	Day/evening (07.00-23.00)	60

Baseline condition photographs specific to topics

Vol 6 Plate G.1 Noise measurement location BEL01

Note: On public footpath alongside Embankment, looking northeast towards Fulham FC

Vol 6 Plate G.2 Noise measurement location BEL02



Note: On public footpath alongside Horne Way, looking south towards Huntingford House

Vol 6 Plate G.3 Noise measurement location BEL03

Note: Southern boundary of Barn Elms playing field opposite Wandsworth boat house, looking southwest

G.2 Construction noise prediction results

G.2.1 The construction noise prediction methodology follows the methodology provided in Volume 2 Environmental assessment methodology.

G.2.2 The assessment has been carried out based on a typical construction programme which has been used to calculate the average monthly noise levels.

G.2.3 Construction plant assumptions used in the assessment are presented in Vol 6 Table G.9.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Vol 6 Plate G.4 to Vol 6 Plate G.12.

G.2.5 Queen Elizabeth Walk and Barn Elms Schools Sports Centre both lie more than 300m from the main site, but much closer to the haul route. The noise levels at these properties are therefore dominated by vehicle movements on the haul route, which has been considered in terms of the peak flow only. No time histories have been given for these properties, as the month by month flows are not available.

Vol 6 Table G.9 Noise – typical construction plant schedule.

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Hoarding General site equipment NOT applicable during this phase	Excavator digging post holes for hoarding	1	98	15	BS5228-1[i]: Table C.2, Item 7	Tracked excavator
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator
	Circular saw cutting timber	1	107	10	BS5228-1: Table D.7, Item 72	Hand-held electric circular saw
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Nail guns for erection of hoarding	2	101	10	BS5228-1: Table C.4, Item 95	Handheld cordless nail gun, 15 to 50 mm nails
	Compressor 250cfm	1	102	15	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar
	Hand-held percussive breaker	1	111	15	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker
	Waste collection via skip or tipper lorry	1	106	5	BS5228-1: Table C.8, Item 21	Skip wagon
	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
Site set up and general site	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	Compressor 250cfm	1	93	50	BS5228-1: Table D.5,	Compressor for hand-

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 5	held pneumatic breaker
	Generator200 kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator
	Cutting equipment (diamond saw)	2	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Wheel wash	1	91	20	BS5228-1: Table C.3, Item 13	Water Jet Pump
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Dewatering Pump	2	89	100	BS5228-1: Table C.4, Item 88	Water pump
	Water settling/treatment	1	104	100	Measured	Dirty water plant
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4, Item 15	Fuel tanker lorry
	Well drilling Rig	1	107	50	Manufacturer	BauerBBA Well Drilling Rig
	JCB with hydraulic breaker	1	116	25	BS5228-1: Table C.5, Item 1	Backhoe Mounted Hydraulic Breaker
Demolition General site	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
equipment also applicable during this phase	22T Excavator c/w hydraulic hammer	1	119	30	BS5228-1: Table D.2, Item 4	Tracked excavator fitted with breaker, 200 kg·m
	Site dumper	1	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Pneumatic breaker	1	111	20	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Piling for shaft/culvert support General site equipment applicable during this phase	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25 tonne mobile crane	1	98	50	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Vibratory piling rig	1	116	80	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
Shaft sinking and connection tunnel drive by SCL General site equipment also	Concrete deliveries (aggitating)	1	99	80	BS5228-1: Table C.4, Item 19	Cement mixer truck (idling)
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C 8, Item 21	Skip wagon
	100t crawler crane	1	103	80	BS5228-1: Table C 4, Item 52	Tracked mobile crane, 105 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
applicable during this phase	25t mobile crane	1	98	20	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Pneumatic breakers	4	111	20	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker
	Vent fans	1	100	100	Measured	Ventilation fans
	400 cfm compressor	1	93	20	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker
	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
Shaft and connection tunnel secondary lining General site equipment also applicable during this phase	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	Concrete pump	2	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
	Fixed and portable concrete vibrators	4	91	20	BS5228-1: Table C.4, Item 33	Poker vibrator
	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Service Crane 40T mobile Crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor

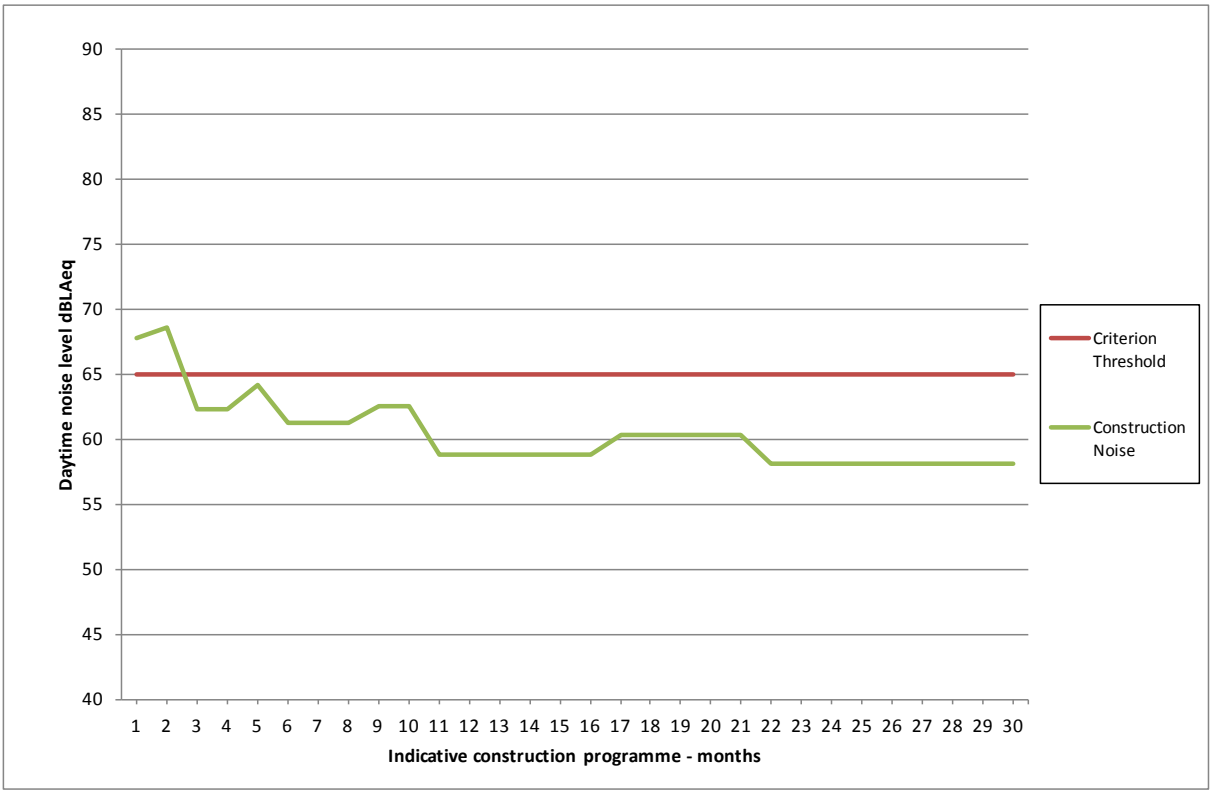
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Culvert and chamber works General site equipment also applicable during this phase	Service crane100T mobile crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Fixed and portable concrete vibrators	4	106	20	BS5228-1: Table C.4, Item 33	Poker vibrator,
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging)
	Concrete boom pump	1	108	20	BS5228-1: Table C.4, Item 29	Truck mounted concrete pump + boom arm, 26 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	97	50	BS5228-1: Table C.2, Item 25	Tracked excavator, 14 t
	Dumper	1	104	70	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Compressor for hand-held breaker	1	102	10	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar
	Hand-held percussive breaker	1	111	10	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol) , 62 kg
	Vibrating rollers	1	101	70	BS5228-1: Table C.2, Item 38	Roller, 18 t

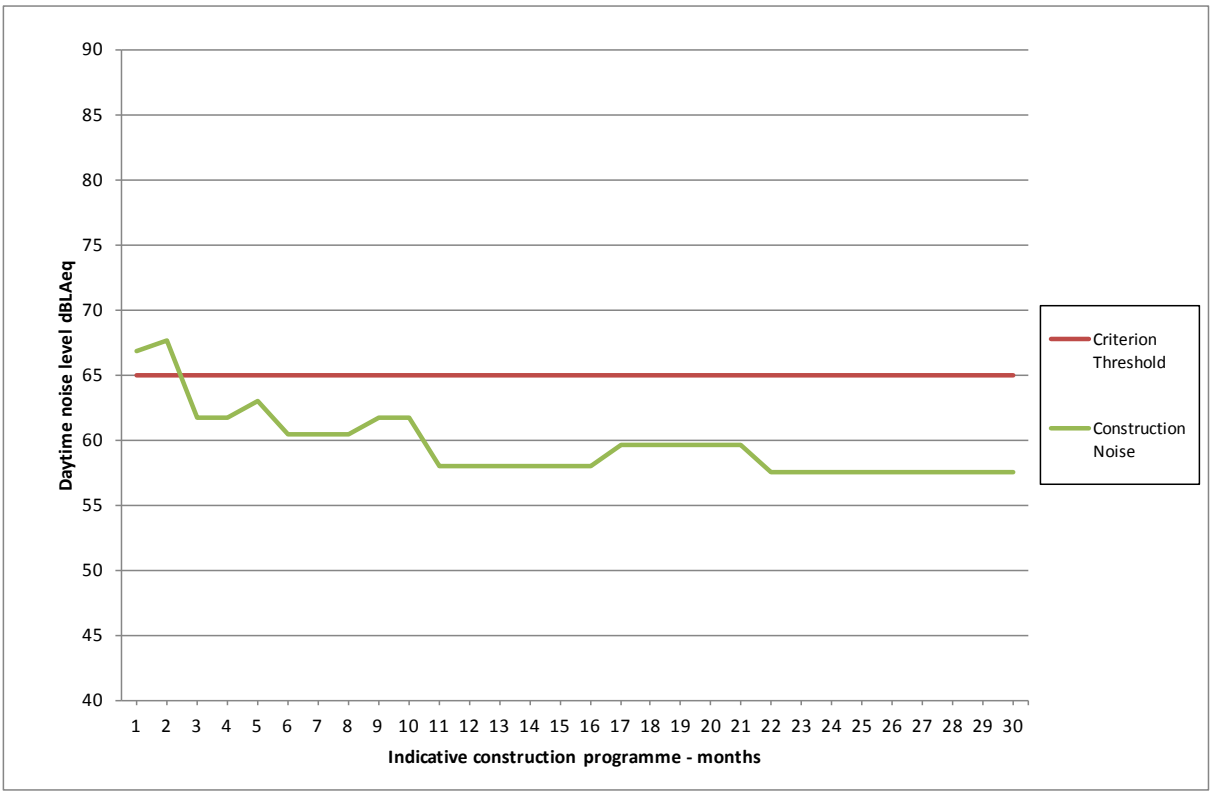
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable assumption for the assessment that can be made at this stage.

G.2.6 The predicted construction noise over time at each receptor is shown in the plates below. It should be noted that these representations are for the worst-case scenarios for noise exposure at the upper floors. For comparison with the construction noise, the plates also show either the potential significance criterion threshold for residential receptors, or the ambient noise level. This comparison is discussed in the main assessment (Vol 6 Section 9). The night-time noise levels have also been assessed for the short period of night-time works; these results are described in the main assessment (Vol 6 Section 9) and not presented here.

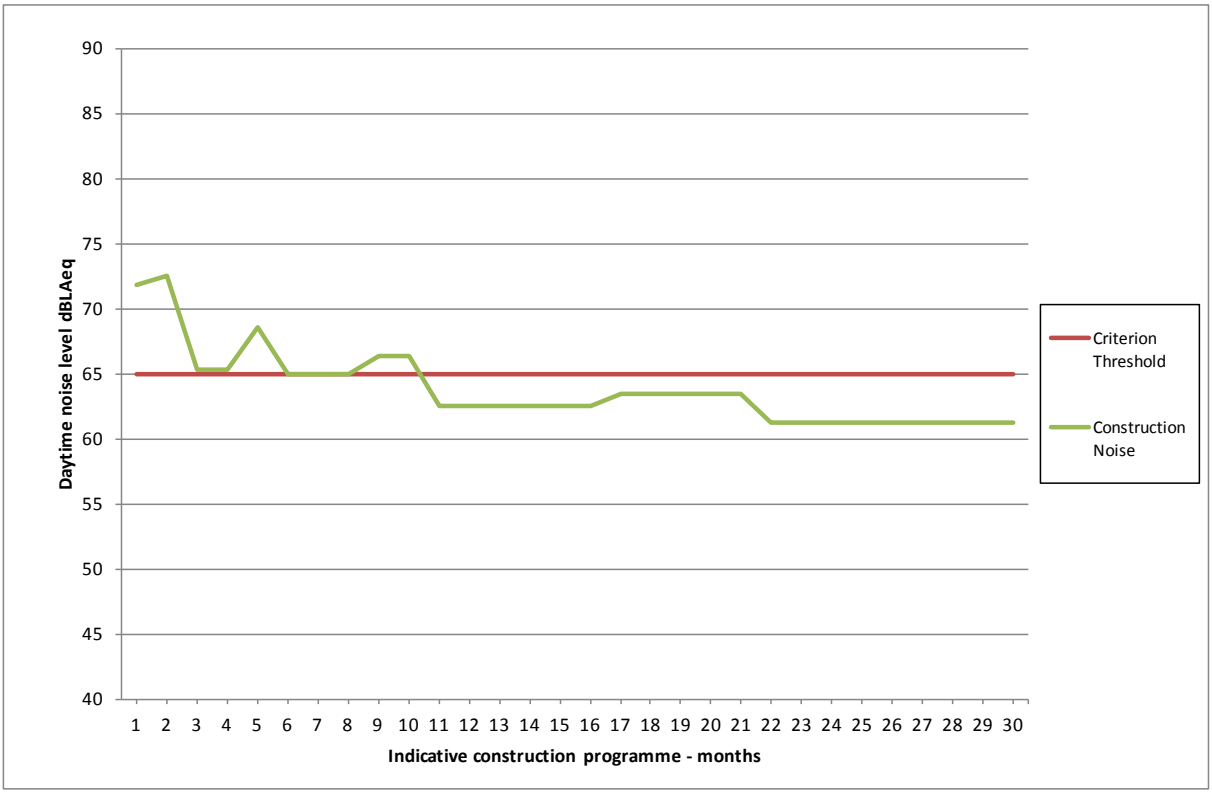
Vol 6 Plate G.4 Average monthly daytime noise level over duration of construction – Pearson House (residential) (BE1)



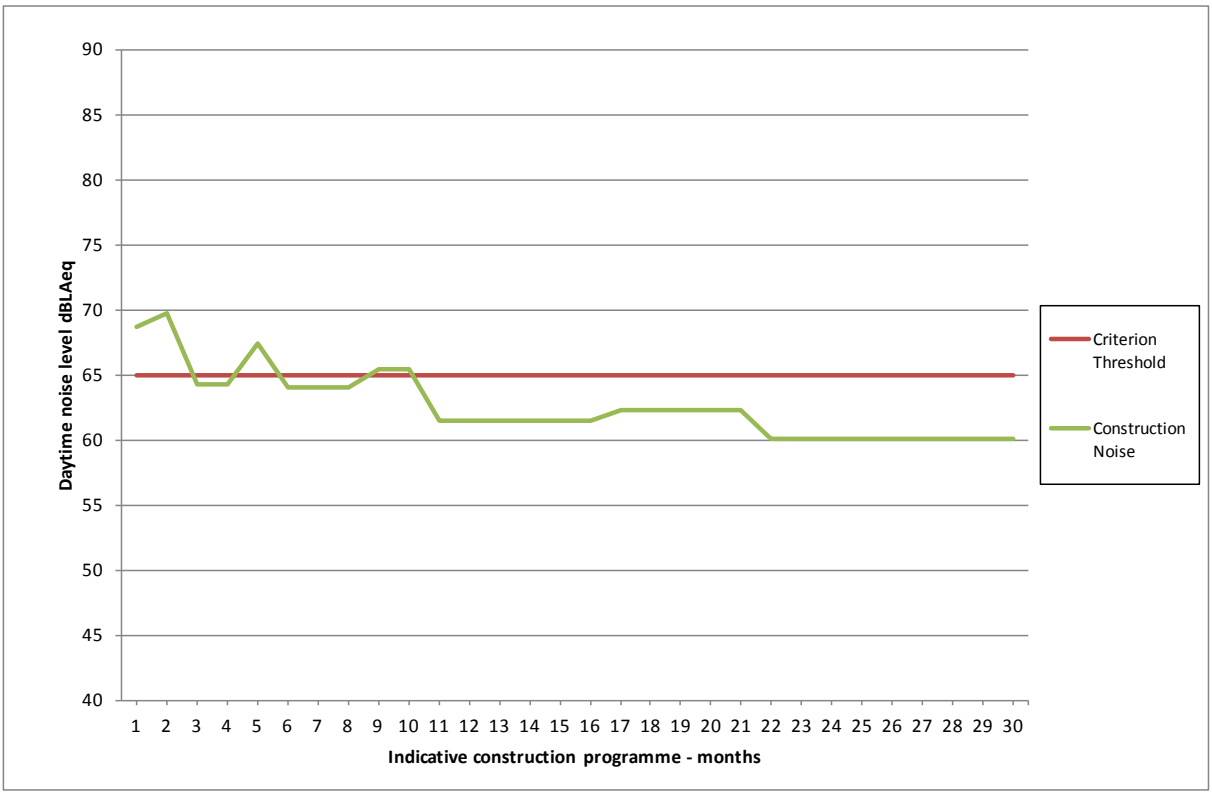
Vol 6 Plate G.5 Average monthly daytime noise level over duration of construction – Huntingford House (BE2)



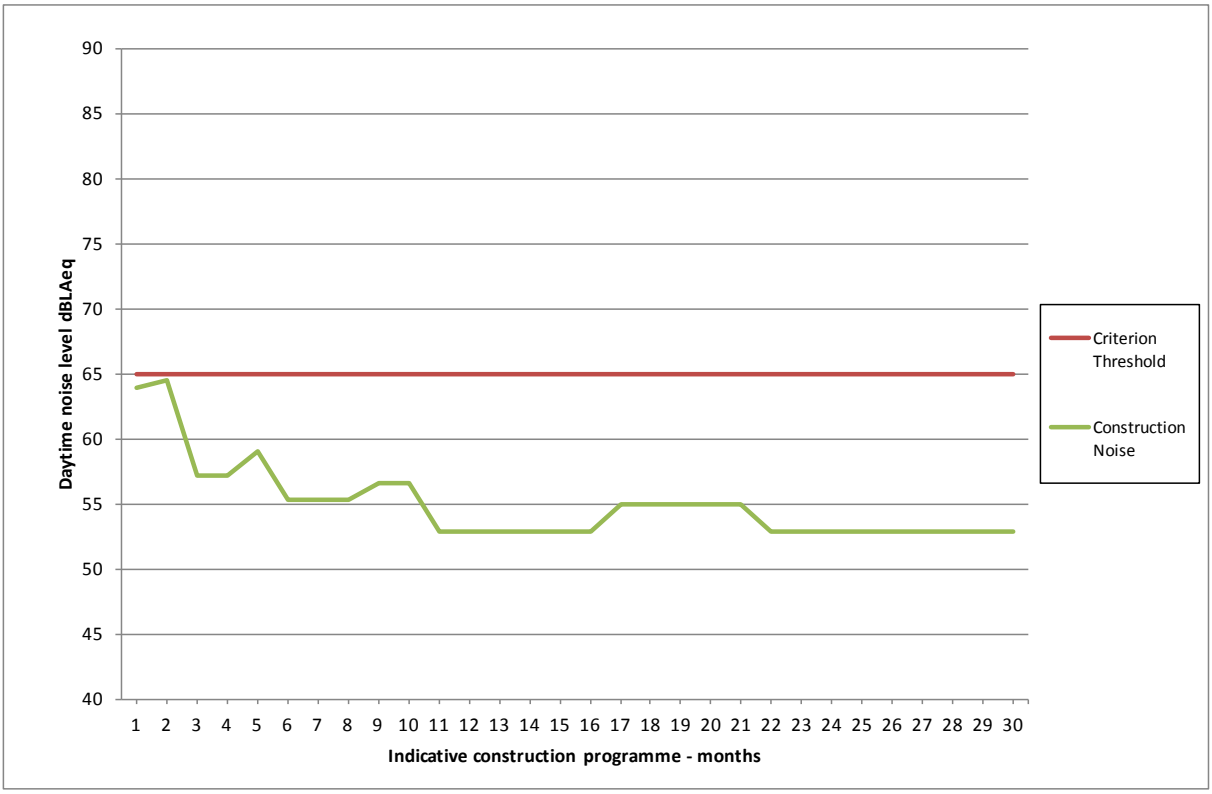
Vol 6 Plate G.6 Average monthly daytime noise level over duration of construction – Lancaster House (BE3)



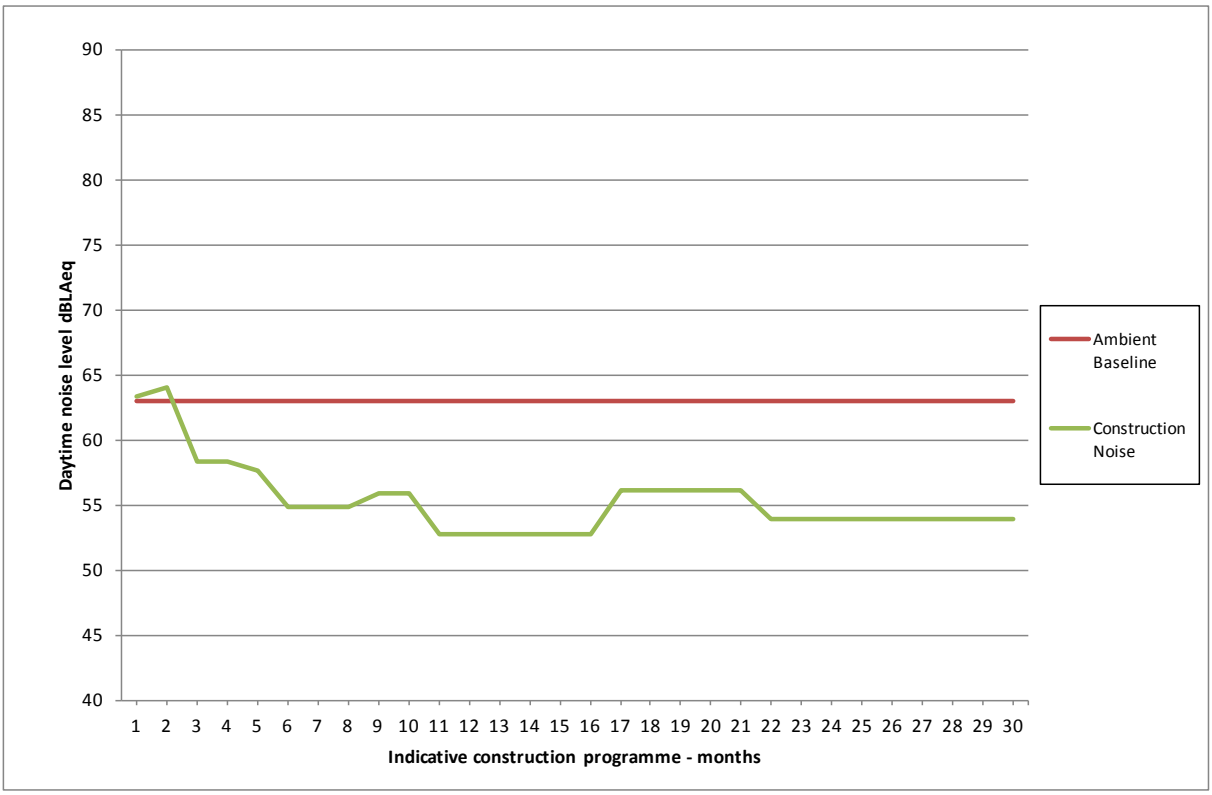
Vol 6 Plate G.7 Average monthly daytime noise level over duration of construction – Jay House (BE4)



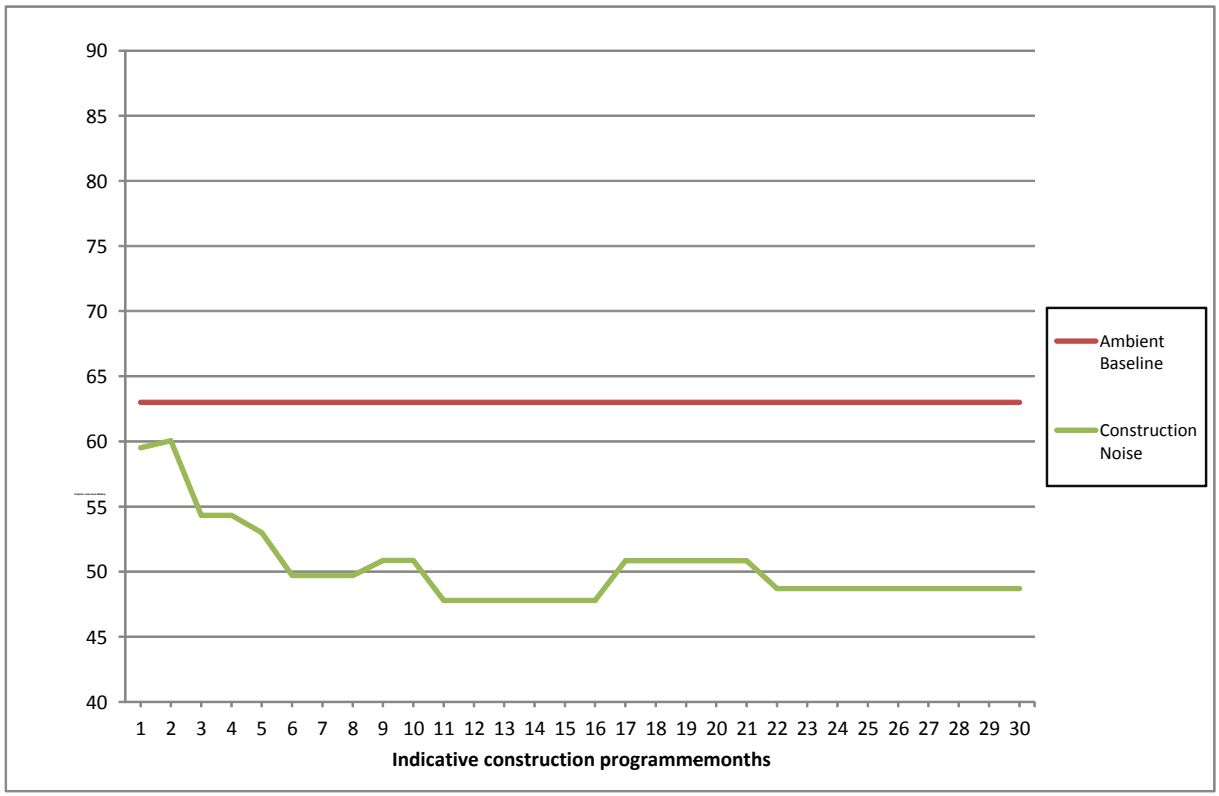
Vol 6 Plate G.8 Average monthly daytime noise level over duration of construction – 34-39 Stockhurst Close (BE5)



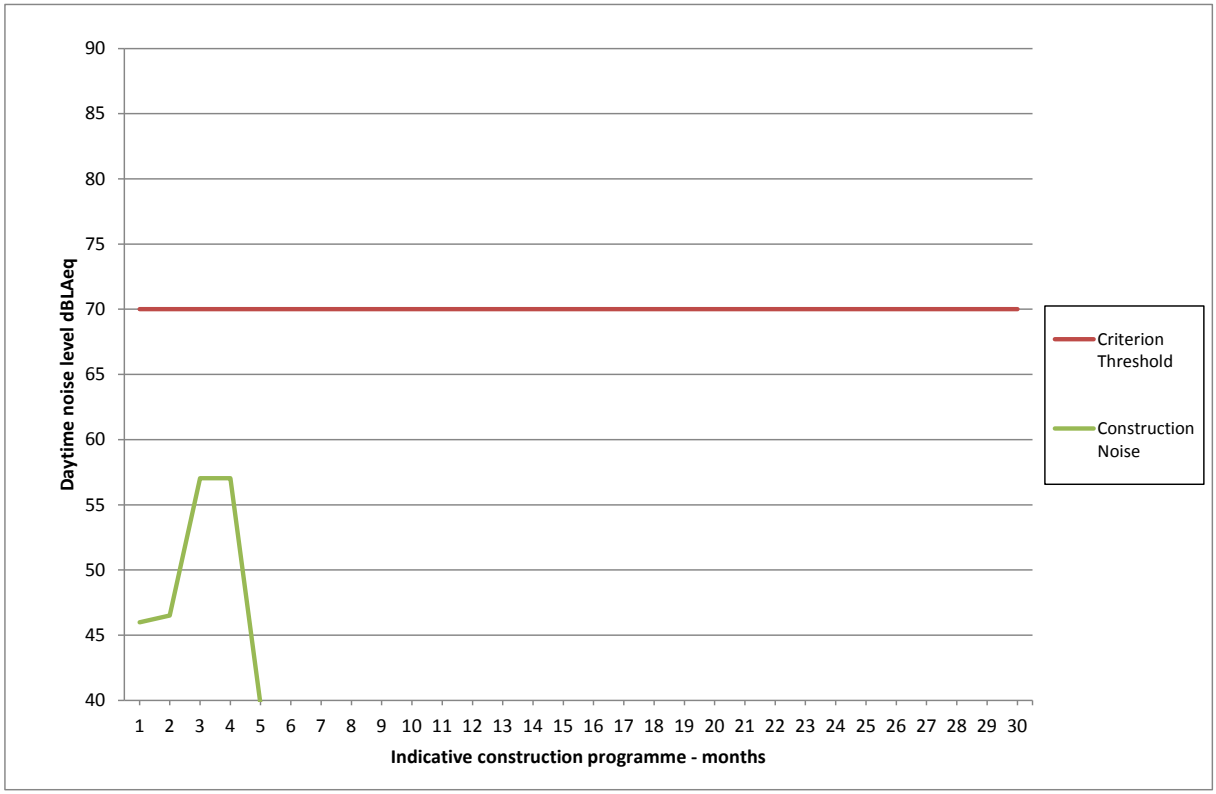
Vol 6 Plate G.9 Average monthly daytime noise level over duration of construction – Scout Hut (BE6)



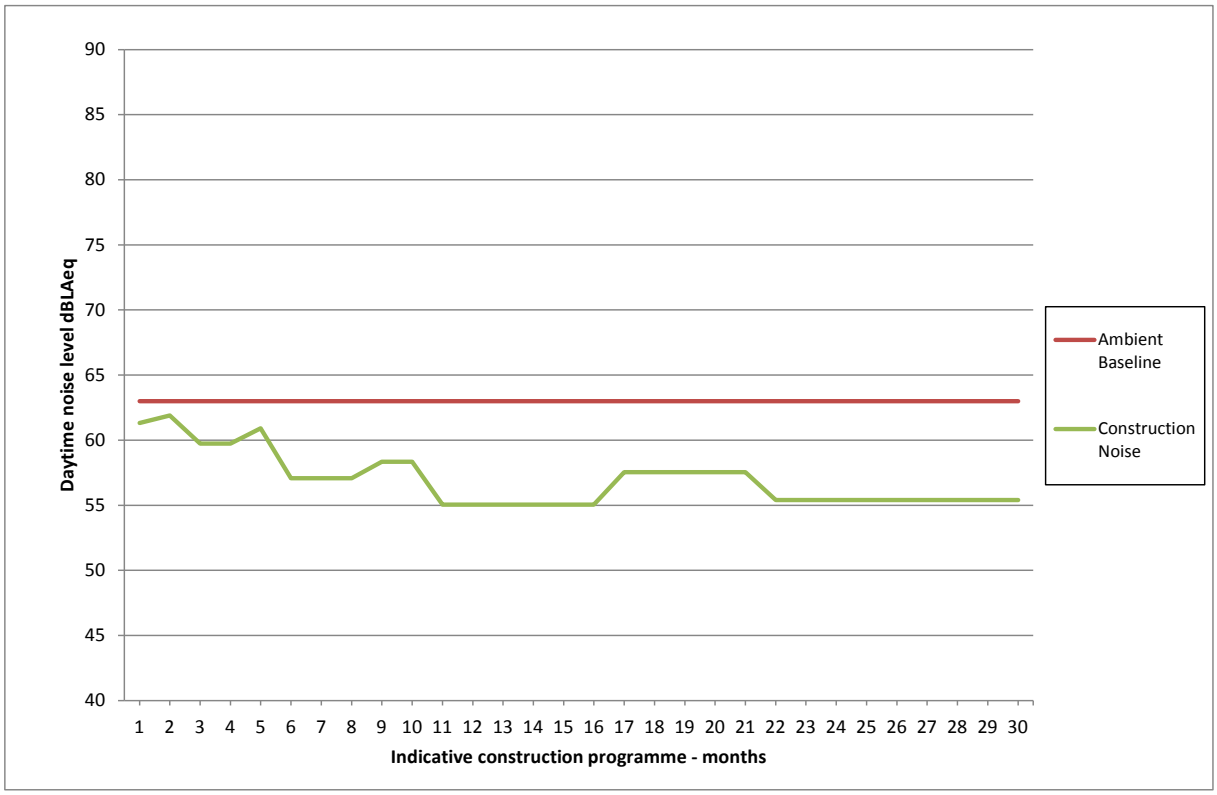
Vol 6 Plate G.10 Average monthly daytime noise level over duration of construction – Barn Elms Boathouse (BE7)



Vol 6 Plate G.11 Average monthly daytime noise level over duration of construction – Queen Elizabeth Walk (BE8)



Vol 6 Plate G.12 Average monthly daytime noise level over duration of construction – Barn Elms Sports Centre (BE9)



References

[i] British Standard Institution, *BS 5228 Code of Practice for Noise and Vibration Control on Open Construction Sites, British Standards Institution* (2009)

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix H: Socio-economics

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 6 Appendices: Barn Elms site assessment

Appendix H: Socio-economics

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Appendix H: Socio-economics

H.1 Baseline community profile

H.1.13 The community profile is based on both Output Area (OA) and local authority level data from the Office of National Statistics (ONS). The data have been obtained from four sources: Census 2001[1] (the last census for which data are available[i]), Department of Communities and Local Government Deprivation Indices 2010[2], London Public Health Observatory 2012[3], and the Network of Public Health Observatories 2011[4] (see Volume 2 Methodology).Data is grouped according to those 'protected characteristics'[ii] or groups which are relevant for consideration in relation to this socio-economic impact assessment. This baseline community profile provides context for this socio-economic assessment.

H.1.14 On the basis of likely impacts on receptors in this socio-economic assessment, the community profile examines the 'immediate area' surrounding the construction site (ie, within an assessment area of 250m) a 'wider local area' (ie, within an assessment area of 1km) and the overall borough level (which in this case is the London Borough [LB] of Richmond upon Thames).

H.1.15 The main protected characteristic group concentrated[iii] within 250m and 1km of the proposed construction site is persons aged under 16 years old.

H.1.16 Further detail on the socio-economic profile of the local community is provided below.

Resident population

H.1.17 The resident population was approximately 2,075 within 250m of the construction site and 30,525 within 1km at the time of the last census.

Gender and age

H.1.18 Of the total population within 250m of the site 52.8% residents are female, slightly higher than within 1km (52.5%) and the LB of Richmond upon Thames (51.6%).

H.1.19 Vol 6 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (18.3%) is broadly in line with the borough wide levels (18.8%) and slightly higher than the proportion of under 16 year olds within 1km (16.4%). The proportion of under 16 year olds within Greater London (20.2%) is slightly higher than within the above assessment areas.

[i] Census 2001. This type of data for the 2011 Census had not been released at the time of the assessment.

[ii] The Equalities Act 2010 defines 'protected characteristics' as: age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, and sexual orientation. Of these characteristics, age, disability, race and religion are relevant for consideration in relation to this socio-economic assessment.

[iii] In this instance 'concentrated' refers to the occurrence of a particular protected characteristic group, the proportion of which is notably higher than borough wide proportions.

H.1.20 The proportion of residents over 65 years old within 250m (12.3%) is broadly in line with the proportion within 1km (12.4%) and Greater London (12.4%). Within the LB of Richmond upon Thames, the proportion of over 65 year olds (13.7%) is slightly higher than within the above assessment areas.

Vol 6 Table H.1 Socio-economics – age breakdown by assessment area

Age group	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Richmond upon Thames)	Greater London
Under 16 years old	18.3%	16.4%	18.8%	20.2%
Over 65 years old	12.3%	12.4%	13.7%	12.4%

Ethnicity

H.1.21 Vol 6 Table H.2 outlines ethnicity by assessment area, showing that within 250m and 1km of the site and at a borough wide level, White residents make up approximately 90% of the population (91.6%, 90.5% and 91.0% respectively). At a Greater London level however, the proportion of White residents (71.2%) is somewhat lower than the above assessment areas.

H.1.22 The proportion of Black and Minority Ethnic (BME) residents within Greater London (28.2%) is considerably higher than within 250m (8.4%), 1km (9.4%) and at a borough wide level (9.1%).

H.1.23 The proportion of Asian residents in Greater London (12.1%) is considerably higher than within 250m (2.2%), 1km (2.8%) and at a borough wide level (3.9%).

Vol 6 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Richmond upon Thames)	Greater London
White	91.6%	90.5%	91.0%	71.2%
BME	8.4%	9.4%	9.1%	28.8%
Asian	2.2%	2.8%	3.9%	12.1%
Black	1.7%	2.5%	0.9%	10.9%
Other	1.2%	2.4%	2.0%	2.7%
Mixed	3.3%	1.7%	2.2%	3.2%

Note: The figure for BME data presented in Table H.2 is the sum of data for Asian, Black, Other and Mixed ethnicities.

Religion and belief

H.1.24 Within 250m of the site, Christians are the predominant religious group at 68.0%, broadly in line with the proportion within 1km (68.3%) and slightly higher than at a borough wide level (65.8%). Muslims are the second most predominant group, the proportions within 250m (1.7%) and 1km (2.1%) are broadly in line with the borough-wide average of 2.2%. Notably, the proportions of Muslim residents within the above assessment areas are approximately four times lower than the Greater London average (8.5%).

Health indicators

H.1.25 Vol 6 Table H.3 outlines health indicators by assessment area, noting that the proportion of residents suffering from a long term limiting illness within 250m (13.0%) is broadly in line with the proportion within 1km (11.5%) and the LB of Richmond upon Thames average (12.4%). This is slightly lower than the Greater London average (15.5%).

H.1.26 Disability allowance claimants within 250m (2.8%) and 1km (2.5%) are broadly in line with the LB of Richmond upon Thames average (2.6%). The Greater London proportion of disability allowance claimants is considerably higher than within the above assessment areas (4.5%).

Vol 6 Table H.3 Socio-economics - health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Richmond upon Thames)	Greater London
Long term limiting sick	13.0%	11.5%	12.4%	15.5%
Disability living allowance	2.8%	2.5%	2.6%	4.5%

H.1.27 In the Middle Super Output Area (MSOA)[iv5] in which the construction site falls, levels of adult and child obesity rank in the lowest 20% (ie, the lowest being the best) in the borough. Data available at a borough wide level only, identifies that adults in this MSOA rank within the most physically active quintile. At a borough wide level, children also rank highly for physical exercise, falling within the second highest quintile (ie, the highest being the best) of all Greater London boroughs.

[iv] MSOAs are areas determined by the Office of National Statistics (ONS) to collect local area statistics. MSOAs have a minimum size of 5,000 residents and 2,000 households. MSOAs have an average population size of 7,200 residents.

H.1.28 Death rates by cancer, heart disease, circulatory disease and strokes within the MSOA are all in the lowest quintile (ie, the lowest being the best) within the borough.

H.1.29 Male and female life expectancy in the MSOA are both in the highest quintile within the borough (ie, the highest being the best) with average life expectancy of both male and female residents being 84.9 to 93.1 years old.

Lifestyle and deprivation indicators

H.1.30 Vol 6 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that a moderate proportion of households within 250m (29.8%) and 1km of the site (32.5%) do not own cars. This is somewhat higher than the LB of Richmond upon Thames average (23.7%) and somewhat lower than the Greater London average (37.5%).

There is no recorded incidence of income deprivation or overall deprivation within 250m or 1km of the site. Income deprivation within the LB of Richmond upon Thames (2.8%) is considerably lower than the Greater London average (21.5%). There is no recorded overall deprivation within the LB of Richmond upon Thames, this contrasts with the Greater London average of 18.3% overall deprivation.

Vol 6 Table H.4 Socio-economics – lifestyle and income deprivation levels by assessment area

Indicator	Assessment area			
	Immediate area (250m)	**Wider local area (1km)**	**Borough wide (LB of Richmond upon Thames)**	**Greater London**
No car households	29.8%	32.5%	23.7%	37.5%
Income	0.0%	0.0%	2.8%	21.5%
Overall	0.0%	0.0%	0%	18.3%

H.2 Baseline economic profile

H.2.13 This section presents a profile of the economy local to the proposed construction site at Barn Elms.

H.2.14 Data are presented for the geographical area within a radius or 'catchment' of approximately 250m from the boundary of the Limits of land to be acquired or used (LLAU) of the project site. Data are also provided at the overall borough level (which in this case is the LB of Richmond upon Thames) and for Greater London.

H.2.15 Data are sourced from Experian's National Business Database (2012)[6] which draws primarily on regularly updated records from Companies House[v].

Employment and businesses

H.2.16 Within approximately 250m of the site there are approximately 2,000 jobs.[vi] Vol 6 Table H.5[vii] below illustrates the breakdown of employment by sector based on the UK Standard Industrial Classification (SIC) 2007[7]. It shows data for those sectors which account for more than 4% of total employment within approximately 250m. It can be seen that:

a. Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles accounts for 54% of employment within 250m, over three times more than within both the LB of Richmond upon Thames (16%) and Greater London (16%).

b. Accommodation and Food Service Activities account for 7% to 8% of employment at all geographical levels.

c. Professional, Scientific and Technical Activities account for 8% of employment within 250m, somewhat less than within the LB of Richmond upon Thames (11%) and Greater London (11%).

d. Other Service Activities account for 4% to 5% of employment at all three geographical levels.

e. Arts, Entertainment and Recreation Activities account for 3% to 5% of employment at all geographical levels.

f. Financial and Insurance Activities account for 3% to 4% of employment at all geographical levels.

[v] Information on employees and businesses reflects aggregated data for seven digit post-code units falling wholly or partially within a 250m boundary of the LLAU. This includes post code units on the opposite side of the River Thames, if relevant. Please refer to Volume 2 Appendix H for further details.

[vi] Employees data reflect a head count of workers on-site rather than Full Time Equivalent (FTE) jobs. While employee figures are mostly based on actual reported data, a proportion is based on modelled data.

[vii] Data in tables rounded to nearest whole percentage and do not always sum due to rounding.

Vol 6 Table H.5 Socio-economics – employment by top six sectors (2012)

Sector (Standard Industrial Code 2007)	Assessment area		
	Immediate area (250m)	Borough wide (LB of Richmond upon Thames)	Greater London
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	54%	16%	16%
Accommodation and Food Service Activities	8%	7%	8%
Professional, Scientific and Technical Activities	8%	11%	11%
Other Service Activities	4%	5%	4%
Arts, Entertainment and Recreation Activities	4%	5%	3%
Financial and Insurance Activities	4%	3%	4%
Other (including unclassified)	18%	53%	54%

H.2.17 Within approximately 250m of the site there are approximately 220 businesses (defined here as business locations[viii]). The number of businesses by sector within 250m follows a somewhat different profile to the breakdown of employment by sector set out in Vol 6 Table H.5, with Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles accounting for only 11% of businesses. Professional, Scientific and Technical Activities account for 14% of businesses, while Accommodation and Food Service Activities and Other Service Activities both account for 8% and Arts, Entertainment and Recreation account for 7%.

H.2.18 Vol 6 Table H.6 below illustrates the size of businesses in terms of the number of employees at each business location / unit. At all geographical levels, businesses within the smallest size band (one to nine employees) account for the majority. Within approximately 250m, 90% of business units have one to nine employees compared to 91% within the LB of Richmond upon Thames and 88% within Greater London. Overall, the size banding profile of businesses within 250m of the site is broadly similar to the LB of Richmond upon Thames and Greater London.

H.2.19 For the sectors accounting for the greatest proportions of jobs and businesses within approximately 250m, the size banding of businesses

[viii] This count relates to business 'locations' or 'units'; an enterprise may have a number of business locations / units. It includes private sector, public sector and voluntary sector / charitable entities.

follows a similar profile. An exception is within the Accommodation and Food Service Activities sector, where 74% of businesses employ one to nine employees compared to an average across all sectors of 90%.

H.2.20 In the Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles sector, 92% of businesses employ one to nine employees. However, this sector has a comparatively high proportion of businesses employing more than 250 employees (4%), considerably more than the proportion for each of the three geographical levels and the other leading sectors (all 0%).

Vol 6 Table H.6 Socio-economics – businesses by size band (number of employees

Assessment area / sector		Size band (number of employees)					
		1-9	10-24	25-49	50-99	100-249	250+
Immediate area (250m)		82%	15%	2%	0%	1%	0%
	Professional Scientific and Technical Activities	62%	31%	0%	0%	8%	0%
	Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	89%	0%	11%	0%	0%	0%
	Accommodation and Food Service Activities	78%	22%	0%	0%	0%	0%
	Other Service Activities	100%	0%	0%	0%	0%	0%
Borough wide (LB of Richmond upon Thames)		92%	5%	1%	1%	0%	0%
Greater London		88%	8%	2%	1%	1%	0%

H.3 Baseline - open space usage surveys

H.3.13 Refer to Volume 2 Appendix H for details on the methodology used for the open space usage surveys and subsequent analysis.

Survey dates and times

H.3.14 Surveys were undertaken as follows.

Summer

a. Tuesday 2nd August 2011, 12pm to 3pm (sunny, 27^{O}C)

b. Sunday 14th August 2011, 1pm to 4pm (partly sunny, 20^{O}C)

c. Wednesday 14th September 2011, 8am to 10am (sunny, 13^{O}C to 17^{O}C), 1pm to 3pm and 5pm to 7pm (sunny, 17^{O}C)

d. Wednesday 30th May 2012, 1.30pm to 4.30pm (sunny, 23^{O}C)

e. Sunday 17th June 2012, 2.15pm to 5.15pm (part cloudy, 21^{O}C)

Autumn

f. Saturday 8th October 2011, 1pm to 3.30pm (partly sunny, 15^{O}C)

g. Tuesday 11th October 2011, 8am to 10.30am and 1pm to 3.30pm (partly sunny, 15^{O}C)

Survey points and zones

H.3.15 Vol 6 Figure H.1 (see separate volume of figures) shows the location of the survey areas listed in Vol 6 Table H.7.

Vol 6 Table H.7 Socio-economics – survey points, zones and duration of survey survey period

Name	Location	Survey times	Frequency
Survey point 1	Thames Path and NCR 4 north of Barn Elms Boat House	10 minutes	Every 2 hours
Survey point 2	Thames Path and NCR 4 at mouth of Beverley Brook	15 minutes	Every 2 hours
Survey point 3	Beverley Brook Walk footpath	20 minutes	Every 2 hours
Survey point 4	Queen Elizabeth Walk	20 minutes	Twice hourly
Survey zone 4	Barn Elms Playing Fields: LB Richmond of Upon Thames	Point in time observations	Every 2 hours
Survey zone 5	Barn Elms School Sports Centre: LB of Wandsworth	Point in time observations	Every 2 hours

Site specific considerations

H.3.16 Survey data presented here is supplemented by data on usage of the Barn Elms School Sports Centre (BESSC) provided by the LB of Wandsworth. See Key findings and observations and Vol 6 Table H.13 and Vol 6 Table H.14 below for further details.

H.3.17 An approximately 70m section of Beverley Brook Walk closest to the Thames Path was physically diverted over the course of the 2011 surveys, owing to Environment Agency flood defence works at Ashlone Wharf. Its connection to the Thames Path was not severed on any survey day.

Key findings and observations

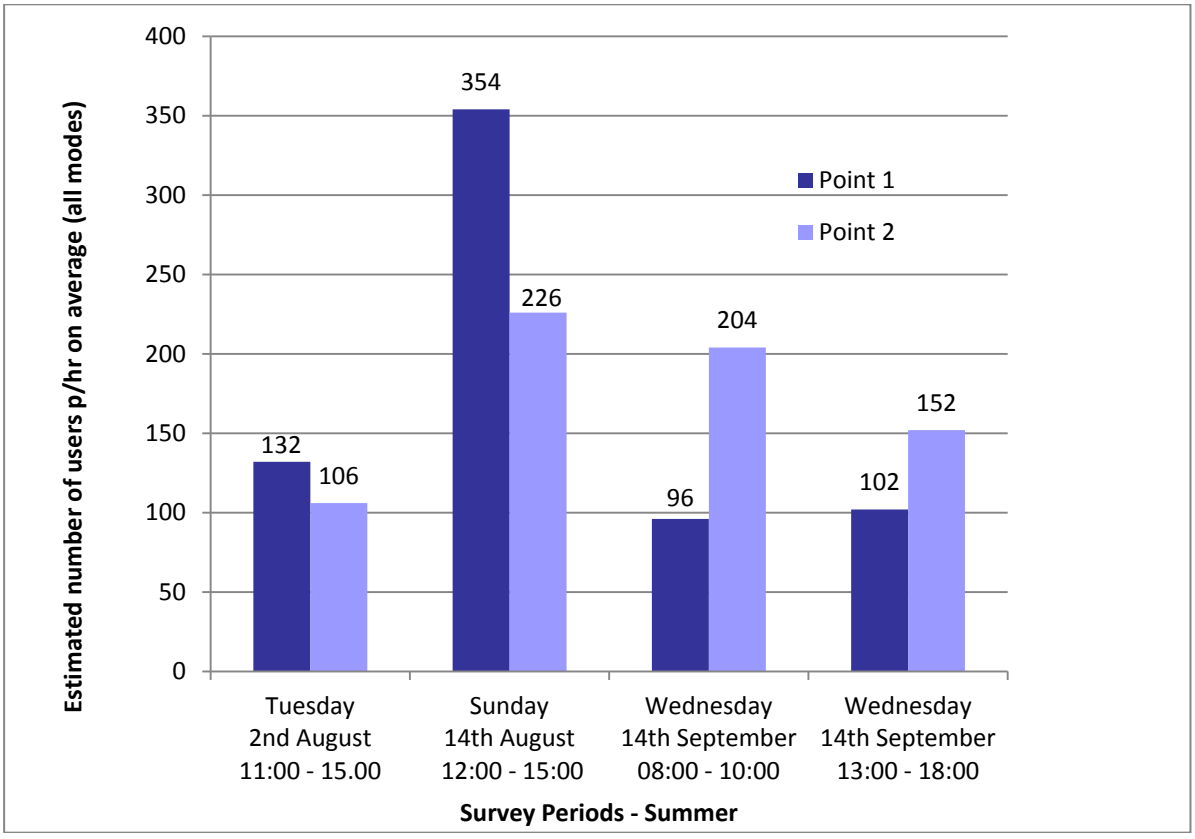
Survey points 1 and 2 – Thames Path and NCR4

H.3.18 The Thames Path experienced 50% higher usage levels were on weekends than on weekdays, in both the summer and autumn surveys. Highest (peak) average hourly usage was recorded at point 1 on a Sunday afternoon (350 movements).

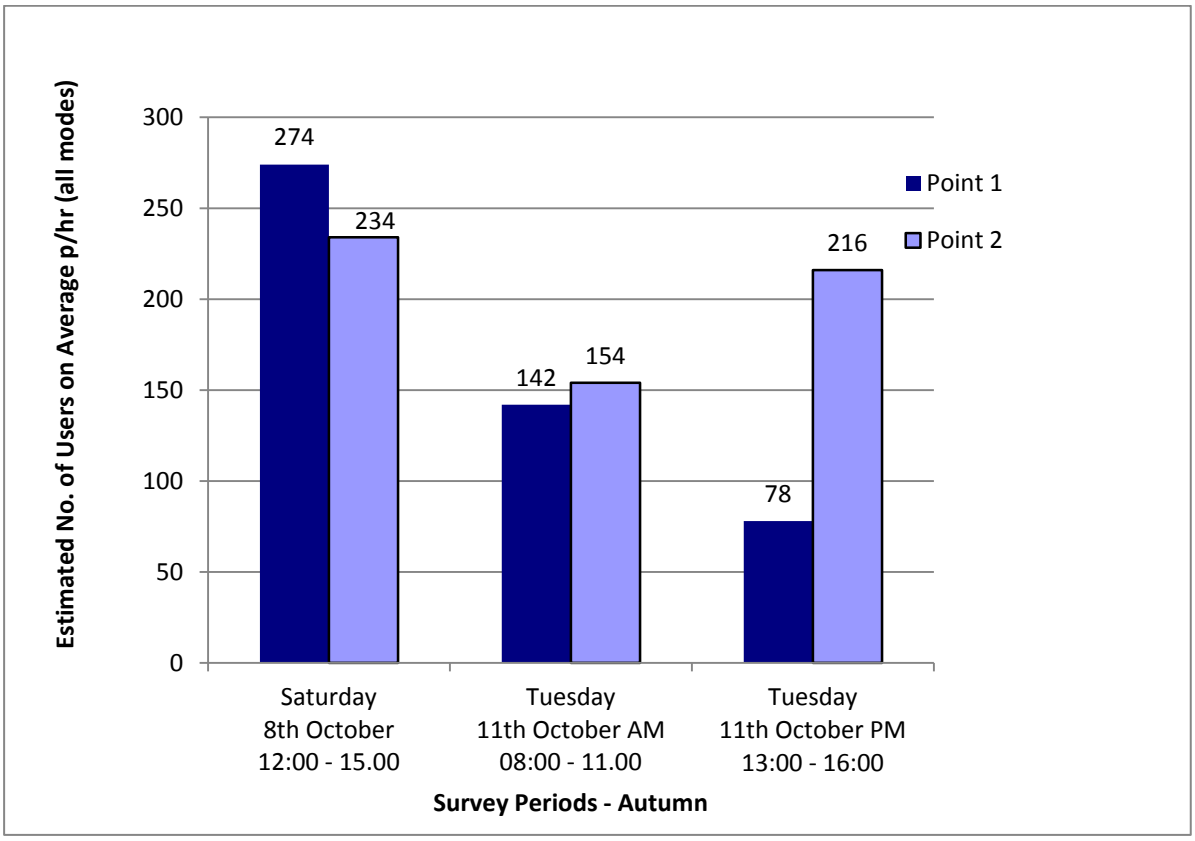
H.3.19 During the survey programme, over 90% of users recorded using the route were White. The majority of joggers and cyclists were young adults (18 to 39 years old). Walkers and dog walkers using the route were more likely to be from a broader range of age groups.

H.3.20 See Vol 6 Plate H.1 and Vol 6 Plate H.2 for further details.

Vol 6 Plate H.1 Socio-economics – average usage level at Thames Path: Summer



Vol 6 Plate H.2 Socio-economics – average usage level at Thames Path: Autumn



Survey point 3 – Beverley Brook Walk footpath

H.3.21 Surveys of this footpath were undertaken in the form of an approximately 20 minute walk along the footpath from the Thames Path to the most westerly crossing point over Beverley Brook and back.

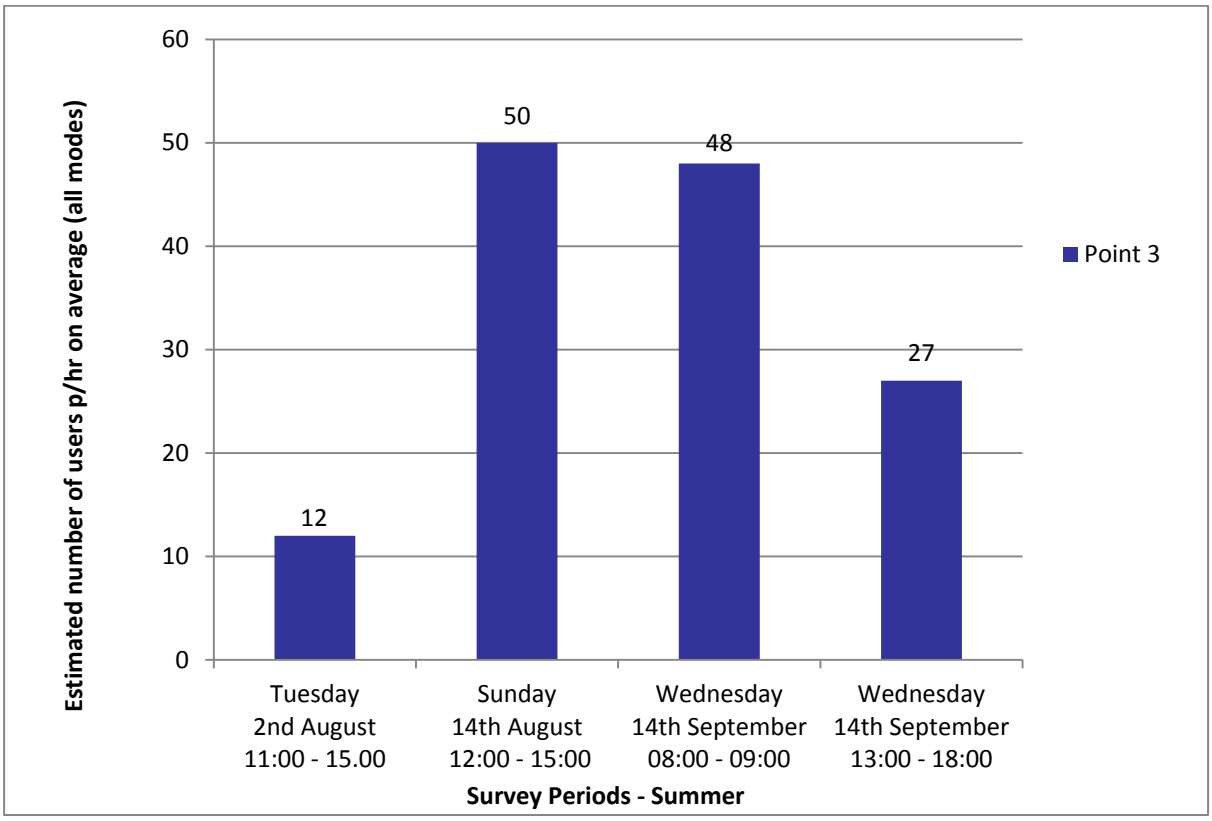
H.3.22 Usage was light in comparison with the Thames Path, with a peak of 22 users (all modes) recorded during any 20 minute survey period. Usage was somewhat lower during the autumn than summer

H.3.23 There was proportionately higher observed usage by older adults (40 to 59 years old) than at the other survey points and zones.

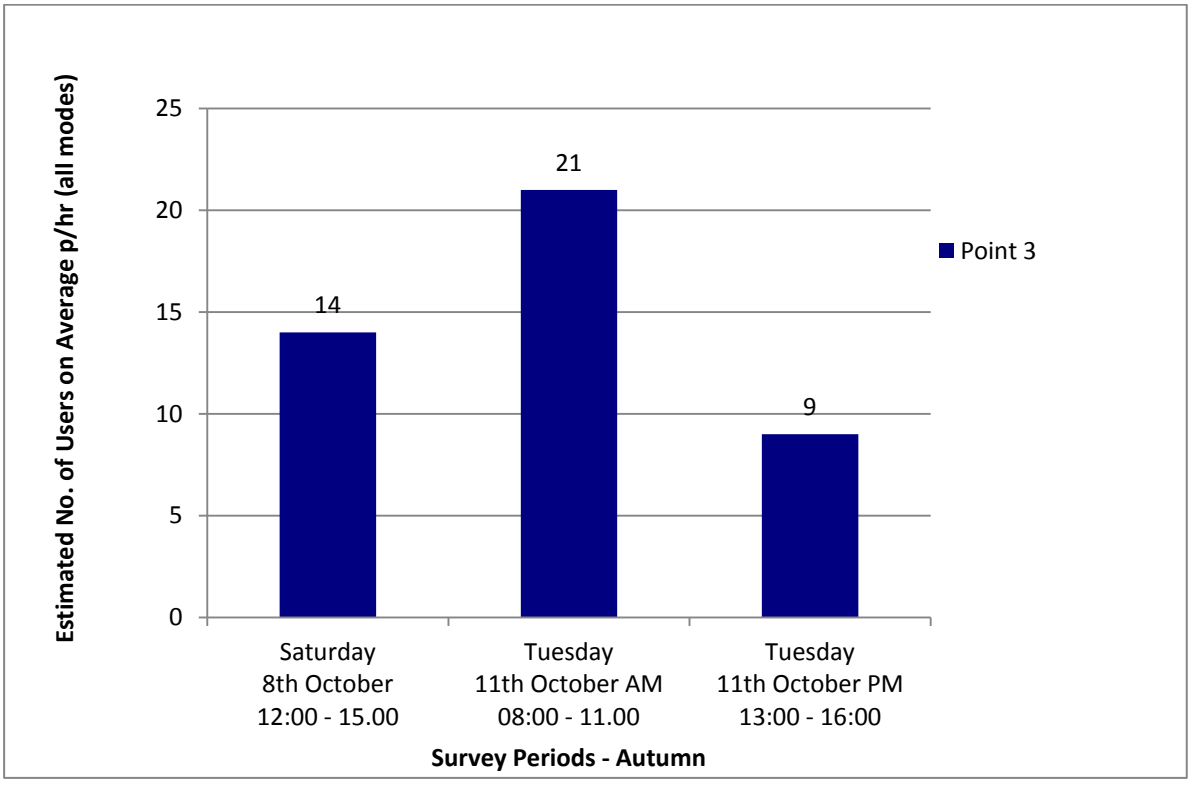
H.3.24 See Vol 6 Plate H.3 and Vol 6 Plate H.4 for further details.

H.3.25 During a separate site visit in average to poor conditions on the day of 2011 Oxford Cambridge Boat Race (Saturday 26th March, 2011) the path was observed to be only sparsely used, particularly compared to the high usage levels observed on that day along the Thames Path.

Vol 6 Plate H.3 Socio-economics – average usage level at Beverley Brook Walk: Summer



Vol 6 Plate H.4 Socio-economics – average usage level at Beverley Brook Walk: Autumn



Vol 6 Table H.8 Socio-economics – usage levels by type of use at survey point 3

Date	Time of survey	Number of users				Estimated number of users p/hr*
		Walkers	Joggers	Dog walkers	Cyclists	
Summer						
Tuesday 2nd August 2011	12:05 – 12:25	2	-	3	-	15
	13:40 – 14:00	1	-	-	1	8
Sunday 14th August 2011	12:05 – 12:25	13	1	8	-	66
	14:05 – 14:25	5	-	4	2	33
Wednesday 14th September 2011 AM	08:20 – 08:40	3	4	7	2	48
Wednesday 14th September2011 PM	13:25 – 13:45	6	1	-	-	21
	16:50 – 17:10	3	2	6	-	33
Autumn						
Saturday 8th October 2011	12:45 – 13:05	-	1	3	2	18
	14:55 – 15:15	-	-	3	-	9
Tuesday 11th October 2011 AM	08:25 – 08:45	-	1	6	1	24
	10:15 – 10:35	1	2	2	1	18
Tuesday 11th October 2011 PM	13:15 – 13:35	2	-	1	-	9

Survey point 4 - Queen Elizabeth Walk footpath

H.3.26 Although usage was lighter than the Thames Path, a peak of 219 movements per hour (all modes) was recorded during the weekend survey at this location.

H.3.27 The majority of users of the footpath, overall, were walkers although cyclists accounted for the largest proportion of users during some surveys, with the National Cycle Route 4 following the path.

H.3.28 Over 90% of users recorded using the route were White, with a varied mix of age groups represented, particularly for walkers using the path.

H.3.29 See Vol 6 Table H.6 below for further details.

Vol 6 Table H.9 Socio-economics – usage levels and type of use at survey point point 4

Date	Time of survey	Number of users				Estimated number of users p / hr*
		Walkers	Joggers	Dog walkers	Cyclists	
Wednesday 30th May 2012	13:30 - 13:50	2	1	1	1	15
	14:00 - 14:20	3	-	-	2	15
	14:30 - 14:50	-	2	2	6	30
	15:00 - 15:20	2	1	-	5	24
	15:30 - 15:50	12	1	-	8	63

Date	Time of survey	Number of users				Estimated number of users p / hr*
		Walkers	Joggers	Dog walkers	Cyclists	
	16:00 - 16:20	2	2	-	6	30
Sunday 17th June 2012	14:15 - 14:35	28	5	-	11	132
	14:45 - 15:05	16	8	-	8	96
	15:15 - 15:35	42	8	1	22	219
	15:45 - 16:05	35	-	-	18	159
	16:15 - 16:35	28	5	2	27	186
	16:45 - 17:05	27	3	-	10	120

Survey zone 5 – Barn Elms Playing Fields: LB of Richmond upon Thames[ix]

H.3.30 Surveys of this zone were undertaken in the form of a walking circuit in conjunction with zone 5, lasting approximately 30 minutes in total every two hours.

H.3.31 In summer, Low levels of usage were recorded on the weekday in the school holidays, with higher usage levels recorded on the weekend associated with cricket matches being played by mostly young adults (aged 18 to 39). More intensive usage was observed on weekday afternoons during school term-time, particularly by children aged 5 to 11 years old for a range of sports and fitness activities.

H.3.32 In autumn, levels of weekend usage were observed to be similar to that recorded during summer, with young adults playing football comprising the majority.

H.3.33 For all surveys, users of the playing fields were predominantly White.

H.3.34 See Vol 6 Table H.10 for further details.

Vol 6 Table H.10 Socio-economics – usage levels and type of use at survey zone 5

Date	Time of survey	Approximate number of users*			
		Tennis courts	Sports pitches	Athletics track/field	Other
Summer					
Tuesday 2nd August 2011	13:00	3	-	2	-
	14:00	3	-	2	2 (cycling)
	15:00	4	5	-	-
Sunday 14th August 2011	13:00	2	25	5	-
	14:00	2	50	5	-
	15:00	3	50	3	-
Wednesday 14th September 2011 AM	09:30	-	-	8	-
Wednesday 14th September 2011 PM	14:10	-	30	-	2 (walking) 2 (sitting)

[ix] Observations were made from the edge of the playing fields.

Date	Time of survey	Approximate number of users*			
		Tennis courts	Sports pitches	Athletics track/field	Other
	17:45	-	-	-	-
Autumn					
Saturday 8th October 2011	13:50	-	58	-	2 (informal fitness training)
	15:30	-	37	33	-
	18:00	-	-	-	-
Tuesday 11th October 2011 PM	09:40	4	-	1	-
	14:20	-	ca. 100	-	2 (dog walking)

** Observations were made from beyond the perimeter of the playing fields and counted as accurately as possible.*

Survey zone 6 – Barn Elms School Sports Centre: LB of Wandsworth[x]

Open space usage survey findings

H.3.35 Surveys of this zone were undertaken in the form of a walking circuit in conjunction with zone 4, lasting approximately 30 minutes in total.

H.3.36 Weekday usage of the sports pitches in zone 5 during school term-time fluctuated between 0 and approximately 100 secondary schoolchildren, with afternoons tending to be busier than mornings.

H.3.37 Weekend usage was predominantly by young adults and was observed to be heavier during autumn (rugby) than summer (cricket).

H.3.38 On all surveys undertaken less than two-thirds of the total number of pitches were recorded as being in use.

H.3.39 See Vol 6 Table H.11 and Vol 6 Table H.12 below for further details.

[x] Observations were made from the edge of the playing fields.

Vol 6 Table H.11 Socio-economics – usage levels and type of use at survey zone 6

Date	Time of survey	Approximate number of users*		
		Tennis courts	Sports pitches	Other
Summer				
Tuesday 2nd August 2011 (school holidays)	12:15	-	ca. 100	-
	13:00	-	ca. 100	-
	15:00	-	ca. 100	
Sunday 14th August 2011	12:00	2	-	1 (jogging)
	14:00	8	-	-
	15:00	8	ca. 25	-
Wednesday 14th September 2011 AM	08:20	-	-	-
	09:10	-	ca. 20	-
	10:15	-	-	-
Wednesday 14th September 2011 PM	14:10	ca. 40	ca. 110	-
	17:30	6	-	-
Autumn				
Saturday 8th October 2011	13:45	-	ca. 105	-
	15:25	-	ca. 105	-
Tuesday 11th October 2011	09:45	-	ca. 15	-
	14:15	-	ca. 100	-

** Observations were made from beyond the perimeter of the playing fields and counted as accurately as possible.*

Vol 6 Table H.12 Socio-economics – approximate user demographics at survey zone 6

Date	Time of survey	Age (%)			Gender (approximate %)		Ethnicity (approximate %)*			
		0-17	18-39	40+	M	F	Black	E. Asian	S. Asian	White
Summer										
Tuesday 2nd August 2011	12:15	100	-	-	50	50	5	-	5	90
	13:00	100	-	-	50	50	5	-	5	90
	15:00	100	-	-	50	50	5	-	5	90
Sunday 14th August 2011	12:00	-	100	-	67	33	-	-	-	100
	14:00	-	100	-	50	50	-	-	-	100
	15:00	-	100	-	100	-	-	-	6	94
Wednesday 14th September 2011	08:20	-	-	-	-	-	-	-	-	-
	09:10	100	-	-	100	-	10	-	10	80
	10:15	-	-	-	-	-	-	-	-	-
	14:10	100	-	-	84	16	5	5	15	75
	17:30	67	33	-	67	33	-	-		100
Autumn										
Saturday 8th October 2011	13:45	-	100	-	100	-	5	-	5	90
	15:25	-	100	-	100	-	5	-	5	90
Tuesday 11th	09:45	-	40	60	20	80	-	-	-	100

Date	Time of survey	Age (%)			Gender (approximate %)		Ethnicity (approximate %)*			
		0-17	18-39	40+	M	F	Black	E. Asian	S. Asian	White
October 2011	14:15	98	-	2	50	50	5	5	9	81

Note: Observations were made from beyond the perimeter of the playing fields and counted as accurately as possible.

LB of Wandsworth data on use of Barn Elms School Sports Centre

H.3.40 Pitch usage and availability information for 2010-11 were provided by LB of Wandsworth.

H.3.41 Information provided indicate that the facility is well used by schools and other groups, but that there are relatively few instances where the use of the facility is at or near its maximum capacity.

H.3.42 Although demand varies according to type of activity, season and school holidays, the information provided indicates that weekday mornings and Saturday afternoons are peak times for pitch use.

H.3.43 During winter term time 2010 (the most recent data available) demand for football pitches (excluding junior pitches) peaks at 71.4% utilisation on Saturday afternoons between 2pm and 4pm. This rises to 85.7% during winter holidays-half term. During summer term time, demand for Australian rules pitch space peaks when full capacity (ie, one field) is utilised on a Saturday between 12pm and 6pm.

H.3.44 During summer (holidays and half term) demand for cricket ground space peaks when full capacity ie, three pitches are utilised on Sundays between 1pm and 7pm. During the same period, demand for Australian rules pitch space peaks when 100% of capacity is utilised on a Saturday between 12pm and 6pm.

H.3.45 See Vol 6 Table H.13 and Vol 6 Table H.14 for LB of Wandsworth supplied data on timetable and average user numbers of the facility.

Vol 6 Table H.13 Socio-economics –timetable of facility use (weekdays) (2010-11)[8]

Date	Winter (term time)			Winter (holidays- half terms)	
	School / club (activity)	Approximate number of users	Time	School / activity	Time and approximate number of users
Monday	London Oratory (Rugby)	100	13:30 - 15:30	Chelsea Football in the Community	10:00-15:00 50
	Fulham Prep (5-a-side)	30	14:00 - 15:30		
	Thomas's Battersea (Football)	30	13:30 - 15:30		
	London Oratory (Astroturf)	40	13:30 - 15:30		
	St Cecilia's (Grids)	40	09:00 - 10:00 13:00 - 14:00		
	Cardinal Vaughan (Tennis)	40	14:00 - 15:00		
Tuesday	London Oratory (Rugby)	100	13:30 - 15:30	Chelsea Football in the Community	10:00-15:00 50
	St Cecilia's (5-a-side)	40	09:00 - 10:00 13:00 - 14:00		
	St Cecilia's (Grids)	40	09:00 - 11:00 13:00 - 14:00		
	Cardinal Vaughan (Tennis)	40	14:00 - 15:00		
	London Oratory (Astro)	40	13:30 - 15:30		
	Fulham Prep (5-a-side)	30	14:00 - 15:30	London Oratory (Rugby)	13:30-15:30 100
	Thomas's Battersea (Football)	30	13:30 - 15:30		
	Fulham Prep (Football)	30	14:00 - 15:30		
	St Cecilia's (Football)	40	15:00 - 17:30		
	St James (Netball)	40	13:30 - 17:00		
	Barnes Rugby Club	40	19:00 - 21:30		
Wednesday	Thomas's Battersea (Football)	30	13:30 - 15:30	Chelsea Football in the Community	10:00-15:00 50
	Fulham Prep (Football)	30	14:00 - 15:30		
	Holland Park (Football)	*	14:30 - 17:30		
	St Cecilia's (Football)	40	15:00 - 17:30		
	London Oratory (Rugby)	100	13:30 - 15:30		
	St Cecilia's (5-a-side)	40	09:00 - 10:00	London Oratory (Rugby)	13:30-15:30 100
	Fulham Prep (5-a-side)	30	14:00 - 15:00		
	Lion House (Astro)	40	13:30 - 14:30		
	Cardinal Vaughan (Tennis)	40	14:00 - 15:00		
	St Cecilia's (Grids)	40	09:00 - 10:00		
Thursday	St Cecilia's (Grids)	40 each	09:00 - 10:00 12:30 - 13:30	Chelsea Football in the Community	10:00-15:00 50
	St James (Grids)	40	13:30 - 15:00		
	Thomas's Battersea (Football)	30	15.30 - 16:00		
	St Thomas More (Football)	*	16:00 - 18:00		

Date	Winter (term time)			Winter (holidays- half terms)	
	School / club (activity)	Approximate number of users	Time	School / activity	Time and approximate number of users
	St Cecilia's (Football)	40	15:00 - 17:00		
	St James (Football)	*	15:30 - 17:30		
	London Oratory (Astro)	40	13:30 - 15:30	London Oratory (Rugby)	13:30-15:30 100
	London Oratory (Rugby)	100	13:30 - 15:30		
	St James (Rugby)	*	13:30 - 15:00		
	St Cecilia's (5-a-side)	40	09:00 - 11:30		
	Fulham Prep (5-a-side)	30	13:30 - 15:30		
	Barnes Rugby Club	40	19:00 - 21:30		
Friday	St Cecilia's (5-a-side)	40	09:00 - 10:00	Chelsea Football in the Community	10:00-15:00 50
	Thomas's Battersea (5-a-side)	30	13:30 - 14:30		
	St Cecilia's (Grids)	40	09:00 - 10:00 11:00 - 12:00		
	London Oratory (Rugby)	100	13:30 - 14:30	London Oratory (Rugby)	13:30-15:30 100
	Cambridge (Netball)	40	13:30 - 14:30		
	Cambridge (Football)	40	13:30 - 14:30		

Date	Summer (term time)			Summer (holidays- half terms)	
	School / club (activity)	Approximate number of users	Time	School / club	Time and approximate number of users
Monday	London Oratory (Cricket Nets)	20	14:00 - 15:00	Passport to Leisure	09:00-15:00 150
	Putney High (Athletics Trk)	30	16:30 - 18:30		
	Thomas's Battersea (Cricket Nets)	30	14:00 - 15:00		
	London Oratory (Tennis Courts)	30	14:00 - 15:00	Chelsea Football in the Community	10:00-15:00 50
	Thomas's Battersea (Cricket)	30	14:00 - 16:30		
	Fulham Prep (Cricket)	30	14:00 - 15:30		
	Fulham Prep (Rounders)	*	14:00 - 15:00		
Tuesday	Fulham Prep (Cricket)	30	14:00 - 15:30	Passport to Leisure	09:00-15:00 150
	Thomas's Battersea (Cricket)	30	14:00 - 16:30		
	Fulham Prep (Rounders)	*	14:00 - 15:00	Chelsea Football in the Community	10:00-15:00 50
Wednesday	London Oratory (Cricket)	20	14:00 - 15:00	Passport to Leisure	09:00-15:00 150
	Thomas's Battersea (Cricket)	30	14:00 - 15:00		

Date	Summer (term time)			Summer (holidays- half terms)	
	School / club (activity)	Approximate number of users	Time	School / club	Time and approximate number of users
	London Oratory (Tennis)	30	14:00 - 15:00	Kensington and Chelsea CC	16:30-18:30
	Thomas's Battersea (Cricket)	30	14:00 - 15:00		50
	Fulham Prep (Cricket)	30	14:00 - 15:30	Chelsea Football in the Community	10:00-15:00
	Fulham Prep (Rounders)	*	14:00 - 15:00		50
Thursday	London Oratory (Cricket)	20	14:00 - 15:00	Passport to Leisure	09:00-15:00
	London Oratory (Tennis)	30	14:00 - 15:00		150
	Fulham Prep (Cricket)	30	14:00 - 15:30		
	Thomas's Fulham (Cricket)	*	16:30 - 17:30	Chelsea Football in the Community	10:00-15:00
	Thomas's Batt'sea (Cricket)	30	14:00 - 15:00		50
	Fulham Prep (Rounders)	*	14:00 - 15:00		
Friday	London Oratory (Cricket)	20	14:00 - 15:00	Passport to Leisure	09:00-15:00
	London Oratory (Tennis)	30	14:00 - 15:00		150
	Thomas's Battersea (Cricket)	30	14:00 - 15:00	Chelsea Football in the Community	10:00-15:00
	Cambridge (Rounders)	40	14:00 - 15:00		50

*Note: Source: LB of Wandsworth Sports and Leisure Department, January 2011 * Approximate user number not supplied*

Vol 6 Table H.14 Socio-economics –timetable of facility use (weekends) (2010-11)

Date	Winter (term time)			Winter (holidays- half terms)		
	School /club (activity)	Approximate number of users	Time	School / club (activity)	Approximate number of users	Time
Saturday	Barnes Minis (Rugby)	50	09:00 - 11:30	Barnes Minis (Rugby)	50	09:30 - 11:30
	London Oratory (Rugby)	175	09:30 - 12:00			
	Barnes RFC	100	15:00 - 17:00	Barnes RFC	175	14:30 - 16:30
	London Exiles (Rugby)	50	14:00 - 16:00	Old Eastbournians	*	12:00 - 16:00
	Old Roehamptonians	30	14:00 - 16:00	Somerville (Football)	30	14:00 - 16:00

Date	Winter (term time)			Winter (holidays- half terms)		
	School /club (activity)	Approximate number of users	Time	School / club (activity)	Approximate number of users	Time
	(Football)					
	Pricewaterhouse (Football)	30	14:00 - 16:00	Pricewaterhouse (Football)	30	14:00 - 16:00
	Arian FC	30	14:00 - 16:00	AFC Cubo (Football)	30	14:00 - 16:00
	Shene Old Grammar	30	14:00 - 16:00	Kew Park Vets (Football)	30	14:00 - 16:00
	Witan FC	30	14:00 - 16:00	Shene Old Grammarians (Football)	30	14:00 - 16:00
Sunday	Tim Pike Tennis	25	11:00 - 13:30	Tim Pike Tennis (Football)	25	11:00 - 13:30
	Deloitte (Football)	30	10:00 - 12:00	Deloitte (Football)	30	10:00 - 12:00
	Pricewaterhouse (Football)	30	10:00 - 12:00	Pricewaterhouse (Football)	30	10:00 - 12:00
	Pricewaterhouse (Football)	30	14:00 - 16:00	Pricewaterhouse (Football)	30	14:00 - 16:00
	KPMG (Football)	30	10:00 - 12:00	KPMG (Football)	30	10:00 - 12:00
	League of Gentleman (Football)	30	12:00 - 14:00	League of Gentleman (Football)	30	12:00 - 14:00

Date	Summer (term time)			Summer (holidays- half terms)		
	School /club (activity)	Approximate number of users	Time	School / club (activity)	Approximate number of users	Time
Saturday	Kensington and Chelsea Cricket Club	50	13:00 - 19:00	Casual Cricket Booking	-	12:30 - 19:00
	All Saints Cricket Club	40	10:00 - 19:00	All Saints Cricket Club	40	10:00 - 19:00
	Australian Rules FA	120	12:00 - 18:00	Australian Rules FA	120	12:00 - 18:00
Sunday	Tim Pike Tennis (Tennis)	25	11:00 - 13:30	Tim Pike Tennis (Tennis)	25	11:00 - 13:30
	Spencer Cricket Club	*	09:30 - 13:00	Thunderers Cricket Club	40	11:00 - 19:00
	Saracen Riffs Cricket Club	40	10:00 - 19:00	Saracen Riffs Cricket Club	40	13:00 - 19:00
	Kensington and Chelsea Cricket Club	50	13:00 - 19:00	Kensington and Chelsea Cricket Club	50	13:00 - 19:00

*Note: Source: LB of Wandsworth Sports and Leisure Department, January 2011 * Approximate user number not supplied*

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix I: Townscape and visual

APFP Regulations 2009: Regulation **5(2)(a)**

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Appendix I: Townscape and visual

I.1 Introduction

I.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix J: Transport

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Appendix J: Transport

J.1 Introduction

J.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 6: Barn Elms appendices

Appendix K: Water resources - groundwater

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Appendix K: Water resources - groundwater

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Appendix K: Water resources – groundwater

K.1 Geology

K.1.1 A summary of the anticipated geological succession at the Barn Elms site is shown in Vol 6 Table K.1 below.

Vol 6 Table K.1 Groundwater – anticipated geological succession

Period	Series	Group	Formation
Quaternary	Holocene	Superficial deposits	Made ground
			Alluvium
	Pleistocene		River Terrace Deposits
Palaeogene	Eocene	Thames	London Clay Formation

K.1.2 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS)[1], is shown in Vol 6 Figure 13.4.1 and Vol 6 Figure 13.4.2 respectively (see separate volume of figures).

K.1.3 The ground investigation undertaken for the Thames Tunnel project has involved drilling boreholes both on the banks and within the main river channel for the purposes of understanding the geology and hydrogeology within the assessment area. The depths and thicknesses of geological layers are based on ground investigation boreholes drilled on site; these are boreholes PR1113, SR1114, SA1115 and SR1116. The locations of boreholes around the site are shown in Vol 6 Figures 13.4.1 and 13.4.2 (see separate volume of figures). The depths and thicknesses of geological layers encountered are summarised in Vol 6 Table K.2 below.

Vol 6 Table K.2 Groundwater – anticipated ground conditions

Formation	Top elevation* mATD**	Depth below ground level (m)	Thickness (m)
Made Ground	103.69	0.00	2.00
River Terrace Deposits	101.69	2.00	7.00
London Clay			
B	94.69	9.00	18.50
A3ii	76.19	27.50	11.60
A3i	64.59	39.10	3.00
A2	61.59	42.10	10.90

** Based on a ground level of 103.69maTD.*

*** mATD = metres above tunnel datum. A commonly used term for sub-surface construction projects, which defines height above a datum set at -100mAOD (above Ordnance Datum).*

K.1.4 The CSO drop shaft and base slab at the Barn Elms site would extend down to approximately 70.75mATD and 68.75mATD respectively and would pass through the Made Ground, River Terrace Deposits and into the London Clay Formation, units B and A3ii.

K.1.5 The West Putney connection tunnel would be constructed within the London Clay Formation, unit A3.

K.1.6 The interception chamber and culvert approximately 5m, as assumed for the purpose of this assessment, would extend down to 98.7m and into the River Terrace Deposits.

K.1.7 The Made Ground, containing sandy slightly gravely clay with brick and occasional clinker, is expected to be 2.0m thick at the site.

K.1.8 The River Terrace Deposits are formed of extensive alluvial sand and gravel deposits laid down in river terraces by a braided river system of approximately 5km width, in river terraces since the Anglian glaciation. The River Terrace Deposits are expected to be 7.0m thick at the site.

K.1.9 The London Clay comprises firm to very stiff clay, slightly sandy and slightly gravely in places and fissured in places. The London Clay is divided into sub-units referred from oldest to youngest as A to E, with some of these sub-units dividing further, for example A2, A3i-iii, B in decreasing age order. The London Clay Formation is expected to be 44m thick at the site.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the Barn Elms site is shown in Vol 6 Table K.3 below.

Vol 6 Table K.3 Groundwater – anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial deposits	Made ground	Hydraulic continuity with upper aquifer
	River Terrace Deposits	Upper aquifer
Thames	London Clay	Aquiclude[i]

K.2.2 The Made Ground overlies the River Terrace Deposits or upper aquifer. The ground investigation boreholes drilled on site indicate that these superficial deposits were drilled dry.

[i] *Aquiclude – a geological formation through which virtually no water moves (EA website, 2012).*

K.2.3 The upper aquifer (River Terrace Deposits) is defined by the Environment Agency (EA) as a secondary A aquifer. These deposits are described as "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers".[2]

K.2.4 The lower aquifer, comprising of the Upnor Formation, the Thanet Sands and the Chalk, is not expected to be encountered by the Thames Tunnel project at the Hammersmith Pumping Station site.

K.2.5 The CSO shaft would pass through the upper aquifer and into the London Clay Formation (B and A3ii sub divisions). The London Clay Formation is generally acknowledged as an aquiclude between the upper and lower aquifers. Any groundwater present in a majority of the London Clay Formation is likely to consist of localised seepages and/or minor flows. It is anticipated that below the River Terrace Deposits the shaft would be excavated in predominantly dry London Clay Formation with the exception of minor seepage at various horizons, namely silt or claystone horizons. In unit A3ii, the presence of fine sand laminea/lenses at this horizon, may act as horizontal conduits for migration of groundwater from a nearby source.

K.3 Groundwater level monitoring

K.3.1 Groundwater level monitoring was undertaken at a number of ground investigation boreholes across the assessment area with a few exceptions. In addition, the EA has a regional network of monitoring boreholes, mainly within the lower aquifer, across London which records are available dating back over 50 years.

K.3.2 Information on groundwater levels for this assessment was collected from one of the three on site ground investigation boreholes (SA1115). This borehole has a response zone[ii][3] and monitors groundwater levels in the River Terrace Deposits. The response zone depth, the monitored strata and the frequency of monitoring area detailed in Vol 6 Table K.4. The manual dip data collected from this monitoring borehole is shown in Vol 6 Table K.5.

Vol 6 Table K.4 Groundwater – monitoring borehole details

Borehole	Response zone mATD	Strata	Monitoring
SA1115	101.41-95.41	River Terrace Deposits	Fortnightly manual dips and 15 minute logger data

[ii] Response zone – the section of a borehole that is open to the host strata (EA, 2006).

Vol 6 Table K.5 Groundwater – summary level data

Borehole ID	Period of record	Maximum		Minimum		Average over period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
SA1115	02/10/09 – 05/04/12	2.53 (Mar. 2010)	101.38 (Mar. 2010)	3.38 (Mar. 2012)	100.52 (Mar. 2012)	3.07	100.84

K.3.3 The recorded water levels in the River Terrace Deposits at SA1115 range between 100.46 to 101.38mATD during the monitoring period. These levels remain below the top of the formation at 101.69mATD, suggesting that the River Terrace Deposits are not fully saturated here. The water levels show seasonal variation and fluctuate with the tidal cycle.

K.3.4 A plot of the groundwater levels within the River Terrace Deposits in the vicinity of the site is shown in Vol 6 Figure 13.4.3 (see separate volume of figures). There is only one borehole in the upper aquifer on the site and as such it is difficult to determine the direction of groundwater flow. However it is expected that the direction of groundwater movement is to the east towards the River Thames in these shallow deposits.

K.3.5 None of the EA groundwater level monitoring boreholes are sufficiently close to the Barn Elms site to provide representative water levels in the upper aquifer.

K.4 Groundwater abstractions and protected rights

Groundwater licensing policy

K.4.1 The London Catchment Abstraction Management Strategy (CAMS), (EA, 2006)[4] does not identify a condition status for the upper aquifer.

K.4.2 The status of the lower aquifer is not relevant to this assessment as the construction would not reach to this depth at Barn Elms site.

K.4.3 No dewatering of the upper or lower aquifers is anticipated at the Barn Elms site. Any water entering the excavation from either the superficial deposits or from minor seepages through silt layers in the London Clay would be pumped to the sewer via appropriate settlement tanks.

Licensed abstractions

K.4.4 The EA licenses abstractions from groundwater within London for all sources in excess of $20m^3/d$. Groundwater abstractions within 1km of the site have been identified.

K.4.5 The licensed abstractions from the lower aquifer (Chalk) would be unaffected due to construction taking place entirely within the upper aquifer and the London Clay.

K.4.6 There are no known unlicensed groundwater abstractions within 1km of the site.

Vol 6 Table K.6 Groundwater – licensed abstractions

Licence number	Licence holder	Purpose	Aquifer	Licensed volume [m^3/annum]
28/39/39/0177	Trustees of the Hurlingham Club	Industrial, commercial and public services	River Terrace Deposits	15,000

K.5 Groundwater source protection zones

K.5.1 The EA defines source protection zones (SPZ) around all major public water supply abstractions sources and large licensed private abstractions in order to safeguard groundwater resources from potentially polluting activities.

K.5.2 There are no SPZs delineated within the vicinity of site. The nearest SPZ for a Chalk source lies approximately 5.2km to the east of the Barn Elms site.

K.6 Environmental designations

K.6.1 A Site of Special Scientific Interest (SSSI) is designated at the Barn Elms Wetland Centre. This is located 140m to the north of the Barn Elms site on the same side of the River Thames.

K.6.2 In addition, to the south of the SSSI, at approximately 0.7km from the Barn Elms site, are a series of playing fields, which are a Grade 2 Site of Borough Importance and Site of Nature Conservation Interest (SNCI).

K.6.3 As dewatering of the upper aquifer is anticipated at the Barn Elms site, the SSSI and the SNCI are not anticipated to be impacted by construction or operation. There are no other environmental designations relevant to groundwater in the vicinity of the site.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical land use mapping, reviewed for the land quality assessment, at the Barn Elms site identified the presence of a tank on site between 1951 and 1952, the contents of which are unknown (Vol 6 Section 8). In addition, minor areas of excavation were also identified on the proposed site between 1951 and 1952. These are considered potentially contaminative on site land uses.

K.7.2 The groundwater quality data presented in Vol 6 Table K.7 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tunnel project and includes data from a monitoring borehole located on site (SA1115) the location is listed in Vol 6 Figure 13.4.1 (see separate volume of figures). The origin of this borehole and groundwater quality data is detailed in Vol 6 Table K.7. Any exceedances

of the UK drinking water standards[5] or relevant Environmental Quality Standards (EQS)[6] are shaded in blue in this table.

K.7.3 The data shows only one exceedance of the relevant standards in the River Terrace Deposits for nitrate at SA1115.

K.7.4 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show a few exceedances of the human health screening values[7] (soil guideline values designed to be protective of human health) with respect to heavy metals within the Made Ground, Alluvium and River Terrace Deposits. Further detail is provided in the land quality assessment (see Vol 6 Appendix F).

K.7.5 The EA monitors groundwater quality at a number of points across London, mainly the Chalk and Lower London Tertiaries (Lambeth Group) (EA, 2006). The water quality information provided from this network is not relevant to the site, where construction would take place entirely with the London Clay.

Vol 6 Table K.7 Groundwater – groundwater quality results

Source of data*				SI
Borehole ID				SA1115
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			221m
Chemical	**Value**	**Units**	**Source**	2009
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	< 0.1
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	-	< 0.1
2,4,6 - Trichlorophenol	-	ug/l	-	< 0.1
2,6 - Dichlorophenol	-	ug/l	-	< 0.1
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	< 0.1
Acenaphthene	-	ug/l	-	< 0.01
Acenaphthylene	-	ug/l	-	< 0.01
Aliphatics >C10-C12	-	ug/l	-	< 1
Aliphatics >C12-C16 (Aqueous)	-	ug/l	-	3
Aliphatics >C16-C21 (Aqueous)	-	ug/l	-	7
Aliphatics >C21-C35 (Aqueous)	-	ug/l	-	10
Aliphatics >C6-C8	-	ug/l	-	< 0.1
Aliphatics >C8-C10	-	ug/l	-	< 0.1
Aliphatics C5-C6	-	ug/l	-	< 0.1
Alkalinity (Carbonate)	-	mg/l as CaCO3	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	-	290
Aluminium Total	200	ug/l as Al	DWS 2010	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-
Ammoniacal nitrogen	-	mg/l	-	0.34
Anthracene	0.1	ug/l	SW WFD	< 0.01
Aromatics >C7-C8	50	ug/l	WFD 2010	< 0.1
Aromatics >EC10-EC12	-	ug/l	-	4

Source of data*				SI
Borehole ID				SA1115
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			221m
Chemical	**Value**	**Units**	**Source**	2009
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	-	5
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	-	7
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	-	14
Aromatics >EC8-EC10	-	ug/l	-	< 0.1
Aromatics C6-C7	1	ug/l	DWS 2010	< 0.1
Arsenic Total	10	ug/l as As	DWS 2010	< 1
Atrazine { }	0.1	ug/l	DWS 2010	-
Bentazone	0.1	ug/l	DWS 2010	-
Benzene	1	ug/l	DWS 2010	< 1
Benzo (a) anthracene	-	ug/l	-	< 0.01
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	< 0.01
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	< 0.01
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	< 0.01
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	< 0.01
Boron Total	1000	ug/l as B	DWS 2010	290
Bromate	10	ug/l as BrO3	DWS 2010	-
Cadmium Total	5	ug/l as Cd	DWS 2010	< 2
Calcium Total	250	mg/l as Ca	DWS 2010	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-
Carbetamide	-	ug/l	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-
Chloride	250	mg/l as Cl	DWS 2010	91
Chloroform	100	ug/l	WS Regs 20	-
Chlortoluron	2	ug/l	FW List II	-
Chromium Total	50	ug/l as Cr	DWS 2010	< 5
Chrysene	-	ug/l	-	< 0.01
Clopyralid	-	ug/l	-	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	960

Source of data*				SI
Borehole ID				SA1115
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			221m
Chemical	**Value**	**Units**	**Source**	2009
Copper Total	2000	ug/l as Cu	DWS 2010	3
Cresols	-	ug/l	-	< 0.1
Cyanazine	0.1	ug/l	DWS 2010	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	< 20
Cyanide (Total)	50	ug/l as CN	DWS 2010	< 40
Cypermethrin	0.0001	ug/l	WFD 2010	-
Dalapon	-	ug/l	-	-
Diazinon	0.1	ug/l	DWS 2010	-
Dibenz-[A,H]-Anthracene	-	ug/l	-	< 0.01
Dichloromethane	20	ug/l	WFD 2010	-
Dichlorprop	0.1	ug/l	DWS 2010	-
Diuron	0.1	ug/l	DWS 2010	-
Ethylbenzene	-	ug/l	-	< 1
Fluoranthene	0.2	ug/l	EEC MAC	< 0.01
Fluorene	-	ug/l	-	< 0.01
Fluoride	1.5	mg/l as F	DWS 2010	-
Glyphosate	-	ug/l	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	< 0.01
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-
Lead Total	10	ug/l	WS Regs 20	< 4
Magnesium Total	50	mg/l as Mg	EEC MAC	14
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-
Mecoprop { }	0.1	ug/l	DWS 2010	-
Mercury Total	1	ug/l Hg	WS Regs 20	< 0.05
Metazachlor	-	ug/l	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	-	< 1
Multi Residual Scan	-	ug/l	-	-
Naphthalene	1.2	ug/l	WFD D 10	< 0.01
Nickel Total	20	ug/l as Ni	DWS 2010	< 10

Source of data*				SI
Borehole ID				SA1115
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			221m
Chemical	**Value**	**Units**	**Source**	2009
Nitrate - N	11.3	mg/l as N	WS Regs 20	21
pH	10	pH units	DWS 2010	6.8
Phenanthrene	-	ug/l	-	< 0.01
Phenol	0.5	ug/l	EEC MAC	< 0.1
Phenol (Pentachlorophenol (PCP)	-	ug/l	-	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	-	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	< 0.2
Potassium Total	-	mg/l as K	-	-
Propazine	0.1	ug/l	DWS 2010	-
Propetamphos	0.1	ug/l	DWS 2010	-
Pyrene	-	ug/l	-	< 0.01
Selenium	10	ug/l as Se	DWS 2010	< 3
Simazine	0.1	ug/l	DWS 2010	-
Sodium Total	200	mg/l as Na	DWS 2010	44
Sulphate	250	mg/l as SO4	DWS 2010	99
Sulphide	-	ug/l	-	< 10
Terbutryn	0.1	ug/l	DWS 2010	-
Tetrachloroethylene	-	ug/l	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	< 1
Total Aliphatic TPH	-	ug/l	-	20
Total Aromatic TPH	-	ug/l	-	29
Total Chemical Oxygen Demand	-	mg/l	-	25
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-
Trietazine	-	ug/l	-	-
Trifluralin	0.1	ug/l	DWS 2010	-
Turbidity	1	FTU	WS Regs 20	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	< 1
Zinc Total	50	ug/l as Zn	DWS 2010	6

Source of data*				SI
Borehole ID				SA1115
Hydrogeological unit**				RTD
Distance from site	**EQS Criteria**			221m
Chemical	**Value**	**Units**	**Source**	2009
Notes:				
xx	GAC1 exceedance			
' - '	Not tested			
' < '	Less than MDL			

** Origin of data: SI – Groundwater quality data collected during site investigation works by Thames Tunnel project (2009-2011), TT – Groundwater quality data collected during ongoing monitoring works by Thames Tunnel project (2009-2012)*
*** Hydrogeological unit: RTD – River Terrace Deposits*

K.8 Groundwater status

K.8.1 The EC Water Framework Directive (WFD) requires the status of groundwater management units (groundwater bodies) within each river basin to be determined as 'good' or 'poor' by 2015. For groundwater there are two separate classifications for groundwater bodies; chemical status and quantitative status. The WFD aims to achieve good status by 2015, or, where this is not possible and subject to the criteria set out in the Directive, the WFD aims to achieve good status by 2021 or 2027.

K.8.2 The Thames River Basin Management Plan (RBMP)[8] shows no groundwater body designation for either the upper or lower aquifers within the area in which the Barn Elms site is located; therefore no baseline assessment of quantitative or chemical status is available.

K.8.3 The baseline assessment for groundwater status classification for the nearby Greenwich Chalk and Tertiaries (consisting of the Lambeth Group, Thanet Sands, Blackheath Formation and Chalk Formation) shows poor quantitative status and poor quality status for 2009. The predicted quantitative and chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.4 The baseline assessment for groundwater status classification for the nearby Lower Thames Gravels is good quantitative status and poor quality status for 2009. The predicted chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.5 Only eight out of forty-six groundwater bodies within the Thames River basin district are at good status overall; this is not expected to change by 2015 (EA, 2009)[8].

K.8.6 The Thames Tunnel project would prevent deterioration of the current and predicted status of groundwater and would adhere to the key actions identified in the RBMP to achieve good status by 2021 or 2027, as follows (EA, 2009)[8]:

a. The control of pollution to groundwater that may arise from any development which takes place on land.

b. Prevent input of nitrates to groundwater body.

c. Prevent inputs to and mitigate potential mobilisation of copper, other metals and hazardous substances in groundwater.

d. Prevent and mitigate potential inflow of river water to groundwater due to dewatering/ abstraction by implementing working methods to protect surface and groundwater from impacts, including changes to flow, by producing site-specific water management plans and by monitoring where required.

e. Prevent direct discharges of pollutants to groundwater.

K.9 Data sources

K.9.1 A list of data used for the Barn Elms site assessment is given in Vol 6 Table K.8.

Vol 6 Table K.8 Groundwater – desk based baseline data sources

Source	Data	Date received	Notes
BGS	British Geological Survey (BGS) 1:50,000 scale digital geological data	February 2009	
EA	Licensed groundwater abstraction boreholes, their ownership and purpose	December 2010,February 2011 and March 2012	Licensed abstraction rates, aquifer, and status (active or dormant)
LB's*	Unlicensed groundwater abstraction boreholes and their details	June 2009	Contacted 14 London Boroughs along main tunnel alignment
EA	Designated source protection zones	December 2010	
EA	Groundwater level records for EA observation boreholes	September 2009, June 2011, December 2011 and October 2012	
EA	Groundwater quality results for EA observation boreholes	August 2009 and May 2011	
EA	Ground Source Heat Pump (GSHP) schemes and their details	December 2010 and March 2012	
Thames Tunnel project	Ground Investigation (2009) borehole logs, construction details, monitoring regime and available water level records and water quality results from 2009 to 2012	Last updated September 2012	Final ES
Thames Tunnel project	Groundwater monitoring strategy	Draft strategy Feb 2012	
Thames Tunnel project	Land quality data	February 2011	

Source	Data	Date received	Notes
Individual licence holders	Letters sent out to 30 licence holders	December 2011 (last updated 15th October 2012)	

** LBs – London Boroughs*

References

[1] British Geological Survey. *British geology onshore digital maps 1:50 000 scale*. Received from Thames Tunnel project (February 2009).

[2] Environment Agency. *Environment Agency website*. Available at: http://www.environment-agency.gov.uk/homeandleisure/117020.aspx. Accessed April 2012.

[3] Environment Agency. *Guidance on the design and installation of groundwater quality monitoring points Science Report SC020093 (2006)*. Available at: http://publications.environment-agency.gov.uk/PDF/SCHO0106BKCT-E-E.pdf. Accessed November 2012.

[4] Environment Agency. *The London Catchment Abstraction Management Strategy (CAMS).* Final Strategy Document (2006). Available at: http://publications.environment-agency.gov.uk/PDF/GETH0406BKRM-E-E.pdf. Accessed November 2012.

[5] *The Water Supply (Water Quality) Regulations, 2000*. Available at: http://www.legislation.gov.uk/uksi/2000/3184/contents/made. Accessed November 2012.

[6] *River Basin Districts Typology, Standards and Groundwater Threshold Values* (Water Framework Directive) (England and Wales) Direction 2010. Available at: http://www.defra.gov.uk/environment/quality/water/legislation/water-framework-directive/. Accessed November 2012.

[7] Environment Agency. *Soil Guideline Value Reports* (2009). Available at: http://www.environment-agency.gov.uk/research/planning/64015.aspx. Accessed November 2012.

[8] Environment Agency*. River Basin Management Plan, Thames River Basin District* (December 2009). Available at: http://publications.environment-agency.gov.uk/PDF/GETH0910BSWA-E-E.pdf. Accessed November 2012.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix L: Water resources - surface water

APFP Regulations 2009: Regulation **5(2)(a)**

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Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

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Appendix L: Water resources – surface water

L.1 Introduction

L.1.1 Construction and operational effects assessments at this site for this topic do not require the provision of any supporting information, so this appendix is intentionally empty.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix M: Water resources - flood risk

APFP Regulations 2009: Regulation **5(2)(a)**

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Appendix M Water resources – flood risk

M.1 Policy considerations

M.1.1 The relevant planning document that would be used to assess the proposals is the National Policy Statement (NPS) for Waste Water (Defra, 2012)[1] which was published in February 2012.

M.1.2 The Waste Water NPS considers the Thames Tideway Tunnel project as 'nationally significant waste water infrastructure.'

M.1.3 General policy documents (eg, NPS) have been reviewed within Volume 2 Environmental assessment methodology. A summary of local and regional policy relevant to flood risk at Barn Elms is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The Barn Elms site lies within the London Borough (LB) of Richmond upon Thames. The LB of Richmond upon Thames produced a Level 1 Strategic Flood Risk Assessment (SFRA) (Jacobs Ltd, 2008)[2]. This outlines the main flood sources to the borough through a review of existing information.

M.1.5 The SFRA confirms that the Thames Tidal Defence network provide a 0.1% AEP standard of protection downstream of Richmond. The risk of flooding is a residual risk associated with a breach in the defences.

M.1.6 According to the SFRA:

a. The site overlies superficial deposits of Alluvium and River Terrace Deposits

b. The site lies within Environment Agency (EA) Flood Zone 3a

c. The site is within close proximity to Beverley Brook and may be at risk of flooding from the Brook during periods of extreme rainfall

d. The site has a medium to low flood hazard rating (as a consequence of a beach in the tidal flood defences)

e. The site is situated within an area susceptible to surface water flooding.

M.1.7 The SFRA promotes the use of Sustainable Drainage Systems (SuDs) suitable to specific site locations within the borough, depending on underlying geology.

Surface Water Management Plan

M.1.8 The Council, in partnership with the Greater London Authority (GLA), Thames Water and the EA produced a Surface Water Management Plan (SWMP) (GLA, 2011)[3] as part of the Drain London project. The SWMP sets out the preferred surface water management strategy for the borough.

M.1.9 According to the SWMP:

a. The site does not lie within a Critical Drainage Area.

b. The pluvial modelling results show surface water flood depths of up to 1m (for the 1% APE event + 30% Climate Change) to the west of the site. The hazard is significant (ie, danger for most).

c. There have been 51-100 sewer flooding incidents recorded in the Barnes (East) SW151 area and 21-50 recorded incidents in the Barnes (West) SW139 area.

Regional policy

Thames Estuary 2100

M.1.10 The Barn Elms site lies within the Barnes and Kew Policy Unit which has been assigned flood risk management policy 'P5' within the Thames Estuary 2100 (TE2100) Plan (EA, 2012)[4], meaning that further action will be taken to reduce flood risk beyond that required to keep pace with climate change.

M.1.11 The TE2100 Plan identifies the local sources of flood risk (relative to the Barn Elms site) as including:

a. tidal and fluvial flood risk from the River Thames

b. fluvial flood risk from Beverley Brook

c. a risk of groundwater flooding from superficial strata which is possibly connected to high water levels in the Thames.

M.1.12 Flood mitigation from these sources include:

a. the Thames Barrier and secondary tidal defences along the Thames frontage (both making up the Thames Tidal Defences)

b. Beverley Brook flapped outfall, and Beverley Brook bypass culverts that provide relief from fluvial flooding

c. combined sewer overflows (CSOs) for mitigation of urban drainage

d. flood forecasting and warning.

M.1.13 The TE2100 Plan seeks to promote, where possible, defence improvements that ensure views are maintained and impacts to river access/views are minimised. Where defence raising in the future to manage the consequences of climate change is not possible,, secondary defences and floodplain management should be introduced. There is also the vision to increase flood risk awareness within the area.

M.1.14 There is an acknowledgement that accretion of the river bed is occurring at Barnes and Putney.

Thames Region Catchment Flood Management Plan

M.1.15 The Thames Region Catchment Flood Management Plan (CFMP) (EA, 2007)[5] covers fluvial and non-tidal sections of the River Thames, ie, the River Thames upstream of Teddington weir and the River Thames tributaries (including the Beverley Brook).

M.1.16 The Thames Region CFMP advocates the reduction in flood risk through the design and layout of developments within the floodplain. This should be achieved through re-creating more natural river systems and giving space for flood water, aiming for a balance between attenuation and conveyance.

M.1.17 The Beverley Brook has many channel types. In the vicinity of the Barn Elms site the channel is natural with no formal flood defences. The following are referenced for the channel adjacent to the site.

M.1.18 The specific messages for developed floodplain with no built defences are:

a. Reduce flood risk through floodplain management, including removing vulnerable development from the flood plain (over long term).

b. Where there are exceptional circumstances for building in the flood plain, flood risk should be reduced through the redevelopment and urban regeneration process, ie, changing the layout and design of development within the floodplain.

c. Flood defences are not the most sustainable way of reducing risk in all areas in the long term, due to climate change. Sustainable schemes will be implemented but no major flood defences are anticipated in the immediate future.

d. Some land may need to be safeguarded from development for future flood management, eg conveying or storing water.

M.1.19 The specific messages for natural floodplain are:

a. To maximise flood plain capacity and retain water in certain areas. This is advantageous for people and the natural environment.

b. Managed flooding of some natural floodplain will reduce flood risk to some communities.

c. Prevention of development that compromises the capacity of the flood plain to retain water. Floodplain capacity should be increased when maintenance work on river channels is undertaken.

London Regional Flood Risk Appraisal

M.1.20 For the reach between Hammersmith Bridge and the Thames Barrier (City Reach, (does not specify inclusion of the Beverley Brook) the London Regional Flood Risk Appraisal (RFRA) (GLA, 2009)[6] encourages small scale set back of development from the river walls where possible. The aim of this is to enable modification, raising and maintenance in a sustainable, environmentally acceptable and cost effective way. Development should be designed in such a way as to take opportunities to reduce flood risk and include resilience.

M.1.21 There is particular concern surrounding confluences of tributaries into the River Thames and the interactions between tidal and fluvial flows in the future due to climate change.

M.1.22 Flood risk on the Beverley Brook should not be increased into the future.

M.1.23 The RFRA indicates that SuDs should be included within developments to reduce surface water discharge.

References

[1] Department of Environment, Food and Rural Affairs (Defra), *National Planning Policy for Waste Water.* (February 2012).

[2] Jacobs Ltd. *LB of Richmond upon Thames Level 1 Strategic Flood Risk Assessment Final Report.* (June 2008).

[3] Greater London Authority. *LB of Richmond Surface Water Management Plan Final Report.* (August 2011).

[4] Environment Agency. *Thames Estuary 2100 Plan*. (November 2012).

[5] Environment Agency. *Thames Region Catchment Flood Management Plan Summary Report.* (January 2007).

[6] Greater London Authority. *London Regional Flood Risk Appraisal.* (October 2009).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.06**

Volume 6: Barn Elms appendices

Appendix N: Development schedule

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 6 Barn Elms appendices

Appendix N: Development schedule

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Appendix N: Development schedule

N.1 Summary

N.1.1 The assessments undertaken for this site take account of other relevant development projects within the vicinity of the site which are under construction, permitted but not yet implemented or submitted but not yet determined. In order to identify the relevant developments for consideration, the Planning Inspectorate, local planning authorities and the Greater London Authority have been consulted on the methodology (see Volume 2) and asked to assist in identifying and verifying the development projects included in the assessment. A schedule is provided in Vol 6 Table N.1 of the resulting development projects, a description of what is proposed and assumptions on phasing. Longer term development projects may be included under both base case, with construction preceding that of the Thames Tideway Tunnel site, and cumulative with construction or operation occurring at the same time as a given Thames Tideway Tunnel site.

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Vol 6 Table N.1 Development schedule for Barn Elms

Category types:

a. Under construction

b. Permitted but not yet implemented

c. Submitted but not yet determined

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions		Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2017 (Site Year 1 of construction & peak construction traffic year)	2023 (Year 1 of operation)		
Former Putney Hospital	Approx 270m southwest	2012/0758	Wandsworth Council	Demolition of all existing buildings. Erection of a two-storey primary school (with roof top playground) for 420 pupils with associated parking and drop off/pick up area; erection of part three/part four-storey building at northern end of site comprising 24 flats with basement level car and cycle parking. Formation of a new vehicular access off Lower Richmond Road and associated landscaping. This revised application includes an Addendum to the Transport Assessment, Addendum to the Energy and Sustainability Strategy and a Revised Environmental Noise Report. The proposal has been amended to include an increase in the number of rooftop solar panels to 93 on the school and 63 on the residential building and increased cycle parking provision to total 88 which would consist of 60 for the school and 28 for the flats.	C	100% complete & operational	100% complete & operational	LB Wandsworth online planning applications database No phasing information available. Assumed 100% completed by Site Year 1 of construction.	Base case (all years)

Note: phasing and site layout information has been sourced from local authority planning portals unless otherwise indicated.

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