Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

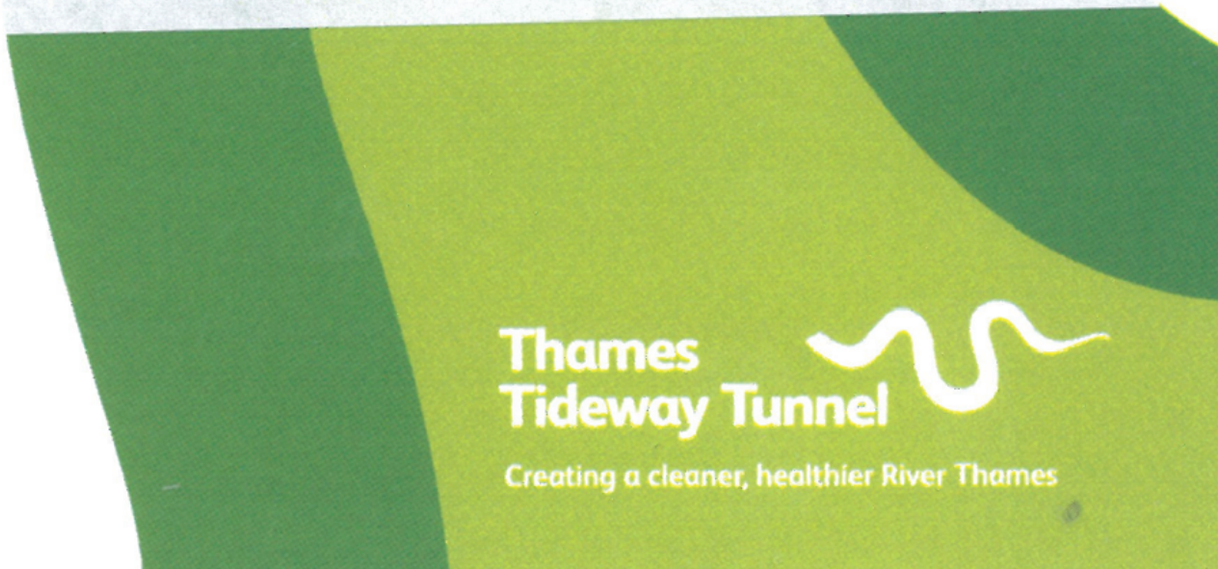
Documents for Certification
September 2014

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
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore appendices

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

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Appendix A: Introduction

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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 16 Albert Embankment Foreshore 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

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Appendix B: Air quality and odour

B.1 Model verification

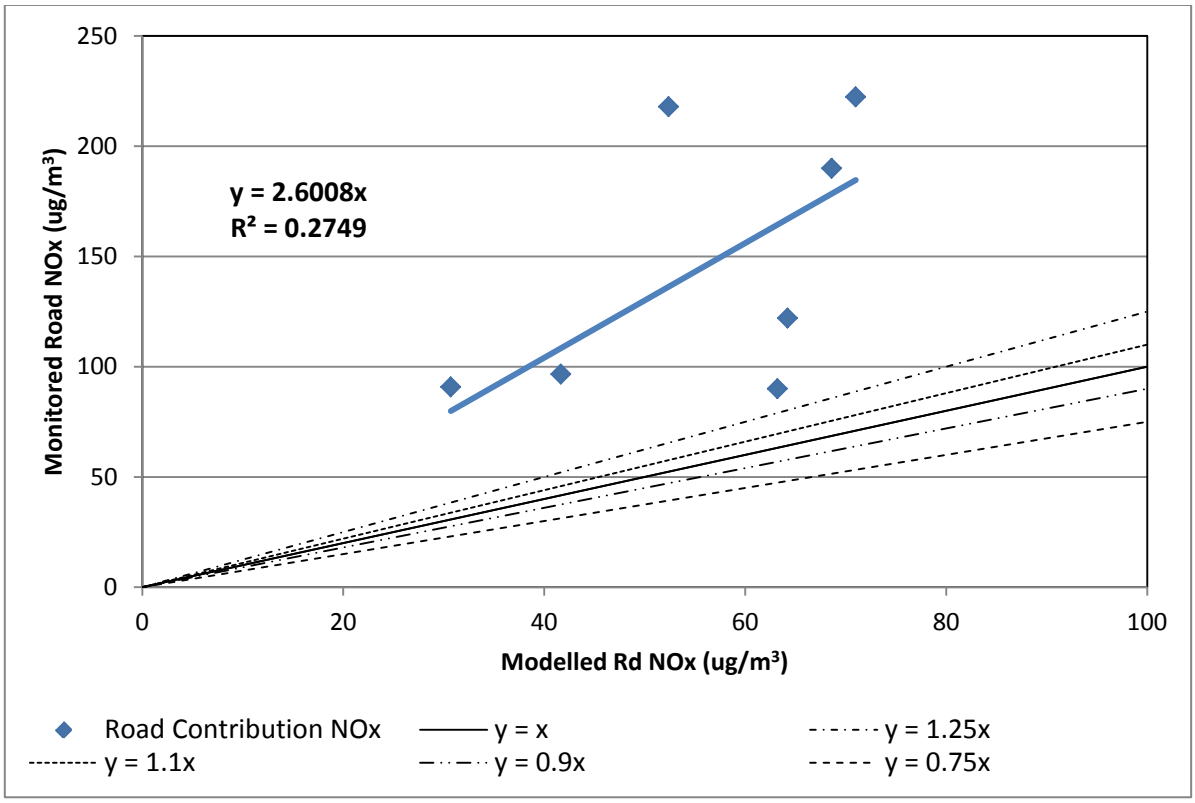
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at seven diffusion tube sites (AEFM1 – AEFM5, HEAM1 and LB5) as shown in Vol 16 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between 9% and 37%. 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.

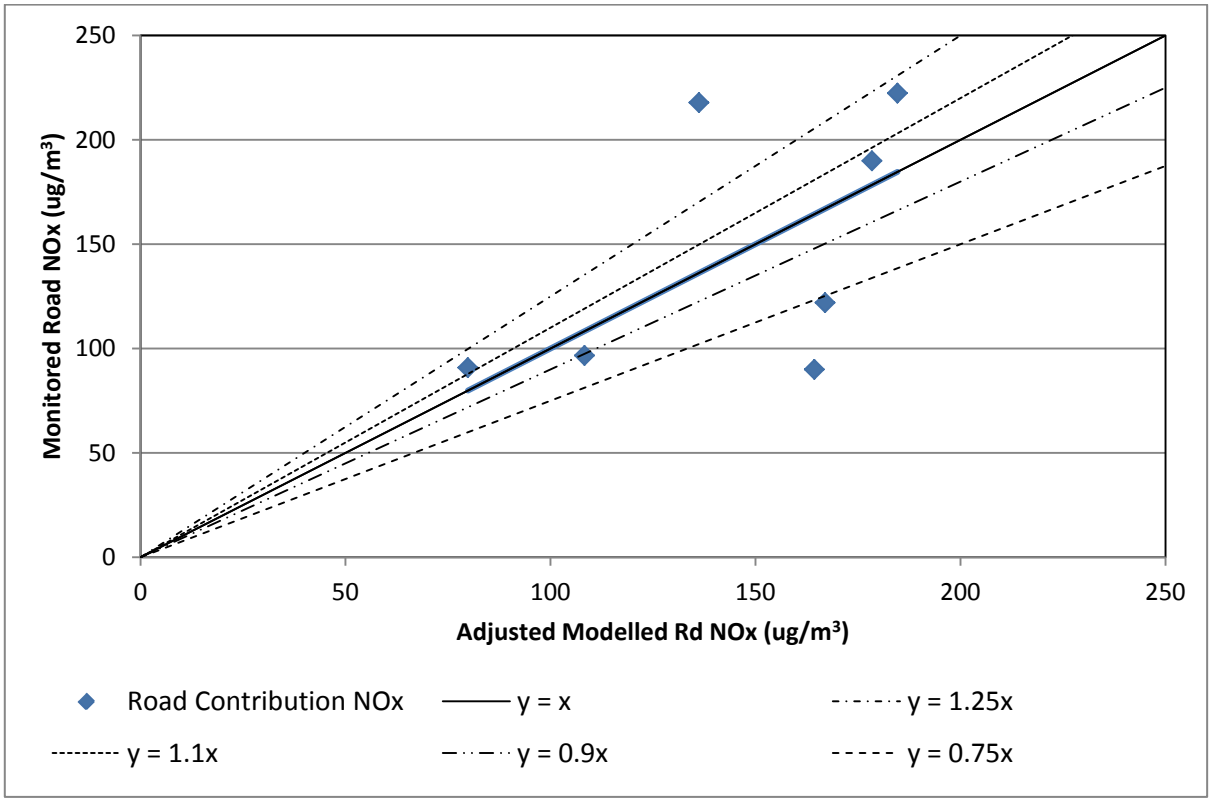
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 16 Plate B.1 below). An adjustment factor of 2.60 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09) (Defra, 2009)[1] and subsequently applied. This factor was also applied to the PM_{10} results as no local PM_{10} monitoring data were available for an area where traffic data were also available.

B.1.4 Applying the NO_X adjustment factor and then calculating NO_2 concentrations, as shown in Vol 16 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 16 Plate B.3, indicated that four of the seven modelled concentrations were within 10% of the measured value and that all seven were within 25% of the modelled value.

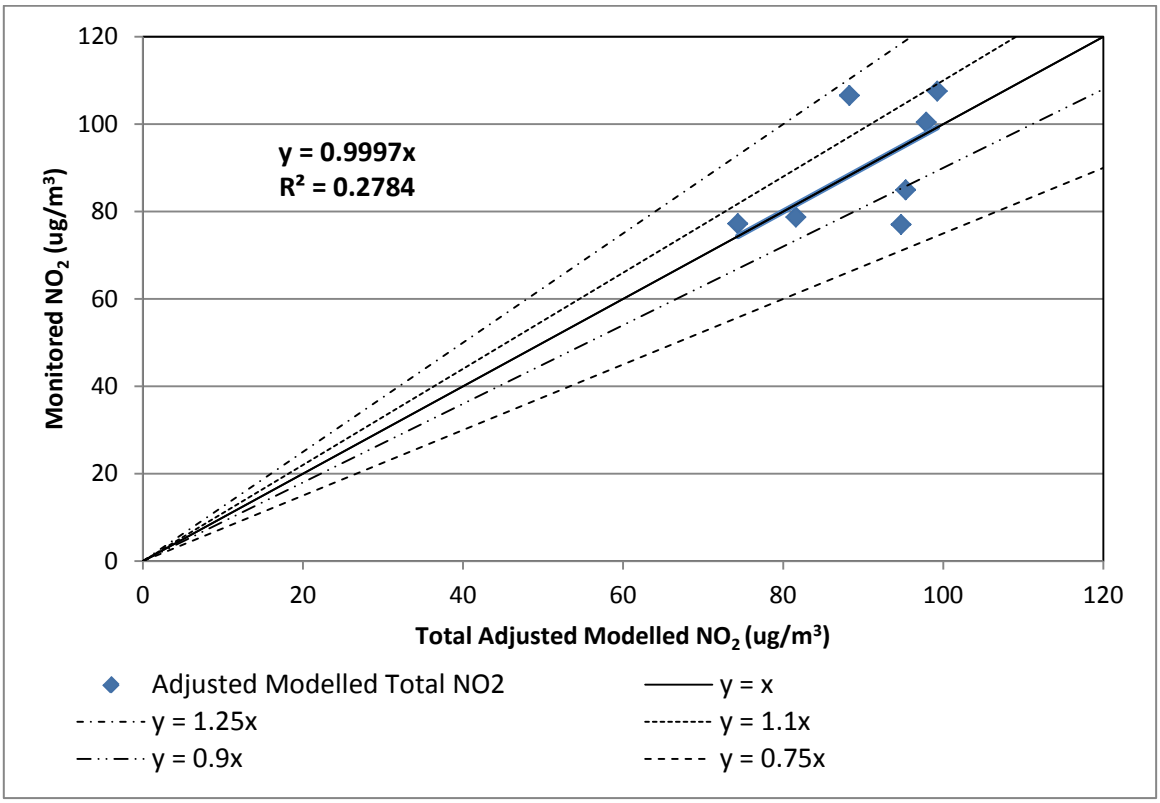
Vol 16 Plate B.1 Air quality – monitored road NO_X vs. modelled road NO_X



Vol 16 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 16 Plate B.3 Air quality – total monitored NO_2 vs. total adjusted modelled NO_2



B.2 Traffic data

B.2.4 The traffic data used in the air quality modelling for the Albert Embankment Foreshore site are shown in Vol 16 Table B.1.

Vol 16 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 construction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construction year development case AADT % HGV (>3.5t)
ATC** 'Indirect'	Albert Embankment south of Lambeth Bridge	31969	7.7	30	30.2	7.4	34350	18	34368	7.8%
TfL Model	Lambeth Bridge	29828	9.0	30	10.3	7.4	32049	25	32074	9.1%
TfL Model	Lambeth Palace Road	26871	9.5	30	15.4	7.4	28872	4	28887	9.5%
TfL Model	Lambeth Road	21476	8.9	30	9.4	7.4	23076	21	23097	9.0%
TfL Model	Vauxhall Bridge	32787	10.3	30	9.6	7.4	35229	0	35229	10.3%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak construction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construction year development case AADT % HGV (>3.5t)
TfL Model	Albert Embankment north of Kennington Lane	4725	14.6	30	20.9	7.4	5076	18	5094	14.9%
TfL Model	Kennington Lane east of Albert Embankment	26146	10.4	30	21.5	7.4	28094	11	28124	10.4%
TfL Model	Kennington Lane east of South Lambeth Road	15889	12.8	30	15.9	7.4	17072	11	17083	12.9%
TfL Model	Harleyford Road	20840	15.5	30	23.3	7.4	22392	10	22403	15.6%
TfL Model	South Lambeth Road north of Parry Street	27885	13.6	30	33.6	7.4	29962	17	30000	13.6%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak construction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construction year development case AADT % HGV (>3.5t)
TfL Model	South Lambeth Road south of Parry Street	17220	12.0	30	11.4	7.4	18503	9	18548	12.0%
TfL Model	Parry Street east of Wandsworth Road	32401	14.0	30	19.7	7.4	34814	17	34848	14.0%
TfL Model	Wandsworth Road south of Parry Street	12799	11.1	30	22.9	7.4	13752	0	13756	11.1%
TfL Model	Nine Elms Lane	27487	16.5	30	11.8	7.4	29535	31	29589	16.6%
TfL Model	Wandsworth Road north of Parry Street	36566	10.4	30	22.9	7.4	39289	23	39323	10.4%
LAEI***	Millbank (A3212)	24778	7.2	30	25.0	7.4	26623	0	26623	7.2%

** AADT – annual average daily traffic. ** - ATC – automatic traffic counter. *** - LAEI – London Atmospheric Emissions Inventory.*

B.3 River tug emission factors

B.3.4 Emissions of NO_X and PM_{10} from tugs pulling the barges were calculated using the data shown in Vol 16 Table B.2 for the Albert Embankment Foreshore site.

Vol 16 Table B.2 Air quality – tug assessment model inputs

Parameter	Value	Units
Total tugs	168	tugs/year
Time per tug*	20	minutes
NO_X base emission factor	10.2	g/kWhr
PM_{10} base emission factor	0.9	g/kWhr
Average tug engine size	984	kW
Manoeuvring and hotelling** load factor	0.2	No units
Total tug area***	4534	m2
NO_X emissions per tug	$1.2x10^{-04}$	g/s/m2
PM_{10} emissions per tug	$1.1x10^{-05}$	g/s/m2

** Time that tug is at the site.*
*** Hotelling refers to when the tug is securely moored or anchored.*
**** Area of the mooring and manoeuvring of tugs*

B.4 Construction plant emission factors

B.4.4 For the purpose of the assessment, the following listed equipment in Vol 16 Table B.3 has been modelled for the peak construction year at the Albert Embankment Foreshore site.

Vol 16 Table B.3 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	$1.9x10^{-07}$	$1.2x10^{-08}$
	Ground level behind hoarding	Generator - 200kVA	1	100	160	$5.7x10^{-07}$	$3.6x10^{-08}$
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	$1.2x10^{-07}$	$7.5x10^{-09}$
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	$4.2x10^{-09}$	$9.1x10^{-09}$
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	$6.4x10^{-08}$	$4.0x10^{-09}$
	Ground level behind hoarding	Hiab*** lorry / crane	1	5	56	$1.0x10^{-08}$	$6.3x10^{-10}$
	Ground level behind hoarding	Well driggin rig	1	50	403	$7.2x10^{-07}$	$4.5x10^{-08}$
Demolition	Ground level behind hoarding	Service crane 25t mobile crane	1	30	275	$3.0x10^{-07}$	$1.8x10^{-08}$
	Ground level behind hoarding	22t excavator complete with hydraulic hammer	1	30	122	$1.3x10^{-07}$	$8.2x10^{-09}$

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	Site dumper	1	30	81	$8.7x10^{-08}$	$5.4x10^{-09}$
	Ground level behind hoarding	Vibrating rollers	2	50	145	$5.2x10^{-07}$	$3.2x10^{-08}$
Cofferdam Construction	Ground level behind hoarding	400cfm compressor	2	50	104	$3.7x10^{-07}$	$2.3x10^{-08}$
	Ground level behind hoarding	150t crawler crane	1	60	240	$5.2x10^{-07}$	$3.2x10^{-08}$
	Ground level behind hoarding	Generator	1	100	28	$1.6x10^{-06}$	$1.5x10^{-07}$
	Ground level behind hoarding	Jack-up barge	1	100	104	$3.7x10^{-07}$	$2.3x10^{-08}$
	Ground level behind hoarding	Secant pile rig	1	60	150	$3.2x10^{-07}$	$2.0x10^{-08}$
	Ground level behind hoarding	25t excavator	2	80	125	$7.2x10^{-07}$	$4.5x10^{-08}$
	Ground level behind hoarding	Plate compactors	2	10	3	$5.5x10^{-09}$	$1.2x10^{-08}$
	Ground level behind hoarding	Vibrating rollers	2	50	145	$5.2x10^{-07}$	$3.2x10^{-08}$
Diaphragm wall construction	Ground level behind hoarding	Diaphragm wall rig (grab)	1	20	250	$1.8x10^{-07}$	$1.1x10^{-08}$
	Ground level behind hoarding	Diaphragm wall rig (hydrofraise)	1	80	250	$7.2x10^{-07}$	$4.5x10^{-08}$

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	Concrete deliveries (discharging)	1	20	223	$1.6x10^{-07}$	$1.0x10^{-08}$
	Ground level behind hoarding	Concrete pump	1	20	223	$1.6x10^{-07}$	$1.0x10^{-08}$
	Ground level behind hoarding	Compressor 400cfm	1	50	104	$1.9x10^{-07}$	$1.2x10^{-08}$
	Ground level behind hoarding	Dumper	1	50	81	$1.5x10^{-07}$	$9.1x10^{-09}$
	Ground level behind hoarding	150t crawler crane	2	50	240	$8.6x10^{-07}$	$5.4x10^{-08}$
Shaft excavation	Ground level behind hoarding	Long reach excavator	2	80	178	$1.0x10^{-06}$	$6.4x10^{-08}$
	Ground level behind hoarding	20t excavator with breaker	2	50	73	$2.6x10^{-07}$	$1.6x10^{-08}$
	Ground level behind hoarding	25t excavator	1	80	125	$3.6x10^{-07}$	$2.2x10^{-08}$
	Ground level behind hoarding	Dumper	1	50	81	$1.5x10^{-07}$	$9.1x10^{-09}$
	Ground level behind hoarding	80t crawler crane	1	50	240	$4.3x10^{-07}$	$2.7x10^{-08}$
	Ground level behind hoarding	150t crawler crane	1	50	240	$4.3x10^{-07}$	$2.7x10^{-08}$

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 ($g/s/m^2$)
Connection tunnel - pipejack	Ground level behind hoarding	100t crawler crane	1	50	240	$4.3x10^{-07}$	$2.7x10^{-08}$
	Ground level behind hoarding	Service Crane 40t mobile crane	1	25	275	$2.5x10^{-07}$	$1.5x10^{-08}$
	Ground level behind hoarding	Dumper	1	25	81	$7.3x10^{-08}$	$4.5x10^{-09}$
	Ground level behind hoarding	Loading shovel	1	30	63	$6.8x10^{-08}$	$4.2x10^{-09}$

*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

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

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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

D.1 Notable species survey report

Introduction

D.1.14 A Phase 1 Habitat Survey was carried out on 9 December 2010 at the Albert Embankment Foreshore site, as shown on Vol 16 Figure 6.4.2 (see separate volume of figures). Based on this, surveys for the following species have been undertaken:

a. bats

b. wintering birds.

D.1.15 The purpose of the surveys is to determine the presence or likely absence of these species at and around the site.

D.1.16 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.1.18 to D.1.23). The results from the surveys are then presented (paras D.1.24 to D.1.30). The final section provides an interpretation of the results (paras D.1.31 to D.1.35). Figures referred to in this report are contained within Vol 16 Albert Embankment Foreshore Figures (see separate volume of figures).

D.1.17 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 site assessment volume.

Survey area

Bats

D.1.18 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.1.19 A remote recording (bat triggering) survey using remote Anabat™ recording devices was carried out. Based on the habitat types identified during the Phase 1 Habitat Survey and their potential to support foraging, commuting or roosting bats, one location was chosen for the installation of the remote recording devices, as shown on Vol 16 Figure 6.4.3 (see separate volume of figures).

D.1.20 Location one is to the south of the site; the Anabat™ was attached to Vauxhall Bridge. This location was selected to record potential bat activity associated with roosting within the bridge abutments, in addition to foraging and commuting along the tidal reaches of the River Thames (tidal Thames).

D.1.21 The bat activity recorded during the remote recording surveys did not trigger the need for an additional dawn survey (see Vol 2 for bat triggering criteria).

Wintering birds

D.1.22 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.

D.1.23 The survey area, as shown in Vol 16 Figure 6.4.4 (see separate volume of figures), comprises the intertidal foreshore of the tidal Thames. The foreshore consists of eroded building rubble, stones of various sizes and silt. Either side of the tidal Thames there are public footpaths on the embankments, which are well-used by pedestrians.

Results

D.1.24 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.1.24 to D.1.30

Desk study

D.1.25 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 16 Table D.1.

Vol 16 Table D.1 Terrestrial ecology – species found within 500m of the site between 2001 - 2011

Common name	Latin name	Record count
Mammals		
Bats	*Vespertilionidae*	1
Common pipistrelle	*Pipistrellus pipistrellus*	7
Birds		
Greylag goose	*Anser anser*	9
Northern pintail	*Anas acuta*	24
Common goldeneye	*Bucephala clangula*	2
European honey-buzzard	*Pernis apivorus*	1
Osprey	*Pandion haliaetus*	1
Peregrine falcon	*Falco peregrinus*	10
Northern lapwing	*Vanellus vanellus*	1
Caspian gull	*Larus cachinnans*	4
Herring gull	*Larus argentatus*	22

Common name	Latin name	Record count
Common tern	*Sterna hirundo*	2
Yellow Wagtail	*Motacilla flava*	1
Hedge accentor / Dunnock	*Prunella modularis*	26
Black redstart	*Phoenicurus ochruros*	12
Fieldfare	*Turdus pilaris*	1
Redwing	*Turdus iliacus*	1
Common starling	*Sturnus vulgaris*	25
House sparrow	*Passer domesticus*	22
Plants		
Mistletoe	*Viscum album*	10

Bat surveys

Bat triggering (remote recording) surveys

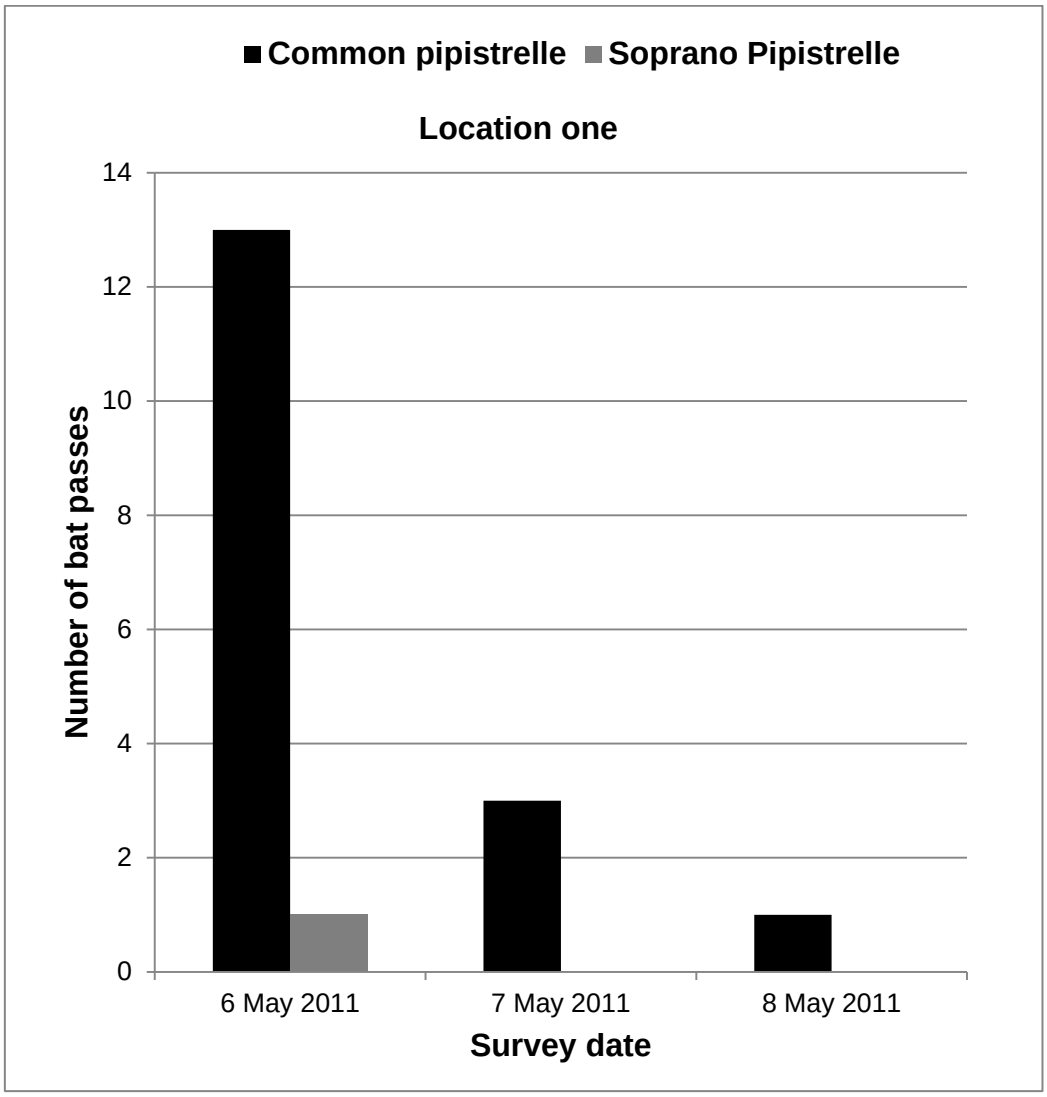
D.1.26 The bat triggering (remote recording) surveys were undertaken over three nights between 6 and 8 May 2011 in suitable weather conditions (see Vol 16 Table D.2).

D.1.27 The remote recording surveys undertaken at this site recorded two species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)* and soprano pipistrelle (*Pipistrellus pygmaeus),* with a maximum number of bat passes recorded in one night as 13 (common pipistrelle) and a single bat pass (soprano pipistrelle) (see Vol 16 Plate D.1). No bat passes were recorded close to sunset or sunrise when bats leave and return to their roost sites, indicating that the movement was unlikely to be associated with a nearby roost.

Vol 16 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
06 May 2011	10°C light breeze, 0% cloud cover, dry
07 May 2011	16°C, calm, 25% cloud cover, dry
08 May 2011	15°C, light breeze, 25% cloud cover, dry

Vol 16 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at one location at Albert Embankment Foreshore site



Wintering bird survey

D.1.28 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 16 Table D.3). The main foraging and resting areas for wintering birds are indicated on Vol 16 Figure 6.4.4 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 16 Table D.4

D.1.29 A total of nine waterbird species were recorded on the foreshore both on and adjacent to the site. Of these waterbird species, six are of nature conservation importance and are included on the Birds of Conservation Concern 3[1] Red or Amber List[i] and/or UK and London BAP as priority species.

[i] The conservation status of all regularly occurring British birds has been analysed in co-operation with the leading governmental and non-governmental conservation organisations, including the Royal Society for the Protection of

D.1.30 Mallard (*Anas platyrhynchos)*, black-headed gull (*Chroicocephalus ridibundus)*, common gull (*Larus canus),* lesser black-backed gull (*Larus fuscus)*, herring gull (*Larus argentatus)* and great black-backed gull (*Larus marinus*) were recorded foraging on inter-tidal mud and along the water's edge on and adjacent to the site.

Vol 16 Table D.3 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
16 December 2010	2°C, light breeze, 100% cloud cover, dry
25 January 2011	9°C, light breeze, 100% cloud cover, dry
24 February 2011	6°C, calm, 100% cloud cover, dry
28 March 2011	14°C, calm, 0% cloud cover, dry
17 October 2011	14°C, calm, 0% cloud cover, dry
29 November 2011	14°C, light breeze, 0% cloud cover, dry

Birds (RSPB), British Trust for Ornithology (BTO) and Birdlife International Birds of Conservation Concern 3 (RSPB, 2009). The basis of species ongoing population trends are assigned to one of three lists of Conservation Concern. These are the UK Red, Amber and Green lists. Although the lists confer no legal status in themselves, they are useful in evaluating the conservation significance of bird assemblages, and for assessing the potential significance of impacts and informing appropriate levels of mitigation with respect to bird populations.

Birds of Conservation Concern (BoCC) Red List criteria for breeding birds are those which have experienced a severe decline of more than 50% of population and / or range over the last 25 years, as measured by the number of 10km squares occupied by breeding birds of the species concerned. Species listed as globally threatened by Birdlife International and those with a historical decline in the UK between 1800 and 1995 (without evidence of recovery) are also included. BoCC Amber List criteria for breeding birds are those which have experienced a moderate decline of between 25% and 49% of population and / or range over the last 25 years. Species of European conservation concern and those with a historical decline but which are currently recovering are also included.

Vol 16 Table D.4 Terrestrial ecology - species and numbers of wintering waterbirds recording during monthly wintering bird surveys

Species name	Latin name	Conservation designation[ii]	Monthly wintering waterbird counts					
			16 December 2010	25 January 2011	24 February 2011	28 March 2011	17 October 2011	29 November 2011
Cormorant	*Phalacrocorax carbo*	None	1	6	2	2	2	-
Grey Heron	*Ardea cinerea*	None	-	-	-	-	1	-
Greylag Goose (Feral)	*Anser anser*	None	-	-	-	2	-	-
Mallard	*Anas platyrhynchos*	Amber List	17	4	5	4	2	2
Black-headed Gull	*Chroicocephalus ridibundus*	Amber List	134	102	129	-	112	150
Common Gull	*Larus canus*	Amber List	3	3	9	-	-	3
Lesser Black-backed Gull	*Larus fuscus*	Amber List	3	3	3	12	7	4
Herring Gull	*Larus argentatus*	Red List UK BAP Priority List	4	14	10	23	35	15
Great Black-backed Gull	*Larus marinus*	Amber List	-	-	-	-	-	2

[ii] 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].

Interpretation

Bats

D.1.31 There is the potential for bats to be commuting and foraging along the tidal Thames on and adjacent to the site, but it is considered that the site is only likely to be used by a small number of bats based on the level of activity recorded.

D.1.32 During the remote recording surveys, the maximum number of common pipistrelle bat passes recorded in one night was 13 (6 May 2011). No bat passes were recorded close to sunset or sunrise when bats leave and return to their roost sites, indicating that the movement was unlikely to be associated with a nearby roost. The bats are considered likely to have been commuting and foraging along the tidal Thames and along the tree line on and adjacent to the site.

D.1.33 Only one soprano pipistrelle bat pass was recorded during the remote recording survey (6 May 2011). This suggests that soprano pipistrelle bats occasionally commute through the site or forage on and adjacent to the site.

Wintering birds

D.1.34 Of the nine waterbird species that were recorded within the survey area, six are of nature conservation importance because they are included on the Birds of Conservation Concern Red or Amber List and/or are UK BAP Priority Species: mallard, black-headed gull, common gull, lesser black-backed gull, herring gull and great black-backed gull.

D.1.35 Within the survey area, the intertidal foreshore was mainly used for foraging and resting by mallard, black-headed gull, common gull, lesser black-backed gull, herring gull and great black-backed gull.

References

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore appendices

Appendix E: Historic environment

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

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Environmental Statement

Volume 16 Albert Embankment Foreshore appendices

Appendix E: Historic environment

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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 16 Table E.1below, with their location shown on the historic environment features map (Vol 16 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, e.g., **HEA 1A**, **1B**, **1C**. References to assets outside the site but within the assessment area begin with 2 and continue onwards, e.g., **HEA 3**, **4**, **5**.

Vol 16 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
1a	Vauxhall Foreshore TDP Foreshore survey and ongoing monitoring. Part of a possible prehistoric roundwood piled structure only visible at low tide was recorded in the western part of the site in an area from which prehistoric artefacts have been recovered and peat layers exposed. Three timbers have been dated to the Mesolithic period, between 4,000 and 5,000 BC, and are associated with a number of other timbers and a scatter of Mesolithic flint, including a tranchet adze. Other artefacts have been found a few metres downstream including Neolithic pottery with a scatter of burnt flint.	MLO64260 092155 VXF93
1b	TAS survey recorded an aggradation layer and feature, a modern dump containing concrete and other debris, a consolidation layer containing concrete and pottery, a consolidation layer formed of stones and another formed of older concrete, a brick consolidation layer; an erosion line, a gravel aggradation layer, indicating a raised foreshore; and timber fenders in the northern part of the site.	FLM01 A115; A116; A118; A119; A120; A121; A122; A123; A124
1c	TAS survey recorded a raised aggradation layer with the leeboard of a vessel in the central part of the site.	FLM01 A127; A128
1d	TAS survey recorded a piece of timber with a metal foot, possibly driftwood, in the central western part of the site.	FLM01 A150
1e	TAS survey recorded a consolidation layer of orange clay in	FLM01 A117

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	the northwestern part of the site.	
1f	TAS survey recorded the concrete apron of a drain, two driftwood timbers with metal feet, a dump of rubble and concrete and two timber mooring blocks. Two timber drains under Vauxhall Bridge in the southern part of the site, with dolphins, outfall structures, storm shutters and the Effra River outfall.	FLM01 A156
1g	TAS survey recorded degradation of the foreshore, comprising a drop in level and a change to softer material in northwestern part of the site	FLM01 A129 A149; A151; A152; A153; A156; A157; A159; A160
1h	Lambeth A number of artefacts were found by chance on the foreshore within the site and reported to the Portable Antiquities Scheme. These included a late Roman pottery vessel, a Neolithic or Bronze Age lithic implement and two post-medieval 18th or 19th century vessels.	MLO100027 MLO100030-2
1i	Thames Foreshore Foreshore survey undertaken by TAS recorded a possible crane base, comprising five planks surrounded by a mass of concrete and debris, a timber structure comprised of vertical timbers with diagonal timbers across the top, a horizontal plank and chain, three further timbers *c.* 12m north of the site and another vertical timber.	FLM01 A110; A111; A112; A113; A114; A130; A131.
1j	Location of an outfall pipeline recorded on the northern part of the site by Sea Zone.	PIPSOL 9400
1k	Location of an outfall pipeline recorded in the central part of the site by Sea Zone.	PIPSOL 9400
1l	Lack's Dock slipway and the site of the former Vauxhall Stairs in the central part of the site.	---
1m	The river wall along the eastern part of the site.	---
1n	Vauxhall Bridge (Lambeth side). Grade II* listed, Vauxhall Bridge (Westminster side). Grade II* listed. A five-span steel arch bridge with concrete piers and abutments faced with granite. The superstructure, constructed entirely of steel and iron, consists of five two-pinned arches each formed from thirteen steel ribs bearing on steel skewbacks built into the abutments or resting on	1393012 1393011

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	the piers. The steel plate decking, where it does not rest directly on the ribs or the framing of the piers, is carried on longitudinal joists supported on stanchions standing on the ribs. The foundations of the abutments and piers consist of solid masses of Portland cement concrete cased in sheet-piling. The bridge is decorated with female bronze figures on either side representing the functions of local government. The bridge is painted in burgundy and orange, with a blue and white trim.	
2	34-46 Albert Embankment Excavation in 1980 by SLAEC *c.* 90m northeast of the site, revealed that natural geological layers were cut by a gully beneath sandy soil, which was itself cut by several features, some of which produced pottery of *c.* 1480-1620. Above these were the earliest buildings and structures, dated *c.* 1620-1720 and succeeded by others dated to *c.* 1720-1900. In 1987 and 1989 DGLA (S&L) undertook a further excavation and revealed the partial remains of at least four kilns, one of them evidently involved in porcelain firing *c.* 1750, as indicated also by documentary evidence. The area was seen to have been subject to constant reworking and modification during its 200-year industrial phase. There was little evidence of sustained human activity in earlier periods, when the area was recorded as open and fallow. A Bronze Age flake and Neolithic implement were recorded. Large quantities of discarded kiln furniture and wasters were found, delftware in the earlier levels and stoneware in the later ones. Fragments of porcelain indicate its early manufacture on the site.	L54/80 L611/87 LAM611 38ALB89 091261 MLO18734 MLO22783-5
3	Vauxhall Bridge Foot (north), Albert Embankment In 1989 DGLA (S&L) excavations *c.* 60m east of the site, revealed substantial remains of a 17th-century glasshouse with much of the kiln intact and large quantities of waste products. The stone foundations of a medieval or later structure fronting the Albert Embankment are thought not to be part of the manor house known to have been in the area. A substantial waterfront complex was built in the 17th century, and the remains of three brick boathouses of that date were found, which remained in use until the 19th century. The boathouses were identified as those which were owned by the Worshipful Company of Fishmongers Mercers and Clothiers and have been recorded in	VBN89 L40/77 MLO21477 MLO11533 MLO220224 MLO23960 MLO22224-6

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	documentary records. An inhumation burial of unknown date was found, dug into the natural gravels. A ditch and flood defences were also recorded. In 1977 SLAEC trial excavation at the same site revealed no archaeological features.	
4	Lambeth High Street Site of Lambeth High Street, post-medieval road, *c.* 130m southeast of the site.	MLO13562 / 090985
5	Albert Embankment Post-Medieval landing steps marked on maps as 'Ffaux Hall Staires', 'Vaux Hall' or Vauxhall Stairs, *c.* 5m east of the site.	MLO11410 090136
6	Vauxhall Bridgefoot Excavations at the Vauxhall Bridgefoot, *c.* 100m east of the site, in 1972 by SLAEC recorded parts of two multiflue stoneware kilns and fragments of three others all datable to the later 18th and 19th centuries. Three large groups of delftware waste material were recorded near a late 17th-century delftware factory. Further remains associated with the Vauxhall Pottery were recorded in 1977–81. Kiln wasters from the pottery were found in 1964.	MLO16858 MLO7790 090105
7	Albert Embankment The area adjacent to eastern boundary of the site is noted as a pottery manufacturing site, possibly owned by J Ariens Van Hamme in 1677. The original pottery manufactory may have been within part of former Vauxhall or Copt Hall manor house. The GLHER also notes a post-medieval house and brewhouse at this location known from the early 18th century.	MLO11471 / 090114 MLO4102 / 090075 MLO4140 / 090128
8	River Thames GLHER records a number of archaeological finds from the river Thames south of Vauxhall Bridge *c.* 40m west of the site. These included a prehistoric axe, a Neolithic Axe, two Bronze Age swords, an early medieval sword and a later medieval sword.	MLO26840-1 MLO26851 MLO26901 MLO26904 MLO27049
9	Near Vauxhall An early medieval iron sword with a straight guard and traces of brass inlay was found in the Thames *c.* 70m west of the site. The pommel is missing and the blade fragmented. The sword has been identified as a Petersen	MLO26817 112025

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	type H.	
10	St George's Wharf and the former Vauxhall Gas Works PCA watching brief in 2007 at St George's wharf, *c.* 90m southeast of the site. The demolition of a jetty platform was monitored to ensure that no damage was caused to a nearby Bronze Age timber feature located on the foreshore of the Thames. No archaeological features were observed. An earlier PCA watching brief in 1997 at the former Vauxhall Gas Works revealed a complete absence of pre-19th century deposits due to widespread and massive truncation by the former gasworks. Site of post-medieval Effra Gas Works and Brunswick Dock.	SGZ07 WNR97 MLO75223
11	Albert Embankment A post-medieval armoury was located *c.* 50m northeast of the site in the former Copt Hall. It was known as the 'Gun House'.	MLO37008 090028
12	Vauxhall The later medieval and post-medieval manor house was also referred to as 'La Salle Fawkes' and was often confused with nearby Copt Hall. The manor house was first documented in the 14th century and originated as part of the manor of South Lambeth. In 1362, the manor was given to the prior of Christchurch Canterbury by Edward, the Black Prince. The original manor house was demolished by 1649, but the site is marked on a map of 1681 *c.* 90m east of the site.	MLO4068 090029
13	Four public benches on Embankment Footpath immediately north of Alembic House. Grade II listed. C19. Now set in blocks of modern concrete with exposed aggregate. Cast iron centre and end supports with ornamental open-work panels and arms in the shape of swans; these hold long wood slats for seating.	1300626
14	Effra site The GLHER records post-medieval made ground close to the line of the former Effra river, a tributary of the Thames, *c.* 100m south of the site.	MLO77342
15	River wall with 28 lamp standards from Lambeth Bridge to the west of Alembic House. Grade II listed Grey granite wall with plinth and square coping heightened	1358189

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	by a later granite course. At intervals lamp standards of cast iron, made of interlinked dolphins writhing around a fluted, wreathed column with globular lampholder and crown finial, on tall granite plinths, holding marine trophies.	
16	Chance find of a post-medieval tile, recorded by the PAS.	SUR-5E97E1
17	Albert Embankment Site of later medieval wharf built for loading stone for building work at Westminster Abbey, *c.* 50m east of the site. Documentary evidence from 1476–7 records the accounts for the construction of a timber wharf at Vauxhall Abbey which covered three quarters of an acre. Westminster Abbey leased the wharf from Christchurch Canterbury in 1478. The wharf had gone out of use by 1478 and its precise location is unknown.	MLO7792 090652
18	Vauxhall Walk Site of post-medieval glass works probably founded by Edward Zouch in Lambeth in 1615 *c.* 110m east of the site. Plate glass was made there from 1620. It produced looking-glass plates, flat glass and glass for coaches. It was owned by the Duke of Buckingham form 1663. The site of about nine acres contained 'the great glasshouse" and 'the little glasshouse with a mill & calcer house, three warehouses, two workmen's dwellings & the manager's house". The factory closed by 1786.	MLO9564 MLO77737 090008
19	Thames Foreshore (structure) The modern riverfront defence and a vertical timber, possibly an anchor point, were recorded in survey zone FWM04, Alpha no. A105 and A113 respectively *c.* 180m west of the site.	MLO70226 083851 MLO70234 083859
20	Thames Foreshore revetment A timber and chalk construction, possibly a barge bed, was recorded by the foreshore survey undertaken by LARF under direction of Mike Webber in 1996; survey zone FWM04, Alpha no. A112.	MLO70233 083858
21	Vauxhall Cross A post-medieval delftware and stoneware pottery kiln was found here in 1970, *c.* 170m east of the site.	MLO7791 090650
22	TAS survey recorded an area of hard consolidation comprising chalk with some brick and broken glass in the southern part of the site.	FLM01 A148
23	Albert Embankment	MLO3867

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	Albert Embankment post-medieval river stairs are recorded at this location *c.* 60m north of the site. Thames Foreshore TAS survey recorded a dump of concrete boulders, a consolidation deposit of old concrete, an aggradation layer of mud, a dump of concrete debris, a vertical plank, a small vertical timber; and a row of three vertical timbers parallel to the shore.	090115 FLM01 A103; A104; A105; A106; A107; A108; A109
24	Albert Embankment Site of the Soap Boiler's House, known before 1724; Snaith's post-medieval distillery, founded before 1814; the Fountain post-medieval public house; and the 'Hoggs Shyse' recorded on post-medieval maps *c.* 50m east of the site.	MLO24427 MLO4141 MLO4143 MLO4144
25	Thames Foreshore (structure) A brick structure, 3m in front of modern river wall and possibly a river defence or a foundation, was recorded during the foreshore survey *c.* 200m east of the site, undertaken by LARF under direction of Mike Webber in 1996; survey zone FWM04, Alpha no. A115.	MLO70236 083861
26	Thames Foreshore A post-medieval timber and chalk barge bed was recorded during the foreshore survey, *c.* 170m west of the site undertaken by LARF under direction of Mike Webber in1996; survey zone FWM04, Alpha no. A114.	MLO70235 083860
27	Vauxhall Bridgefoot The site of the post-medieval Cumberland Tavern and tea garden is recorded here, *c.* 20m southeast of the site.	MLO7784 090644
28	Albert Embankment In 1972 roadworks along the Albert Embankment, revealed a small deposit of kiln wasters associated with the Vauxhall Pottery, *c.* 70m north-east of the site.	MLO7780 090638
29	Thames Foreshore Foreshore survey undertaken by TAS recorded a timber structure, either a barge bed or a possible riverfront defence *c.* 200m west of the site.	FWM04 A111
30	Thames Foreshore Foreshore survey undertaken by LARF under direction of Mike Webber in 1996 revealed a timber structure, possibly a bank revetment or a barge bed, in survey zone FWM04,	MLO70232 083857

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	Alpha no. A111, *c.* 200m west of the site.	
31	Thames Foreshore Foreshore survey undertaken by LARF under direction of Mike Webber in 1996 revealed a timber revetted chalk construction, identified as a barge bed, mud deposits extending out from river wall and a small modern pot in survey zone FWM04, Alpha no. A109, A110 and A108 respectively, *c.* 180m west of the site.	MLO70229 MLO70230 MLO70231
32	Thames Foreshore TAS foreshore survey recorded an aggradation layer *c.* 10m south of the site.	FLM01 A126
33	Thames Foreshore Foreshore survey undertaken by LARF under direction of Mike Webber in 1996 revealed a two timber structures, possibly barge beds (Alpha no A103 and A104); a fragment of quern (Alpha no. A106); and another timber revetted chalk construction or possible barge bed (Alpha no. A107) all in survey zone FWM04, *c.* 170m west of the site.	MLO70224 MLO70227-8 MLO70225
34	Vauxhall Bridgefoot Site of stone working site as owned by Gerrard Weymans in the late 17th-century, who built mills for cutting marble and a brick house *c.* 60m east of the site, according to the Survey of London.	MLO4667 090175
35	Albert Embankment A copper alloy tanged Bronze Age chisel was retrieved from the Thames near the Albert Embankment *c.* 60m north of the site. It was collected by Reverend William Greenwell and later bought by John Pierpont Morgan who donated them to the British Museum in 1908.	MLO19531 114030
36	Vauxhall Bridgefoot Site of the Royal Oak Inn, destroyed during the construction of Vauxhall Bridge, *c.* 40m east of the site.	MLO7785 090645
37	Thames Foreshore TAS survey recorded a dump deposit of concrete boulders *c.* 120m north of the site.	FLM01 A102
38	The chance find of a Mesolithic tranchet axe and post-medieval kiln furniture, recorded by the PAS.	LON-1C6B83 LON-E93653
39	Vauxhall Cross building. Designed by Terry Farrell, in use since 1994.	---

E.2 Site location, topography and geology

Site location

E.2.1 The site lies almost entirely on the Thames foreshore and within the river channel. It is bounded by the Thames to the west, the Thames foreshore to the north and south and Camelford House, the Vauxhall Cross building and Bridge House to the east. The site lies within the parish of Lambeth and within a former county boundary of Surrey.

E.2.2 The River Thames flows from south to north in this area and the site lies on its eastern side, at its confluence with the River Effra, one of London's 'lost' rivers. On the opposite side of the Thames, *c.* 200m northwest of the site, the Tyburn River formerly discharged into the Thames. Both of these former tributaries have now been covered over and converted into sewers(Barton, 1962)[1].

Topography

E.2.3 The foreshore within the site slopes downstream and towards the river. At the southern edge of the site, the foreshore lies at 99.9m ATD (above Tunnel Datum, the equivalent of –0.1m Ordnance Datum) adjacent to the river wall, 99m ATD, at the low water mark, falling to 98.6m ATD on the river bed in the south west corner of the site. At the northern edge of the site, the foreshore lies at 101.4m ATD adjacent to the river wall and 96m ATD on the riverbed in the northwest corner of the site.

E.2.4 The river wall itself dips down from south to north. The southern end of the embankment adjacent to Bridge House is at 106.3m ATD. The central part, adjacent to the Vauxhall Cross building is at 105.1m ATD and the northern part adjacent to Camelford House is at 105.0m ATD. The eastern arm of the site along the former Lacks Dock rises up to 105.0m ATD adjacent to the Albert Embankment. The foreshore has until recently been relatively stable. Since the construction of a new pier upstream, however, it has become an extremely dynamic environment.

Geology

E.2.5 Geologically, the site is situated on alluvium overlying sand and gravel deposits associated with the floodplain of the River Thames. The Kempton Park river terrace is 25m to the east of the site (British Geological Survey Solid and Drift Geology, Sheet 270). The BGS mapping shows that the Kempton Park river terrace in the vicinity of the site has been eroded at the mouth of the River Effra, suggesting that in the past it was a significant river.

E.2.6 Borehole data from ground investigations relating to the Thames Tideway Tunnel project, in the vicinity of the site, provide reasonable information on stratigraphy. Examination of two borehole logs from boreholes some 150m to the south of the site, in a similar foreshore location (TQ37NW1593 and TQ37NW2393), indicate the floodplain gravels lie at 99.6m ATD, over London Clay at 97.1m ATD. These gravels are known as the Shepperton gravels and underlie the present floodplain, following erosional downcutting by the Thames which left the Kempton Park gravels

as a river terrace. Notably, no made ground was seen in these boreholes. However, in two boreholes 50m nearer to the site (boreholes TQ37NW2680 and TQ37NW2681), 4m and 2.9m of undated made ground was encountered directly over the gravels, and no alluvium was noted (unfortunately, no datum levels are available for these boreholes). A borehole in a similar location to the site, *c.* 190m to the south of the site (TQ37NW1618) had a deposit of loose clayey sandy gravel with timber fragments lying between 101.1m ATD to 103.2m ATD over the Shepperton gravels. Although the timber fragments in the gravel could have come from the made ground above, (which occurred from 103.2m ATD to 106.1m ATD at this location), the wood and loose gravel could be remnants of a boat-working platform or barge bed (a foreshore structure to prevent barges from sinking in the river mud when moored). However, there was no evidence of chalk, which is usually used in these structures.

E.2.7 Two vibro cores to the west of the site record deposit survival within the deeper parts of the channel. The southern vibro-core (VC 6033A) records scouring by river action down to the London Clay, at c. 95.0m ATD. The northern vibro core (VC 6034) records c. 0.4m of foreshore dumping and gravel over London Clay recorded at c. 95.4m ATD.

E.2.8 Borehole data from the surrounding area suggests that the most likely sequence to be found in the vicinity of the site would consist of made ground directly overlying gravels. The absence of alluvial deposits in the vicinity on other sites could be because the site lies on the outside of a Thames meander, where the erosion of the finer sediment will be at its greatest or it might be attributable to truncation from human activity. It should be emphasized, however, that there will be considerable very local variation in the depositional sequence on the foreshore and that on this site there are known early prehistoric remains which have not yet been eroded away and that these are likely to lie above riverine deposits dating to the early Holocene period.

E.3 Past archaeological investigations within the study area

E.3.1 The Thames Archaeological Survey (TAS) carried out a survey of the foreshore within the site in the 1990s (the 'Alpha Survey'), followed more recently by an ongoing survey by the Thames Discovery Programme (TDP). The most significant remains recorded through these surveys comprise a group of roundwood piles probably representing a structure in the western part of the site, of Mesolithic date, around which prehistoric peat deposits and artefacts have been recorded (**HEA 1a**; Vol 16 Figure 7.4.3, see separate volume of figures). Prehistoric artefacts were also seen on the site during the foreshore walkover survey. These included flints, pottery and an antler pick (Vol 16 Appendix A.2.6). Several probably post-medieval timber structures were also noted in the southern part of the site (Vol 16 Appendix H).

E.3.2 The TDP survey also recorded some degradation of the foreshore associated with the cutting away of the foreshore by the modern river (**HEA 1g**). A number of consolidation layers and dumps were also

recorded, ranging from modern concrete to undated deposits which may be archaeological (**HEA 1b**; **1e**; **1h**). These consolidation attempts may indicate earlier erosion of the Thames on the foreshore at this point. A number of wooden artefacts were recorded; these comprised timbers with metal feet (**HEA 1d**; **1f**); the leeboard of a vessel (**HEA 1c**); and timber mooring blocks and drains (**HEA 1f**). Some of this material is likely to be driftwood, but other items (such as the mooring blocks, drains and bargeboard) may be associated with historic use of the site.

E.3.3 Other archaeological investigations in the area have also provided information on the more recent historic use of the area for pottery and glass manufacture (**HEA 2**; **3**; **6**).

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 the research framework presented in 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 (ie, 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)

E.4.2 During the early prehistoric the Thames comprised a braided river channel spanning a wide area of the current Thames floodplain. The site, located adjacent to the modern channel of the Thames and close to the Effra tributary, would have been within an area which may have comprised marsh, dry land and river channel at different times. This area was increasingly subject to flooding and alluvial sedimentation as sea levels rose. The mixed marshy and dry land of this part of the Thames valley would have been especially exploitable as a predictable source of food from hunting and fishing, and water, as well as a means of transport and communication. Evidence of activity is typically characterised by flint tools rather than structural remains. A possible pile structure which has been radiocarbon dated to the Late Mesolithic period (5,000-4,000BC) has been located within the site (**HEA 1a**; Vol 16 Figure 7.4.3, see separate volume of figures). It is associated with in situ stratified prehistoric deposits. A large amount of burnt flint, flint tools dating to the Late Mesolithic and Early Neolithic, Early Neolithic pottery and animal bone have been recorded eroding out of these deposits. The sheer quantity of anthropogenic material suggests that the site was occupied during this period, rather than just being an indication of a presence in the area. The Portable Antiquities Scheme (PAS) database records the finding of a Mesolithic tranchet axehead in the centre of the site. The layers around the Mesolithic timbers are currently being scoured away by the action of the river. During the site visit archaeologists noted an antler pick, which may have been associated with prehistoric activity on the site, although it

was in the southern part of the site, some distance from the Mesolithic structure. Just upstream of Vauxhall Bridge, immediately to the south of the site, a further peat deposit containing Mesolithic and Neolithic flints and burnt flint has recently been recorded.

E.4.3 The Neolithic (4000–2000 BC), Bronze Age (2000–600 BC) and Iron Age (600 BC–AD 43) are traditionally seen as times of technological change, settled communities and the construction of communal monuments. The environment of the Thames became more settled with the area to the south of the modern river forming a marshy area, with occasional river channels and higher gravel islands (eyots). Farming was established and forest cleared for cultivation. An expanding population put pressure on available resources and necessitated the utilisation of previously marginal land, such as the marshes and eyots. In such areas, prehistoric populations sometimes constructed wooden trackways to cross wet areas. In some circumstances these trackways could be associated with ritual activity and votive deposits, which resulted from the ritual significance ascribed to wetlands and rivers during these periods. A Neolithic or Bronze Age lithic implement was recorded on the foreshore adjacent to the site and reported to the portable antiquities scheme (**HEA 22**). A prehistoric axe, a Neolithic axe and two Bronze Age bronze swords were also found south of Vauxhall Bridge, *c.* 40m west of the site (**HEA 8**). A copper alloy tanged Bronze Age chisel was also recovered from the Thames near the Albert Embankment, *c.* 60m north of the site (**HEA 35**). Such artefacts may have been deposited for ritual reasons. A short distance to the south of the assessment area a timber structure on the foreshore has been radiocarbon-dated to the Iron Age and was identified as a possible fishtrap but has been subsequently washed away by river action (Haughey, 1999)[2].

E.4.4 At St George's Wharf, *c.* 90m south-west of the site (**HEA 10**) demolition of a jetty was monitored to ensure no damage was done to a Bronze Age timber feature which is believed to have been a bridge to a now-disappeared island. The replacement pier in this location has caused a large amount of ongoing scouring, revealing in situ peat horizons. Mesolithic and Neolithic flint tools along with Bronze Age pottery have been recorded eroding out of these horizons. A previous investigation at 34–46 Albert Embankment, *c.* 90m north-east of the site (**HEA 2**), recorded a Neolithic implement and a Bronze Age flake, but no evidence of features associated with these remains.

Roman period (AD 43–410)

E.4.5 Within approximately a decade of the arrival of the Romans in AD 43, the town of *Londinium* had been established on the north bank of the Thames where the City of London now stands, *c.* 3.1km northeast of the site. *Londinium* quickly became the provincial capital, a major commercial centre, and the hub of the Roman road system in Britain.

E.4.6 Possibly the only permanent Thames crossing was in the vicinity of modern London Bridge, *c.* 3.5km to the north-east of the site, but a ford may have existed at Lambeth, near the site of modern Lambeth Bridge, *c.* 600m north of the site. The Roman road from the Kent coast via

Canterbury and Rochester, which ran *c.* 1.1km south of the site, may have reached the Thames at this point, where the river was easily fordable and the road could link up with another on the line of modern Edgware Road. In Roman times the ebb and flow of the tide did not extend above the London Bridge area, and the river was considerably shallower than it is today (Roberts and Godfrey, 1951)[3].

E.4.7 The route of the main road from *Londinium* to Chichester ran *c.* 950m southeast of the site, on the alignment of Kennington Park Road. A branch left this road in the vicinity of Kennington Park, *c.* 1.0km southeast of the site, to run south to the Brighton area (Margary, 1967)[4]. The site was not therefore located close to any known roads, along which cemeteries and small settlements were typically located (MoLAS, 2000)[5].

E.4.8 Rising water levels from the late Prehistoric period suggest that during the Roman period the Albert Embankment Foreshore site may have been prone to flooding and probably lay in open marshland or on the foreshore of the Roman Thames. As such it would not have been suitable for settlement. The area may have been exploited for a number of intertidal/marshland resources, in some places on an industrial scale (e.g. pottery, kilns, fish processing etc). Evidence of Roman activity in the area is limited to a late Roman vessel found adjacent to the Albert Embankment Foreshore site (**HEA 1h**). The limited evidence of Roman activity and rising sea levels suggest that the site was unsuitable for habitation.

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

E.4.9 Following the withdrawal of the Roman army from England in the early 5th century AD, the Roman city of *Londinium* was apparently abandoned, at least initially, and the main early to mid-Saxon settlement of Lundenwic shifted westwards to what is now Covent Garden and the Strand, 2km northwest of the site. In AD 866, in response to threats from Viking invaders, King Alfred moved the town back within the walls of the Roman city, establishing Lundenburh as the medieval city of London 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.

E.4.10 The name ‘Lambeth’ occurs in many forms in early records. It is of Saxon origin and signifies either a harbour from which sheep were shipped, or a muddy harbour. Of the two the latter seems the more likely (Roberts and Godfrey, 1951)[6]. Many of the place names in the area are of Saxon origin, and include Clapham, Balham, Kennington, *c.*1.3km east of the site; and Lambeth, *c.* 740m north of the site (Gower and Tyler, 2003)[7], suggesting a broad settlement pattern.

E.4.11 The shallow crossing point on the Thames, *c.* 600m north of the site in the vicinity of modern Lambeth Bridge, and possibly established during the Roman period, continued in use (Roberts and Godfrey, 1951)[8]. Situated near the edge of the river is the parish church of St Mary at Lambeth, on Lambeth Palace Road, *c.* 740m to north of the site. This was founded before the Norman Conquest of 1066 (Roberts and Godfrey, 1951)[9]. The exact location of settlement in this period is uncertain, but was probably

close to the river crossing and church, with a manor house in the vicinity of the later site of Lambeth Palace, *c.* 750m to north of the site (Maldon, 1912)[10].

E.4.12 The site was located within the manor (estate) of Lambeth, or South Lambeth, which extended from the area of modern Harleyford Road and the Oval, along the riverfront to the west (Renier, 2006)[11]. The manor may have been given by King Harold (ruled 1035–1040) to Waltham Abbey, the gift being confirmed by Edward the Confessor (1042–1066)(Maldon, 1912)[12]. The GLHER (ref. 090959) notes the location of a settlement on modern South Lambeth Road, *c.* 640m south of the site.

E.4.13 Excavations at 34–36 Albert Embankment, *c.* 90m north east of the site, recorded a gully of possible early medieval date, underlying a sandy soil containing later medieval pottery (**HEA 2**). Two medieval swords were found in the Thames at Vauxhall, *c.* 40m and *c.* 70m west of the site (**HEA 8** and **HEA 9** respectively).

E.4.14 No evidence of early medieval activity has been recorded at the site, which was some distance from the nearest settlements and would probably have been unsuitable for habitation due to the rising water levels which followed the Roman period and waterlogged the floodplain in this area. Nonetheless several early medieval artefacts have been recorded from the Thames and there is evidence of activity nearby. It is possible that the site was located near to an early ferry, perhaps a predecessor to the Horse Ferry which was replaced by Vauxhall Bridge.

Later medieval period (AD 1066–1485)

E.4.15 Throughout this period much of the area continued as low-lying marshland and open fields crossed by a few roads raised against the floods. By 1331, Lambeth parish included the settlements of Lambeth, Kennington, Stockwell and South Lambeth, and Lambeth Deane (Maldon, 1912)[13].

E.4.16 After the Norman Conquest (1066) the manor of South Lambeth was acquired by King William's half-brother, the Count of Mortain. By the late 12th century it was held by the de Redvers family; in 1262 it was recorded as being held by Margaret, the widow of Baldwin de Redvers, along with Vauxhall manor (Maldon, 1912)[14]. Vauxhall is not mentioned in Domesday, and so must be assumed to have been established as a separate manor some time after. Margaret subsequently married Falkes de Breaute, and it may be from Fawkes Hall that Vauxhall acquired its name (Roberts and Godfrey, 1951)[15]. The manor house of Fawkes Hall was located *c.* 90m east of the site (**HEA 12**). The northern part of Vauxhall manorial estate was separated from the Kennington manor by the northern arm of the River Effra which divided into two streams, just west of where the Oval now lies, before entering the Thames. Both manors remained in the hands of the de Redvers family until 1293, when they were acquired by the Crown, and afterwards were administered together as Vauxhall. In 1324, Vauxhall, along with Kennington, was granted to Hugh le Despenser (Maldon, 1912)[16].

E.4.17 In 1362, Vauxhall manor was granted by Edward, Prince of Wales, to the Prior and Convent of Christ Church in Canterbury (Maldon, 1912)[17]. The

GLHER records a site of medieval settlement at the east end of modern Vauxhall Bridge, *c.* 200m east of the site, and a small settlement along South Lambeth Road, *c.* 770m to the south of the site. At the junction of Wandsworth Road and South Lambeth Road, where the railway bridge now stands, was Cox's Bridge (sometimes called Vauxhall Bridge) over the northern channel of the Effra; this was in existence by 1340, when the Abbot of Westminster was charged with the repair of "cokkesbrugge"[18].

E.4.18 There is evidence of some later medieval activity around the site, although it is unlikely to have been suitable for habitation and lay some distance from the nearest settlements. Later medieval features and buildings were recorded at 34–46 Albert Embankment, *c.* 90m north-east of the site (**HEA 2**) and stone foundations of a possible later medieval building were recorded at Vauxhall Bridge Foot *c.* 60m east of the site (**HEA 3**). A later medieval wharf was also present *c.* 50m east of the site. Owned by Christchurch Canterbury, according to the GLHER it was leased to Westminster Abbey in 1478 to load stone for the rebuilding of the church (**HEA 17**).

E.4.19 A number of undated features in the study area may also date to this period. These include a number of timber constructions; *c.* 160m west of the site (**HEA 20**); *c.* 180m west of the site (**HEA 19; HEA 31**); *c.* 12m north of the site (**HEA 1i**); *c.* 200m west of the site (**HEA 30**; **HEA 31**); and *c.* 170m west of the site (**HEA 33**). Most of these features are likely to be barge beds or revetments, but one may be a crane base (**HEA 1i**). It is possible some may be associated with the Horse Ferry which operated at Vauxhall before the construction of the Bridge.

Post-medieval period (AD 1485–present)

E.4.20 During the early post-medieval period the riverside area comprised marshy fields. The easy access to the river meant the area was also used for wharves and warehouses. Three boathouses associated with the Worshipful Company of Fishmongers, Mercers and Clothiers were found in excavations at Vauxhall Bridge Foot, *c.* 60m east of the site (**HEA 3**), and formed part of a substantial waterfront complex from the 17th-century. At the same location (HEA 3), an undated burial was also recorded and was probably of post-medieval date (Nathalie Cohen, TDP, pers comm). Much of the site remained within the river channel or foreshore during this period.

E.4.21 During the 17th and 18th centuries the character of the area was mostly industrial. Although the Vauxhall pleasure gardens lay close to the site to the east . These gardens are believed to have opened in the mid-17th century and survived as a park and place of entertainments until 1840, being known as Vauxhall Gardens from 1785 onwards. A popular means of access to the gardens was by boat and customers were dropped off at Vauxhall Stairs near the present Lack's Dock. A post-medieval armoury was located *c.* 50m northeast of the site at the former Copt Hall (**HEA 11**). A 17th-century stone working site was established at Vauxhall Bridge Foot by Gerrard Weymans, *c.* 60m east of the site (**HEA 34**); and along Albert Embankment, *c.* 50m east of the site, was a Soap Boilers, distillery and pub all founded in the 18th and early 19th century. A post-medieval

glasshouse was constructed *c.* 40m east of the site by Edward Zouch in 1615. The site covered over nine acres and gave its name to Glasshouse Street *c.* 110m east of the site (**HEA 18**). The glasshouse was owned by the Duke of Buckingham from 1663 and made looking-glass, flat glass and glass for coaches until it closed in 1786. Evidence of the extensive area of the glasshouse has been recorded in excavations in the area at Vauxhall Bridge Foot, *c.* 60m east of the site (**HEA 3**).

E.4.22 Vauxhall was also the location of an important pottery producing delftware, stoneware, and later porcelain. The pottery manufacturing area extended eastwards from the site and may have been founded by J Ariens Van Hamme in 1677 in part of Copt Hall or Vauxhall manor house (**HEA 7**). The area occupied by the pottery was extensive. In 1972, kiln wasters were recorded during roadworks along the Albert Embankment *c.* 70m northeast of the site (**HEA 28**); a delftware and stoneware kiln was found in 1970, *c.* 170m east of the site (**HEA 21**); in 1972 excavations *c.* 100m east of the site at Vauxhall Bridge Foot recorded two multiflue stoneware kilns and fragments of three others (**HEA 6**); four further kilns were recorded in 1987 and 1989 *c.* 90m north-east of the site, including at least one used in the manufacture of porcelain by *c.*1750 (**HEA 2**).

E.4.23 In *c.* 1809–1816, a new bridge was constructed as part of a plan to regenerate the south bank. This bridge replaced a former Horse Ferry between Vauxhall and Pimlico and was initially called the Regent Bridge, later being renamed Vauxhall Bridge. The bridge was constructed above and to the west of the southern part of the site, necessitating the demolition of several buildings, including the Royal Oak Inn, *c.* 40m east of the site (**HEA 36**); and the Cumberland Tavern and Tea Garden, *c.* 20m south-east of the site (**HEA 27**). In 1906, the original Vauxhall Bridge was replaced by the current Grade II* listed structure (**HEA 1n**).

E.4.24 Joseph Bazalgette's Albert Embankment (**HEA 15**), north of the site, was originally intended to extend beyond Vauxhall Bridge but was abandoned due to high costs. The extent of the completed Embankment was described by Bazalgette's son Edward in 1878 (Bazalgette, 1878)[19] and is worth quoting here in full: "It was commenced in September, 1865, and opened to the public in May, 1868. It extends along the river for a length of 2000 feet between Westminster and Lambeth bridges, and for a further length of 2100 feet from Lambeth Bridge to the site of the London Gas-works. It was originally intended to be extended 1000 feet further to Vauxhall Bridge, but this portion of the work was abandoned for lack of funds. The wall is straight from Westminster Bridge to Lambeth Bridge, and the remainder curves to a radius of 21,120 feet, and with very few exceptions is of uniform character. It is similar in elevation to that on the Middlesex side, having a highly-dressed granite facing, with plain curved battered surface up to high water mark and above that a moulded parapet and plinth, the mouldings being stopped at frequent intervals against plain pedestals of granite, furnished with ornamental bronzed mooring rings, similar to those on the Middlesex embankment, and surmounted with standards for gas-lights. A small portion of this wall differs from that on the Middlesex side, in being formed of cement faced with granite".

E.4.25 The earliest map to show the site is Thomas Hill's Map of Vauxhall Manors of 1681 (Vol 16 Plate E.1). It shows the site in the River Thames, to the west of Cox's Bridge, where the northern channel of the Effra discharged into the Thames. By this period the Effra had become little more than a sewer, but was still open. The map shows the site as demesne land held directly by the manor.

E.4.26 Rocque's map of 1746 (Vol 16 Plate E.2) shows the site mainly within the river Thames. The eastern edge of the site includes some buildings constructed along the river front, and the western side of some small plots of land. One arm of the site extends east along the southern side of the road leading to Vauxhall Stairs and includes a row of buildings fronting onto that road. Several small docks or wharves are shown along the eastern boundary of the site, and the buildings in the area are probably warehouses.

E.4.27 Faden's 1813 revision of Horwood's map of 1799 (Vol 16 Plate E.3) is the first map to show the line of the future Vauxhall Bridge rising above and to the west of the site. Much of the site is still located within the river but the eastern edges are shown within the built up industrial area and wharfage. The new bridge is shown cutting through existing industrial properties including a Vinegar Manufactory located partly within the eastern boundary of the site. The northeastern part of the site includes the Vauxhall Stairs and part of the heavily built up area of wharves and warehouses between what is now the Albert Embankment and the river Thames.

E.4.28 The Ordnance Survey 1st edition 25 inch: mile map of 1862 (Vol 16 Plate E.4) shows the site comprising the foreshore beneath the completed Vauxhall Bridge. The southeastern part of the site includes a 'Coal Store' and the north-eastern part of the site includes 'Luck's Dock' where the Vauxhall Stairs were previously located. To the north of Luck's Dock, the site includes the western end of the warehouses and buildings between the river and High Street (now Albert Embankment). To the south-east and outside of the site, the Vinegar manufactory is now also described as a Gin distillery.

E.4.29 The Ordnance Survey 2nd edition 25 inch: mile map of 1896 (Vol 16 Plate E.5) shows little change to the site, which remains mainly within the Thames foreshore. The area in the southeastern part of the site formerly labelled 'Coal Store' is now simply shown as a building. In the central part of the site Luck's Dock is now labelled 'Lacks Dock' and occupies part of the gin and vinegar distillery just within the site. In the northeastern part of the site, the wharves and docks between Albert Embankment and the Thames are no longer shown as a solid block, but as a mixture of open wharves and warehouses. Draw Dock is located towards the northern end of the site, which also includes the western part of a flour mill.

E.4.30 The Ordnance Survey 3rd edition 25 inch: mile map of 1909 (Vol 16 Plate E.6) shows little change to the site. Two landing stages are shown, one just north of and one beneath Vauxhall Bridge. One of the buildings on the north-eastern edge of the site is now labelled 'Site of Copt Hall'.

E.4.31 The London County Council Bomb Damage Maps of 1939–45 (not reproduced) show that several of the buildings of the distillery outside the site to the east had been damaged seriously, but were repairable at cost. There was also minor blast damage to the building on the southeastern part of the site and general blast damage to the building partly inside the central part of the site to the south of Lack's Dock. Otherwise the bombing had no impact on the site (London Topographical Society, 2005)[20].

E.4.32 The Ordnance Survey 1:1250 scale map of 1947 (Vol 16 Plate E.7) shows further change to the site. In the northeastern part of the site, the flour mill has expanded. To the south a warehouse has been cleared and is labelled 'New Belgrade Wharf', further south the warehouses have been demolished and a new building constructed in their place. The former gin and vinegar distillery, outside the site to the east, is now labelled 'Oil Works'. In the southern part of the site, two 'Dolphins' and two sewer outfalls are labelled to the north of and beneath Vauxhall Bridge.

E.4.33 The Ordnance Survey 1:1250 scale map of 1947–1991 (Vol 16 Plate E.8) shows limited change to the site, except along the eastern edge. The original warehouses have been cleared and Camelford House built in their place just within the eastern boundary of the site. Lack's Dock is labelled 'disused'. To the east, the former Oil Works has been cleared. The northwest corner of this vacant lot is located within the site. The southeastern part of the site includes part of a coach, lorry and car park.

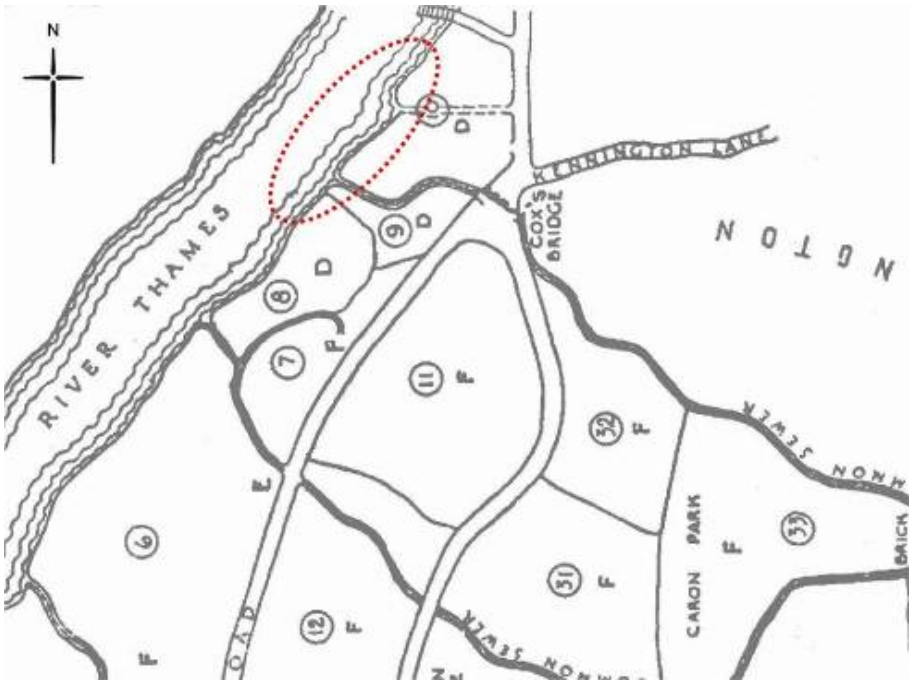
The current site

E.4.34 The site currently comprises a large area of Thames foreshore with associated alluvial mud, aggradation and consolidation deposits. The Grade II* listed Vauxhall Bridge (**HEA 1n**) is located in the southern part of the site and is flanked to the north and south by two sewer outfalls with associated timber dolphins and granite cobbled slipways. The northern sewer outfall also contains the outflow of the River Effra. Along the eastern part of the site is the brick and stone river wall (**HEA 1m**). To the southeast, the site includes part of the embankment associated with Bridge House. To the east the site includes the riverwall and embankment west of the Vauxhall Cross building (**HEA 39**), the Lack's Dock (**HEA 1l**) as far as the Albert Embankment, and the riverwall and embankment west of Camelford House are also included in the site.

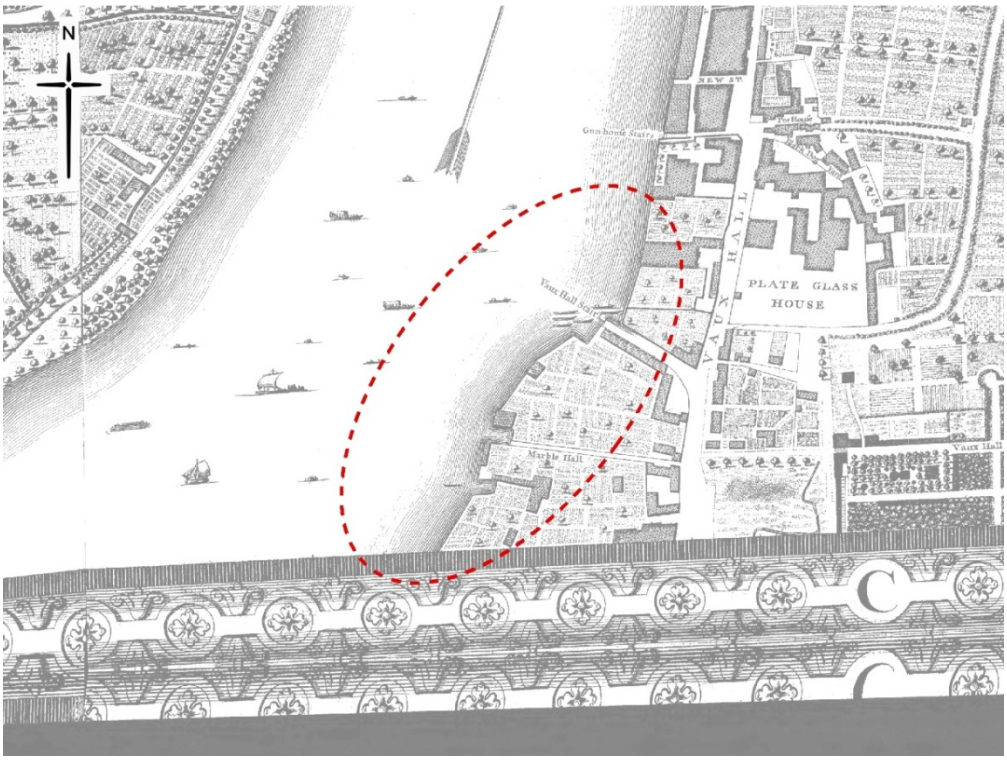
E.5 Plates

(Maps not to scale)

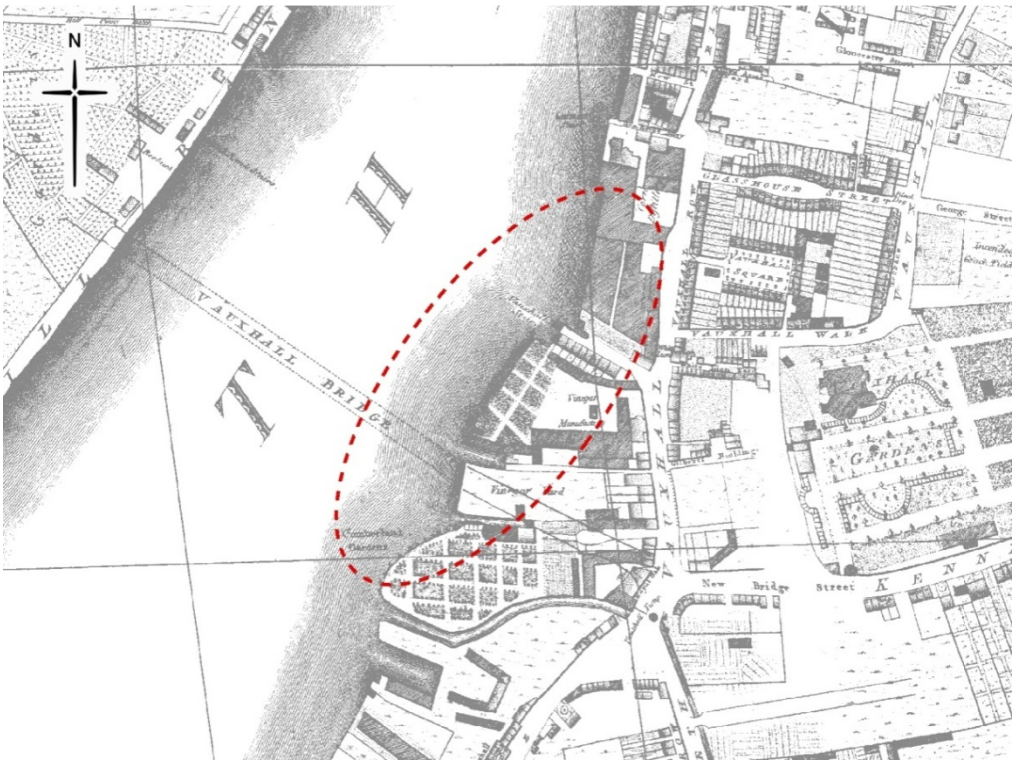
Vol 16 Plate E.1 Historic Environment – Thomas Hill's Map of the Vauxhall Manor's of 1681



Vol 16 Plate E.2 Historic Environment – Rocque's map of 1746

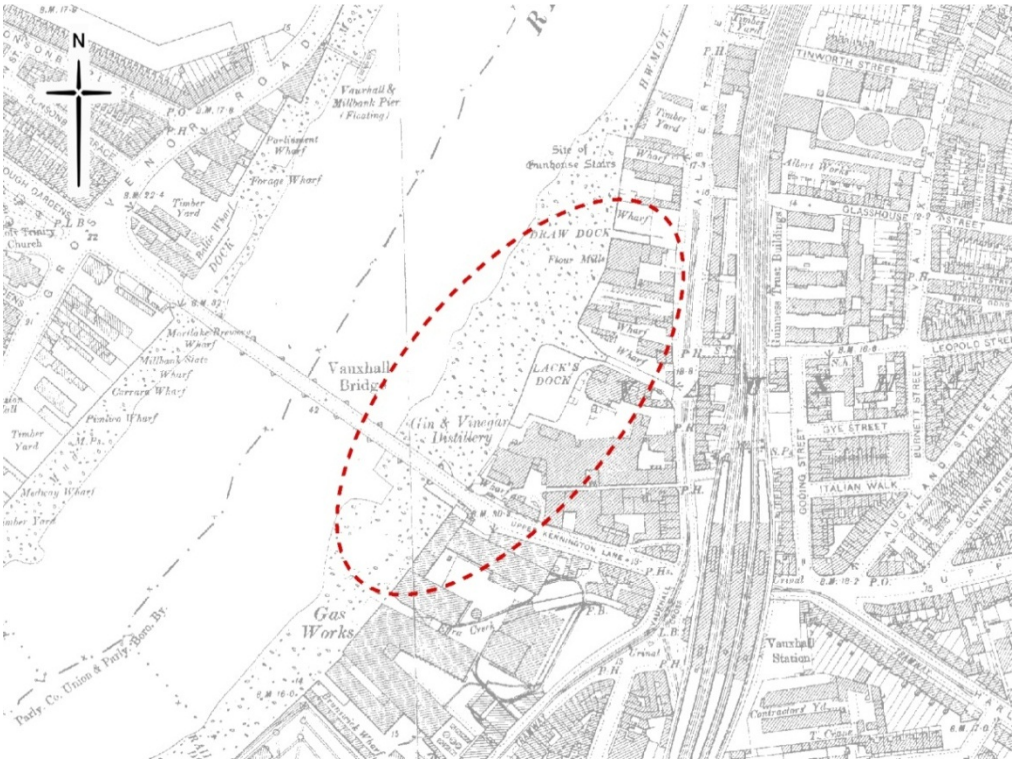


Vol 16 Plate E.3 Historic Environment – Faden's 1813 revision of Horwood's map of 1799

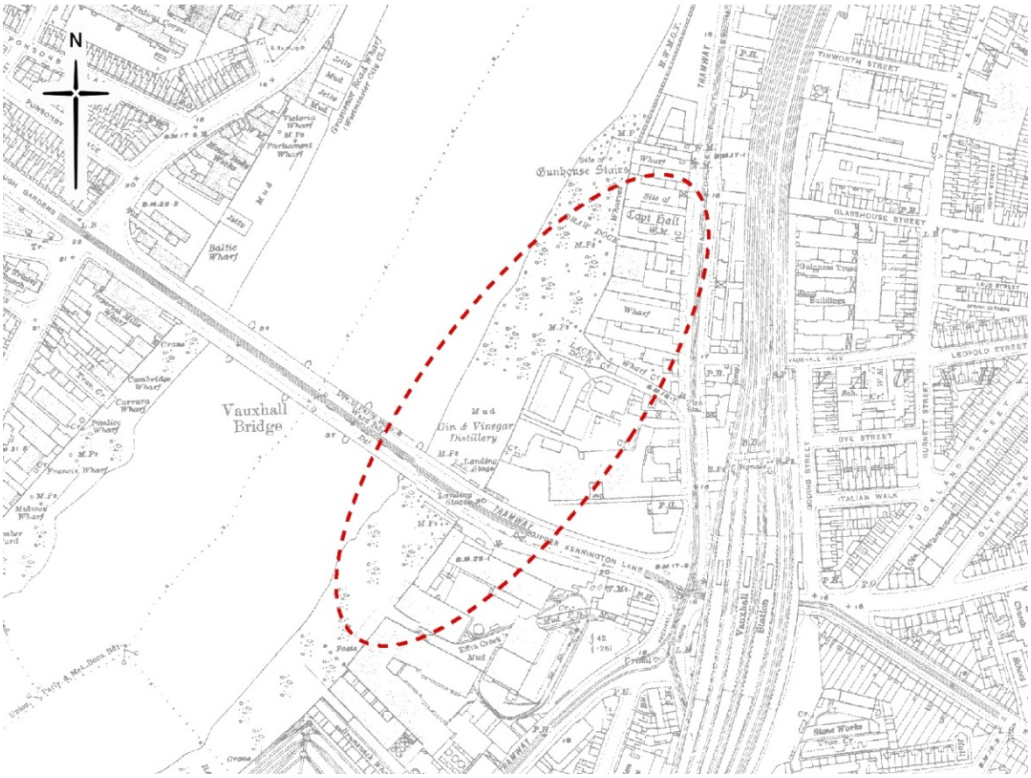


Vol 16 Plate E.4 Historic Environment – Ordnance Survey 1st edition 25" scale map of 1862 (not to scale)

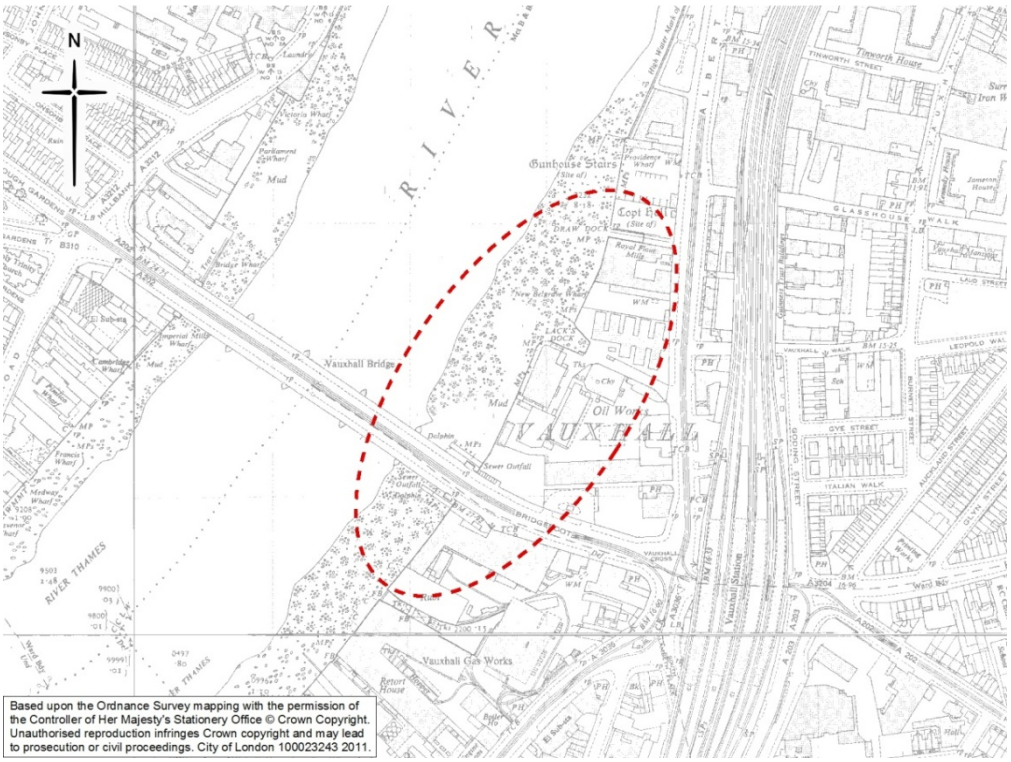
Vol 16 Plate E.5 Historic Environment – Ordnance Survey 2nd edition 25” scale map of 1896 (not to scale)



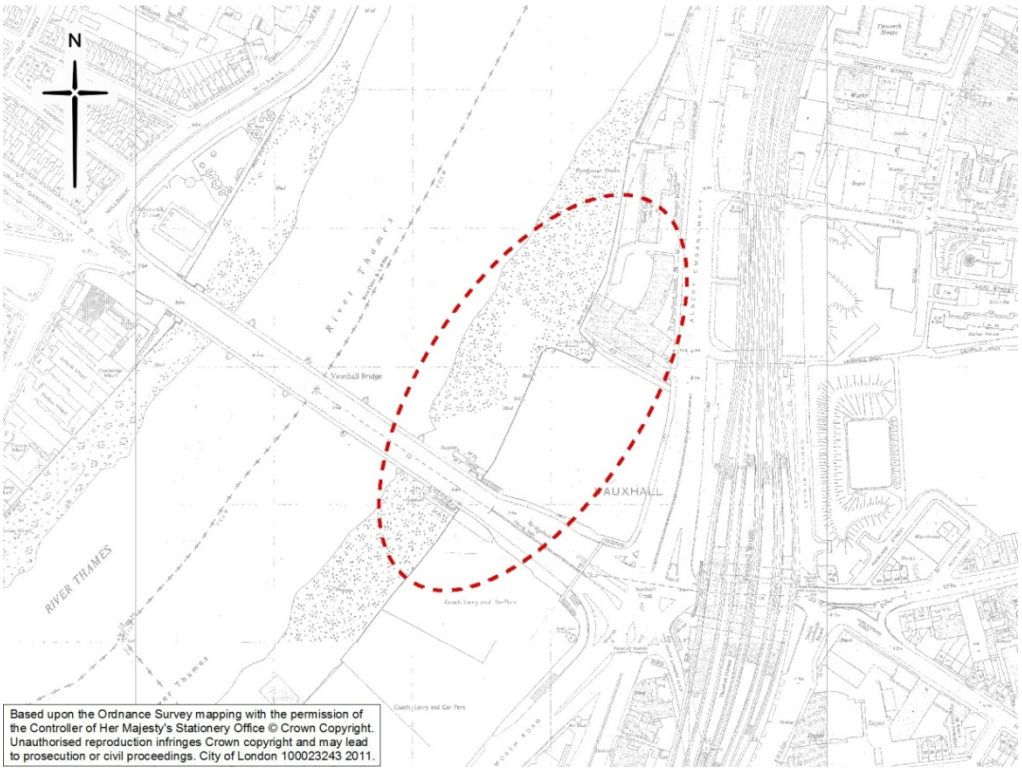
Vol 16 Plate E.6 Historic Environment – Ordnance Survey 3rd edition 25” scale map of 1909 (not to scale)



Vol 16 Plate E.7 Historic Environment – Ordnance Survey 25” scale map of 1947 (not to scale)



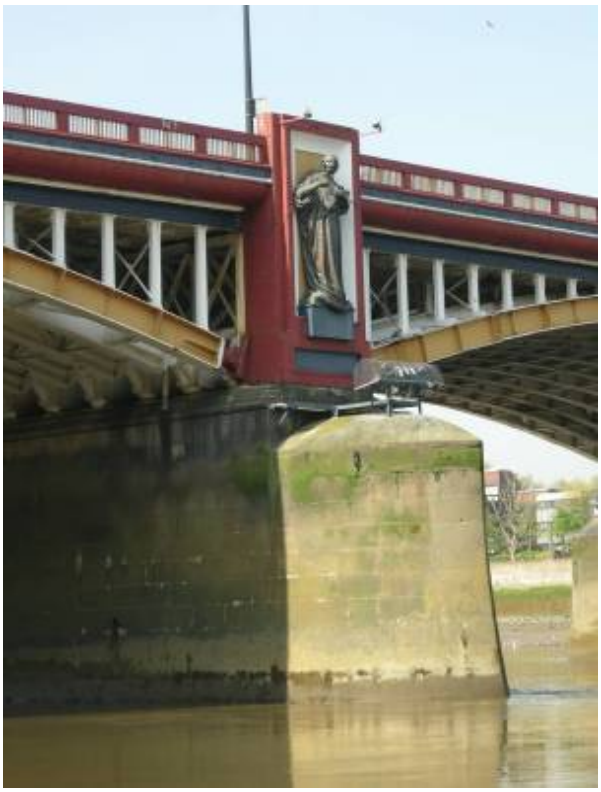
Vol 16 Plate E.8 Historic Environment – Ordnance Survey 25” scale map of 1948–1991 (not to scale)



Vol 16 Plate E.9 Historic Environment – The river wall within the northern part of the site looking south-east; standard lens

Vol 16 Plate E.10 Historic Environment – A timber dolphin and outlet below the river wall in front of the Vauxhall Cross building, looking east. The river wall is decorated with the lion heads holding a mooring ring; standard lens

Vol 16 Plate E.11 Historic Environment – One of the sculptures on Vauxhall Bridge looking south-west; standard lens



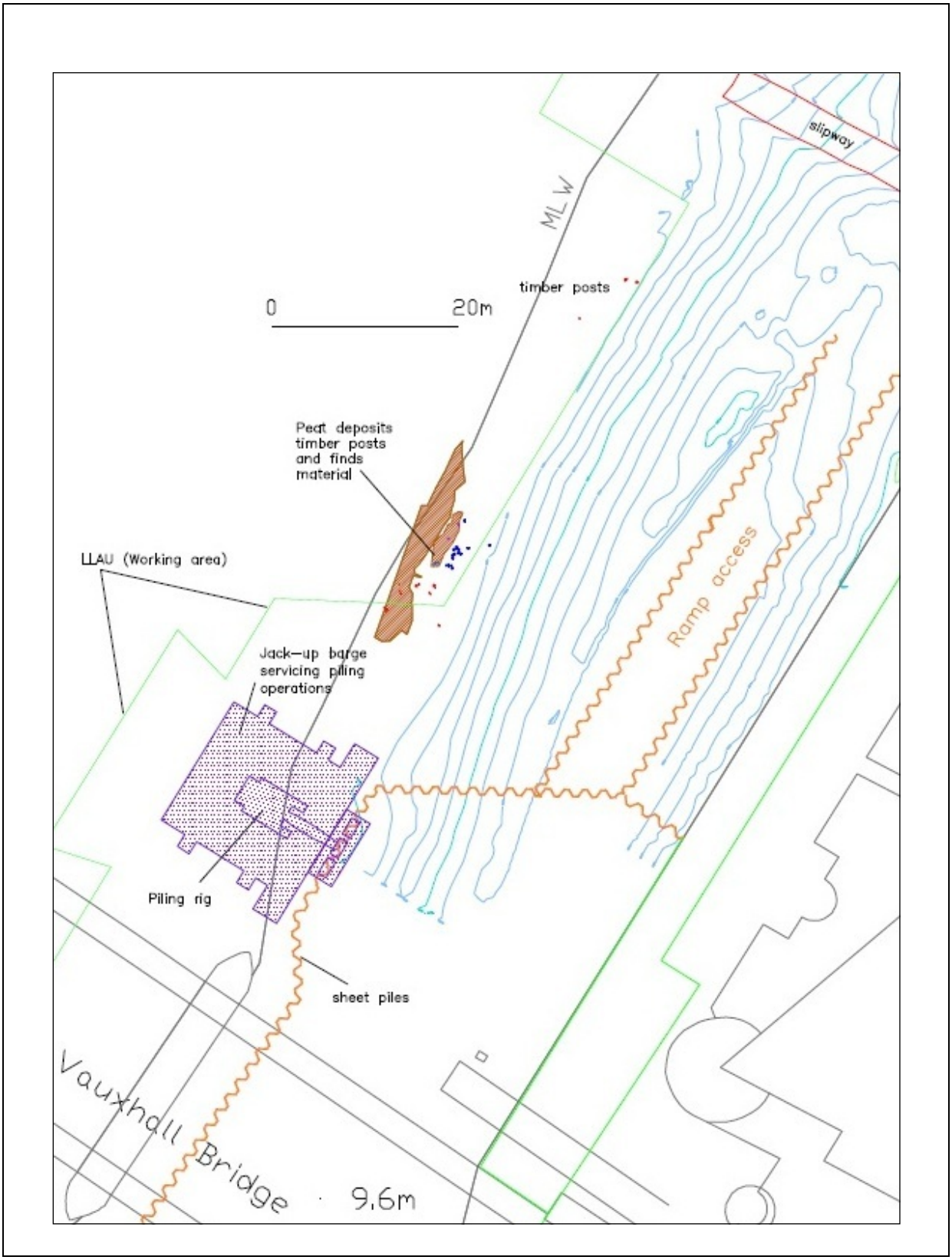
Vol 16 Plate E.12 Historic Environment – The extended section of river wall to the south-east of the site looking north; standard lens

Vol 16 Plate E.13 Historic Environment – The possible prehistoric antler pick identified during the site visit in April 2011 by archaeologists; standard lens

Vol 16 Plate E.14 Historic Environment – Post-medieval timber structure identified by archaeologists during the site visit in April 2011; standard lens

Vol 16 Plate E.15 Historic Environment – Prehistoric timber of the Mesolithic structure rising above the low tide mark; standard lens

Vol 16 Plate E.16 Historic Environment – Position of Mesolithic timbers on foreshore in relation to proposed construction works.



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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore 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 16 Albert Embankment Foreshore appendices

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, which includes 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 4th 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 historic or ongoing contamination sources, as well as any nearby sensitive receptors.

F.1.4 No tidal outflows were visible within the river wall at the time of the survey.

F.1.5 Detailed site walkover notes are provided in Vol 16 Table F.1 below.

Vol 16 Table F.1 Land quality – site walkover report

Item (Site ref: PLH1X, Albert Embankment Foreshore)		Details
Date of walkover	4th November 2010	
Site location and access	The proposed work site is located on the foreshore of the tidal Thames, situated on the A3036 Albert Embankment, in the London Borough (LB) of Lambeth. Access across the entirety of the site. The site continues along the foreshore under Vauxhall Bridge.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	The proposed site is on the foreshore of the southern side of the tidal Thames and is located immediately north and west of the Secret Intelligence Service building. The combined sewer overflow connection is underneath Vauxhall Bridge within the worksite. The foreshore area is relatively wide at this site.

Item (Site ref: PLH1X, Albert Embankment Foreshore)		Details
Neighbouring site use (in particular note any potentially contaminative activities or sensitive receptors)	North	The immediate area is characterised by commercial and residential properties namely Peninsula Heights. An operational fuel filling station (Texaco garage) is located east. Albert Embankment Gardens is located northeast of the site
	South	Bordering the A3036 are retail properties located under a railway bridge. These properties are distant from the worksite in a southeasterly direction.
	East	The immediate area is characterised by commercial and residential properties and the train line to Vauxhall. In addition to the Vauxhall Bridge Industrial Estate immediately adjacent to Vauxhall Bridge in a southeasterly direction.
	West	Site is bordered to the west by the tidal Thames.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	Within the site is a dock, which is still in use as a connection between the road and the tidal Thames for the launching of river vessels.
Surfacing	Record type and condition	Sand and gravel with pockets of exposed tidal mud exposed during the survey.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	None observed
Services	Evidence of buried services?	None observed

Item (Site ref: PLH1X, Albert Embankment Foreshore)		Details
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 liquids	None observed
	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?	Occasional litter including cans and bottles were noted on the foreshore.
Surface water	Record on-site or nearby standing water	Tidal Thames
Site drainage	Is the site drained, if so to where? Evidence of flooding?	An outflow pipe with a tidal flapgate was also visible within the river wall at the time of the survey.
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		Nearby petrol filling station Dock
Any other comments	Eg, access restrictions/ limitations	None observed

Review of historical contamination sources

F.1.6 Historical mapping (dated between 1875 and 1978) has been reviewed to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.7 Vol 16 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 the table below are also shown on Vol 16 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 16 Appendix E.

Vol 16 Table F.2 Land quality – potentially contaminating land-uses

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
On-site			
1	Draw Dock	c1896-present	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
2	Phoenix Gas Works/Vauxhall Gas Works and associated stores/goods sheds and railway dock	c1875-c1967	Benzene, toluene, ethylbenzene and xylenes, phenols, PAH, cyanide, ammonia, sulphur compounds, arsenic, chromium
3	(a) Gin and vinegar distillery	c1875-c1896	Volatile organic compounds (VOC), total petroleum hydrocarbons (TPH), heavy metals, ethanol/methanol, ammonia, chlorinated alkalis, benzene, toluene, ethylbenzene and xylenes

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	(b) Oil works	c1950-c1967	Monoaromatic hydrocarbons, benzene, toluene, ethybenzene and xylenes, PAH, n-alkanes (C5-C20), lead
4	Vauxhall Wharf	c1875	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
13	Wharves	c1896	
14	Lacks Dock	c1896-present	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
Off-site			
5	Coal wharf (adjacent east)	c1875	Hydrocarbons, heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons
6	Timber yard (100m northeast)	c1875-c1896	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs, cresols
7	Railway and station (40m east)	c1875-present	PAHs, heavy metals, phenols, sulphates, fuel/oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons
8	London Gas Works (110m east)	c1875	Benzene, toluene, ethylbenzene and xylenes, phenols, PAH, cyanide, ammonia, sulphur compounds, arsenic, chromium
9	(a) Millbank Saw Mills (155m west)	c1875	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
			cresols
	(b) Motor body works (155m west)	c1916-c1950	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals, asbestos
10	Wharves (150m west)	c1875	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
11	Timber yard (40m northeast)	c1896	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs, cresols
12	Albert Works (145m east)	c1896-present	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds. heavy metals and asbestos
15	Millbank Barracks (175m west)	c1916-c1962	Nitroaromatics, nitroglycerin, benzene, toluene, ethylbenzene and xylenes, aliphatic hydrocarbons
16	Laundry (155m west)	c1951	Heavy metals, arsenic, various solvents; fluorocarbon 113, asbestos, PCBs, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, nitrate and sulphate
17	Tinworth Works (waste reclamation) (165m east)	c1967-c1978	Heavy metals, arsenic, sulphide, sulphate, asbestos, oil/fuel hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
18	Light engineering	c1967-c1978	Heavy metals, arsenic, boron, nitrate, sulphide, sulphate,

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item1,2
	works (155m east)		asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
19	Garage (25m east)	c1967	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds. heavy metals and asbestos
20	Lift works (145m northeast)	c1967-present (works)	Heavy metals, arsenic, boron, nitrate, sulphide, sulphate, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
21	Areas of worked ground (85m east)	c1978	Unknown

On-site

F.1.10 The majority of the Albert Embankment Foreshore site has generally not been subject to major contaminative history as it comprises the tidal Thames foreshore.

F.1.11 However, the historical mapping shows that the eastern edge of the site was formerly occupied by a number of potentially contaminating land-uses, notably dock, gas works and oil works. These land-uses have in all cases ceased, with the exception of the dock which is still in use to provide the connection between the road and the river for the launching of river vessels.

Off-site

F.1.12 Within the 250m assessment area, the historical mapping has identified pockets of historical industrial activities in the vicinity of the site that in most cases have ceased.

Geology

F.1.13 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 16 Table F.3 below.

Vol 16 Table F.3 Land quality – anticipated site geology

Geological Unit/ Strata	Description	Approximate depth below river level (m)
Alluvium	Silty, sandy clay and clayey gravel	0.00-1.20
River Terrace Deposits	Medium dense to dense to dense sand and gravel (predominantly quartz sand and flint gravel).	1.20-4.10
London Clay Formation	Grey fissured clay that weathers to a chocolate brown. Locally with crystals of selenite (gypsum).	4.10-32.0
Harwich Formation	Sand and shelly sandstone	32.0-32.4
Lambeth Group (Upper Shelly Beds)	The Lower and Upper Mottled Beds can be described as a mottled or multicoloured, stiff or very stiff fissured clay, compact silt, and dense or very dense sand. The Upper Shelly Beds is mainly a grey shelly clay, and occasionally sand dominated unit and shelly limestone. The Laminated Beds consists of thinly interbedded fine- to medium-grained sand, silt and clay, with locally more extensive sand bodies and thin shell and lignite beds. The Lower Shelly Beds is a dark grey to black clay with abundant shells but may also be Shelly sand. Where shells predominate, thin limestone bands are formed. The base of the Lambeth Group is marked by the Upnor Formation which comprises dense silty glauconitic sand.	32.4-33.7
Lambeth Group (Upper Mottled Beds)		33.7-39.0
Lambeth Group (Sand Channel)		39.0-41.3
Lambeth Group) (Laminated Beds/Lower Shelly Beds)		41.3-41.7
Lambeth Group (Lower Mottled Beds)		41.7-46.1
Lambeth Group (Lower Mottled Beds-Gravel)		46.1-49.3
Lambeth Group (Upnor Formation)		49.3-50.4

Geological Unit/ Strata	Description	Approximate depth below river level (m)
Thanet Sand Formation	Generally dense glauconitic silty fine sand with occasional rounded flint gravel. The base of the formation is marked by the Bullhead Beds, which comprise rounded gravel and cobbles of flint.	50.4-59.6
Chalk Group	Weak fine grained limestone with nodular and tabular flints.	59.6-unproven

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 at the Albert Embankment Foreshore site (Vol 16 Appendix F.2). The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.16 The report advises that the borough in which the site is located (LB of Lambeth) experienced high levels of bombing during World War II. One high explosive bomb is recorded as landing directly within the study site boundary, with a further four within the buffered site boundary. In addition, a further 17 strikes were recorded within 100m of the buffered site boundary and a V1 bomb strike occurred 20m east of the site.

F.1.17 The Albert Embankment Foreshore site area has not been developed since WWII and as such buried UXO items are unlikely to have been removed, the site was therefore given a high risk rating.

Thames Tideway Tunnel ground investigation data

F.1.18 This section summarises the ground investigation undertaken by the Thames Tideway Tunnel project.

F.1.19 A borehole was drilled in the immediate vicinity of Albert Embankment Foreshore site as part of the project-wide ground investigation (borehole ref SR2059) as shown on Vol 16 Figure F.1.2 (see separate volume of figures).

F.1.20 Vol 16 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 drop shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination testing

F.1.21 Contamination testing was limited to five samples of the undisturbed (natural) soils from borehole SR2059 at between 1.5m bgl and 51.25m bgl. The soil samples were tested for a suite of common heavy metals and metalloids and PAHs.

F.1.22 The testing did not record elevated concentrations of contaminants above widely used human health screening values (EA, 2009)[3,4] (for any land use) for any of the determinands tested for. See Volume 2 Environmental assessment methodology for guidance on the benchmarks used in the assessment.

Soil gas testing

F.1.23 There has been no soil gas testing undertaken with an immediate vicinity of the site.

Groundwater contamination data

F.1.24 No groundwater contamination testing was undertaken at the Albert Embankment Foreshore site.

F.1.25 Refer to Section 13 Water resources – groundwater of this volume for further information.

Sediment quality testing

F.1.26 At the Albert Embankment Foreshore site, the results of testing of the samples retrieved from borehole SR2059 at 1.5m bgl were compared against the Threshold Effect Levels (TEL) and Probable Effect Levels (PEL) to assess potential risk to aquatic life as endorsed by the Port of London Authority (PLA). See Vol 2 for guidance on the benchmarks used in the assessment.

F.1.27 Four contaminants (arsenic, zinc, copper and lead) were recorded to exceed the TEL.

F.1.28 No samples were recorded as having contaminant values above PEL.

Third party ground investigation data

F.1.29 No third party ground investigation was available for review at the Albert Embankment Foreshore site.

Other environmental records

F.1.30 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 16 Table F.4. Pertinent records are discussed in further detail below.

F.1.31 The location of these records is shown on Vol 16 Figure F.1.3 (see separate volume of figures).

Vol 16 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
Control of major accident hazard sites	0	0
Historical landfill site	0	0
LA pollution prevention and control	0	1
Licensed waste management facility	0	0
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	Areas of past potential contaminated industrial uses are present on-site and within 250m.	
Pollution incident to controlled water*	1	5
Registered waste transfer site	0	0
Registered waste treatment or disposal site	0	0

**Does not include regular combined sewer overflow (CSO) discharges*

F.1.32 Inspection of the data has identified one record of a pollution incident to controlled water recorded as being present within the boundary of the site.

F.1.33 Both on-site and within the 250m assessment area there are areas that have been recorded as having past potential contaminated industrial uses. From the historical mapping it can be inferred that these relate to industrial activities located along the bank of the river as highlighted on Volume 16 Figure F.1.1 (see separate volume of figures), in addition to the railway land located east of the site. Common contaminants associated with such land-uses are identified in Vol 16 Table F.2.

F.1.34 Within 250m of the Albert Embankment Foreshore site, inspection of the data has identified one local authority pollution prevention and control site, which relates to the fuel filling station located on Albert Embankment.

F.1.35 There are a further five pollution incidences to controlled water recorded within 250m of the site.

Land quality data from local authority

F.1.36 The LB of Lambeth was consulted with respect to land quality information they hold in relation to the site and search area.

F.1.37 The LB Lambeth searched their database and stated that there is no record of contamination or pollution found at Albert Embankment Foreshore site (LB of Lambeth , 2011)[5].

F.1.38 The LB Lambeth also searched for information on historical use of land at surrounding areas and there is no record of contamination or pollution5.

Summary of contamination sources

F.1.39 The majority of the area within the site has generally not been subject to major contaminative history as it comprises the River Thames foreshore.

F.1.40 However, following the review of the baseline data, the following sources of on-site contamination which may impact on the construction of the proposed development have been identified:

a. The eastern edge of the site was also formerly occupied by a number of potentially contaminating activities, notably dock, gas works and oil works. The remains a possibility that residual contamination from previous activities adjacent to the site may have impacted the River Terrace Deposits that are located at a shallow depth beneath the site (and are less than 3m in thickness).

b. historic contamination of foreshore sediments – minor metals and PAH contamination of soils/sediments in comparison with PLA guidance for protection of aquatic organisms

c. CSO discharge – sewage (bacteriological) contamination of sediments

d. potential UXO.

F.1.41 Site walkover information also identified the presence of an off-site fuel filling station located approximately 25m east from the site boundary.

F.2 Detailed Unexploded Ordnance (UXO) risk assessment

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PLH1X – Albert Embankment Foreshore
Document Number: 336-RG-TPI-PLH1X-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R5_V1.0
Date: 17th May 2012

Originator: Max Chainey (16th May 2012)
Quality Review: Lisa Askham (17th May 2012)
Released by: Lee Gooderham (18th May 2012)

Contents

Figures

EXECUTIVE SUMMARY	
Study Site	The Client has specified the Study Site as Work Area PLH1X, located at National Grid Reference "530270, 178217". Whilst this Site is predominantly situated on the foreshore, there is a marginal overlap at street level. However this street level overlap is considered too minor to warrant the division of the Site.
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • The Work Area is situated at *Albert Embankment* on the foreshore of the *River Thames*. • Whilst no World War Two (WWII) bombing targets have been identified within the Work Area, "gas works" were located within the buffered Site boundary. Numerous other primary and "opportunistic" bombing targets were found within 1km of the Work Area. • *Lambeth Metropolitan Borough*, where the Site is located, experienced a bombing density of 335 High Explosive (HE) bombs per 1,000 acres. This is a notable bombing density for *London*. • One HE bomb strike occurred within the Work Area, as well as four strikes within the buffered Site boundary. A further seventeen HE bomb strikes were recorded within 100m of the buffered Site boundary. A V1 bomb strike occurred 20m to the east of the Work Area. It is unlikely that UXO would have been witnessed and reported given the environmental conditions. • Bomb damage was not recorded within the Work Area, but was recorded within the buffered Site boundary ranging from "general blast damage; minor in nature" to "damage beyond repair". • The Site has not been developed since WWII and thus is unlikely to have removed buried UXO items. 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 primarily posed by WWII *German* HE bombs, with a secondary threat from Incendiary Bombs 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	**HIGH**
Recommended Risk Mitigation	**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 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. 3. **On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth. **4. Non-intrusive Magnetometer Survey**; Prior to any dredging and cofferdam piling of the foreshore, 6 Alpha recommend a non-intrusive magnetometer survey. Any magnetic contacts that model as UXO should either be investigated or avoided.

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 PLH1X. The Site is located at National Grid Reference 530270, 178217. 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.

See *Figures 1* and *2* for the Site location.

Location Description *(Figure 3)*

The Work Area is situated to the southwest of the *City of London* within the *Lambeth Metropolitan Borough*. Current aerial photography has identified the Work Area as foreshore along the *River Thames*, with no structural developments on site.

Proposed Engineering Works

Thames Water have specified a summary of the proposed engineering works, including working draft plans with drawing no. 100-DA-CNS-PLH1X-259105_AJ; 100-DA-CNS-PLH1X-259106_AJ; 100-DA-CNS-PLH1X-259107_AJ; 100-DA-CVL-PLH1X-359020_AH; and 100-DA-CVL-PLH1X-359021_AI_1. The proposed works may not represent the full scheme but rather those that may present an UXO risk:

- A 16m internal diameter Combined Sewer Overflow (CSO) drop shaft, approximately 56m deep.
- Underground chambers and ventilation ducts constructed with the permanent cofferdam in the foreshore.
- A 3.2m diameter connection tunnel to link the CSO shaft with the main Thames Tunnel.
- A long connection culvert running beneath the foreshore linking the CSO shaft and overflow weir chamber.
- Temporary and permanent cofferdams and campshed construction in the foreshore to enable construction of the works. This will require dredging / excavation of the river bed.

Ground Conditions

Thames Water have indicated the following ground conditions for the Work Areas as:

Site Geology	Depth Below Ground Level (m)	Thickness (m)
Alluvium	0.00	2.00
River Terrace Deposits	2.00	2.50
London Clay	4.50	29.05
Harwich Formation	33.55	0.50
Lambeth Group	34.05	14.25
Thanet Sand	51.50	9.00
Seaford Chalk	60.50	Not Proven

It is important to establish the ground conditions within this report to determine both the maximum *German* UXB bomb penetration depth (BPD) as well as 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** – The Work Area is situated on predominantly undeveloped foreshore. *Lack's Dock* is labelled within the east of the Site. **1949 OS mapping** – There are no significant or noticeable changes to the Site. *Lack's Dock* is no longer identified.
1945 Aerial Photography ***(Figure 4)***	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 within the area.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	Primary targets have been identified as a "gas works" located within the buffered Site boundary, as well as one located approximately 650m to the southeast. Other primary targets include a "power station" 250m to the east, a "Gas Light and Coke Co" 460m to the northeast and *Kennington Lane Gas Holder Station* 470m to the west. "Opportunistic" targets include railway stations and railway infrastructure, "depots", "docks", "wharves", "reservoirs" and "factories" all located within 1km of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate that one bomb strike occurred within the Work Area. Additionally, four bomb strikes occurred within the buffered Site boundary and seventeen strikes occurred within 100m of the buffered Site boundary. There was also one V1 strike 20m to the east of the buffered Site boundary.
WWII Bomb Damage ***(Figure 7)***	*London County Council* (LCC) bomb damage maps indicate no bomb damage within the Work Area, however varying degrees of damage occurred within the buffered Site boundary, ranging from "general blast damage; minor in nature" to "damage beyond repair".
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located within the *Lambeth Metropolitan Borough,* which recorded 335 HE bombs per 1,000 acres. 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 recorded no abandoned bombs on or within 1,000m of the Work Area.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	Yes; the Work Area is located on the foreshore and was undeveloped.
Is there a reason to suspect that the immediate area was a bombing target during WWII?	Yes; the Work Area is located directly adjacent to a "gas works" and numerous other primary bombing targets have been identified within the vicinity of the Site.
Is there firm evidence that ordnance landed on Site?	Yes; there was one bomb strike within the Work Area and four strikes within the buffered Site boundary.
Is there evidence of damage sustained on Site?	No; but unlikely to have been recorded given the environment and lack of structures within the Work Area. Within the buffered Site boundary there has been "general blast damage; minor in nature" and "damage beyond repair".
Is there any reason to suspect that military training may have occurred at this location?	No; there is no evidence to suggest that military training occurred within any of the areas.
Would an UXB entry hole have been observed and reported during WWII?	Unlikely; UXBs falling in the *River Thames* are unlikely to have been observed and reported. Additionally, any impact craters of UXBs falling on the foreshore during low tide would have been masked and covered by the high tide.
What is the expected UXO contamination?	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?	No; no significant earthworks have occurred.

STAGE FOUR – RISK ASSESSMENT		
Explanation For Non-Division Of Site	The Site has a slight overlap at street level off the foreshore. However this street level overlap is considered too marginal to warrant the division of the Site. Additionally, the area under the bridge does not represent a decreased probability of UXO encounter due to the J-curve effect, whereby a UXBs sub-surface trajectory can be lateral and come to rest up to 15m from the original entry hole position.	
Threat Items	The threat is predominately posed by WWII *German* HE bombs and incendiary bombs. Additionally, *British* Anti Aircraft Artillery (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	The general ground conditions (highlighted in Stage 1) of the Work Area that are relevant consist of Alluvium, River Terrace Deposits and London Clay, and thus the most likely Bomb Penetration Depth (BPD) for a 250kg bomb is assessed to be a maximum of 8m bgl, dependant on the depth of any rock sediment. As the Work Area overlaps with the foreshore of the *River Thames* and the river itself, the BPD will vary due to the softer ground conditions and the water causing a deceleration of the impacting bomb. It is important to note that strong river currents, sedimentation build-up and erosion over time can significantly alter the depth of UXO. 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* incendiary bombs 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	WORK AREA		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	3x1=3	3x2=6	3x6=18
Tunnelling	3x2=6	1x2=2	6x2=12
Shaft Installation	3x2=6	1x2=2	6x2=12
Open Excavations	3x2=6	2x2=4	6x4=24
Cofferdams (including Piling)	3x3=9	2x2=4	9x4=36
Dredging	3x3=9	3x2=6	9x6=54

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 and composition of made ground (which in this case is largely non-existent) as any magnetometer results are highly likely to be affected by ferro-magnetic contamination due to previous construction activities within the Study Site location. This method is likely to be effective on the foreshore and within the cofferdam as this is area is undeveloped, however any scrap metal may mask buried items of UXO. **Intrusive Methods of Mitigation** – Intrusive magnetometry is expected to be possible on this Site. 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 ACTIVITIES	**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. Posters and information of the general nature of the UXB threat should be held in the site office for reference and as a reminder.	ALARP
EXCAVATION WORKS	**3. On-Site Banksman;** all open excavation works should be accompanied by an UXO Specialist to monitor works down to the maximum bomb penetration depth.	
COFFERDAM PILING AND DREDGING	**4. Non-intrusive Magnetometer Survey**; Prior to any cofferdam piling and dredging of the foreshore, 6 Alpha recommend a non-intrusive magnetometer survey. Any magnetic contacts that model as UXO should either be investigated or avoided. It should be noted that there is likely to be scrap metal on the foreshore and riverbed that will reduce the effectiveness of non-intrusive magnetometry.	
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.		

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Report Figures

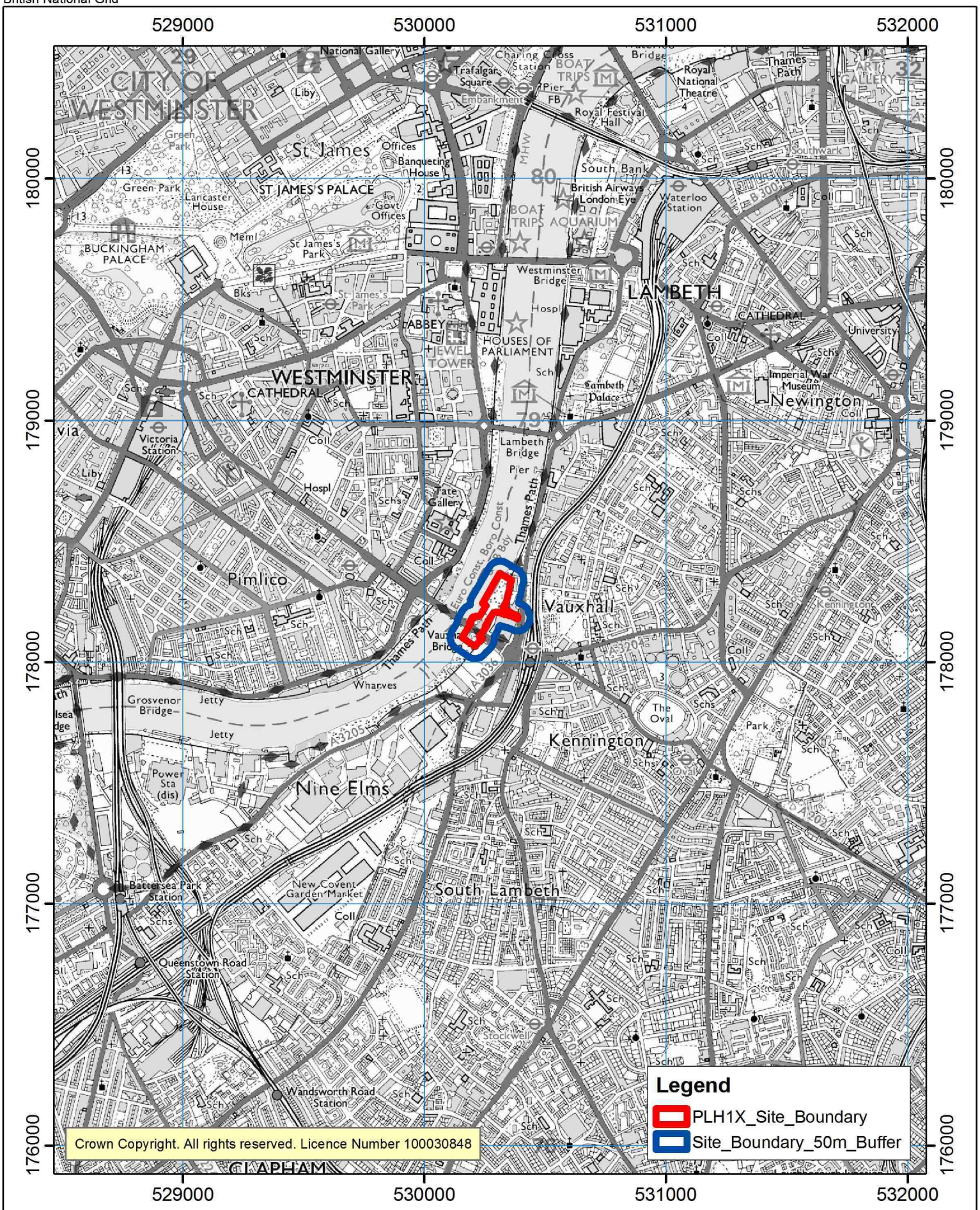
Figure One

Site Location

Thames Tideway Tunnel - Work Area PLH1X
Site Location

Figure 1

British National Grid



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0 100 200 400 600 800 1,000 Meters

N

Project Number: P2853_PLH1X
Drawn By: Dominique René
Checked by: Lee Gooderham
Date: 14th May 2012

Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PLH1X
Site Boundary

Figure 2

British National Grid

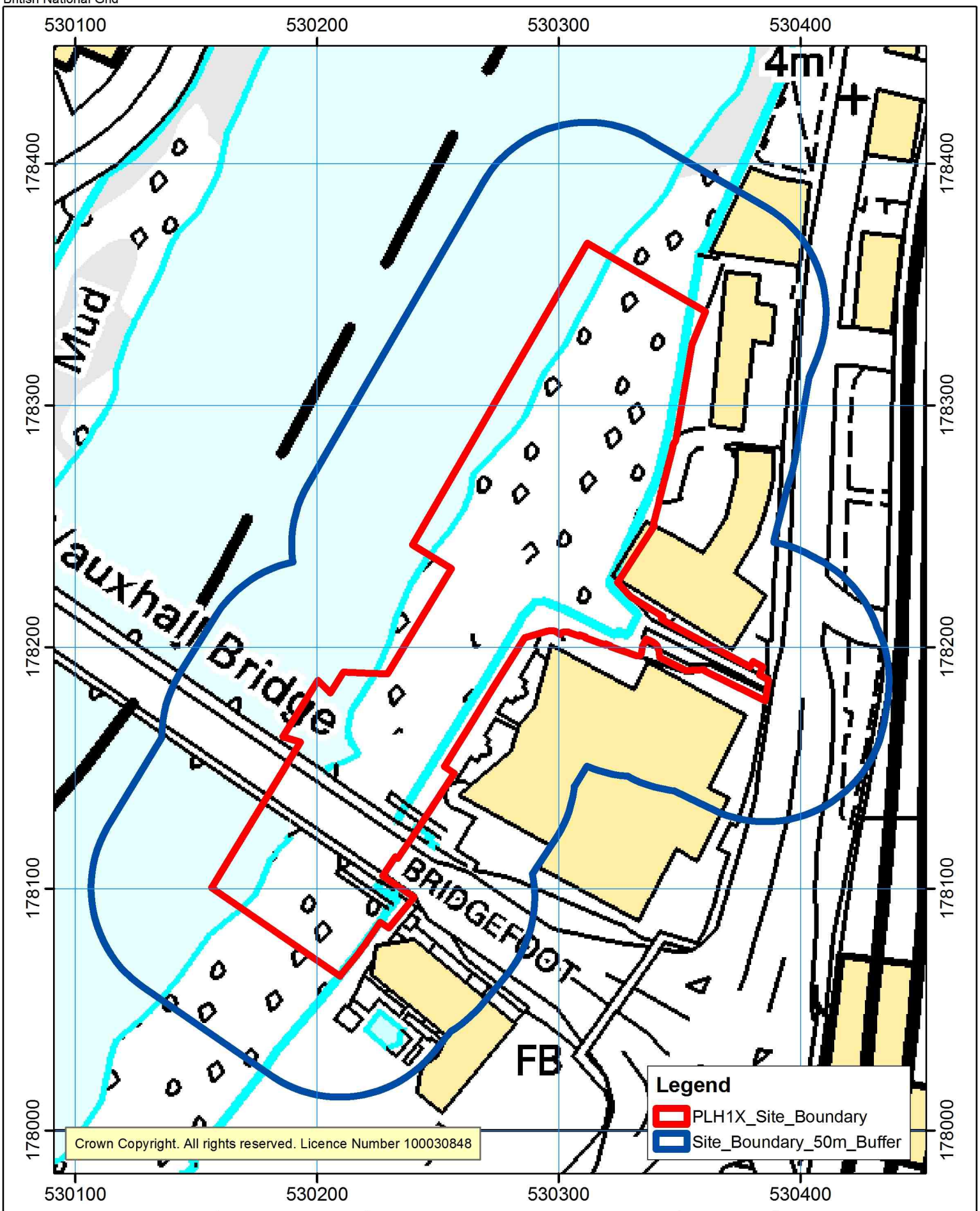

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Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PLH1X
Current Aerial Photography

Figure 3

British National Grid

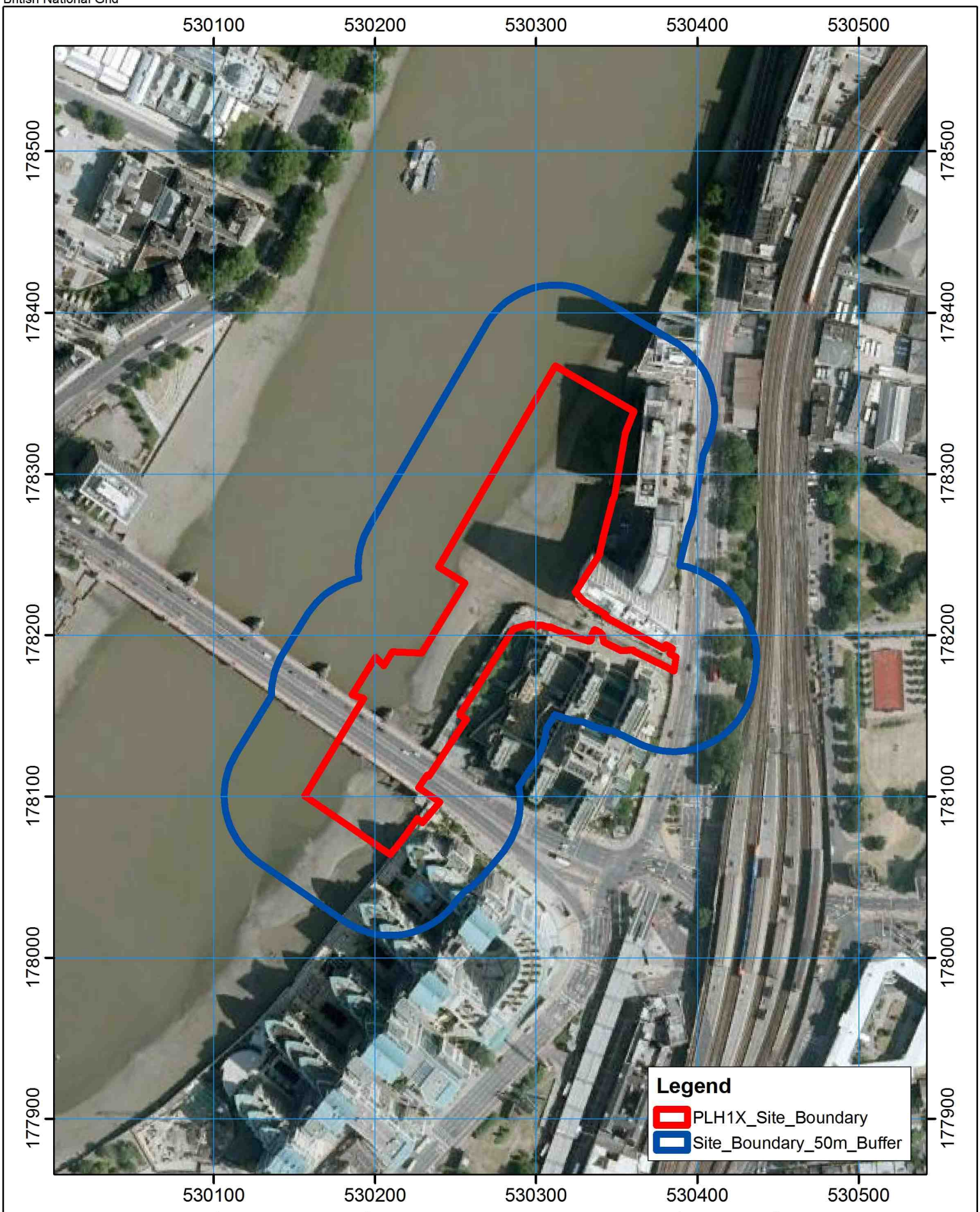

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PLH1X
1945 Aerial Photography

Figure 4

British National Grid

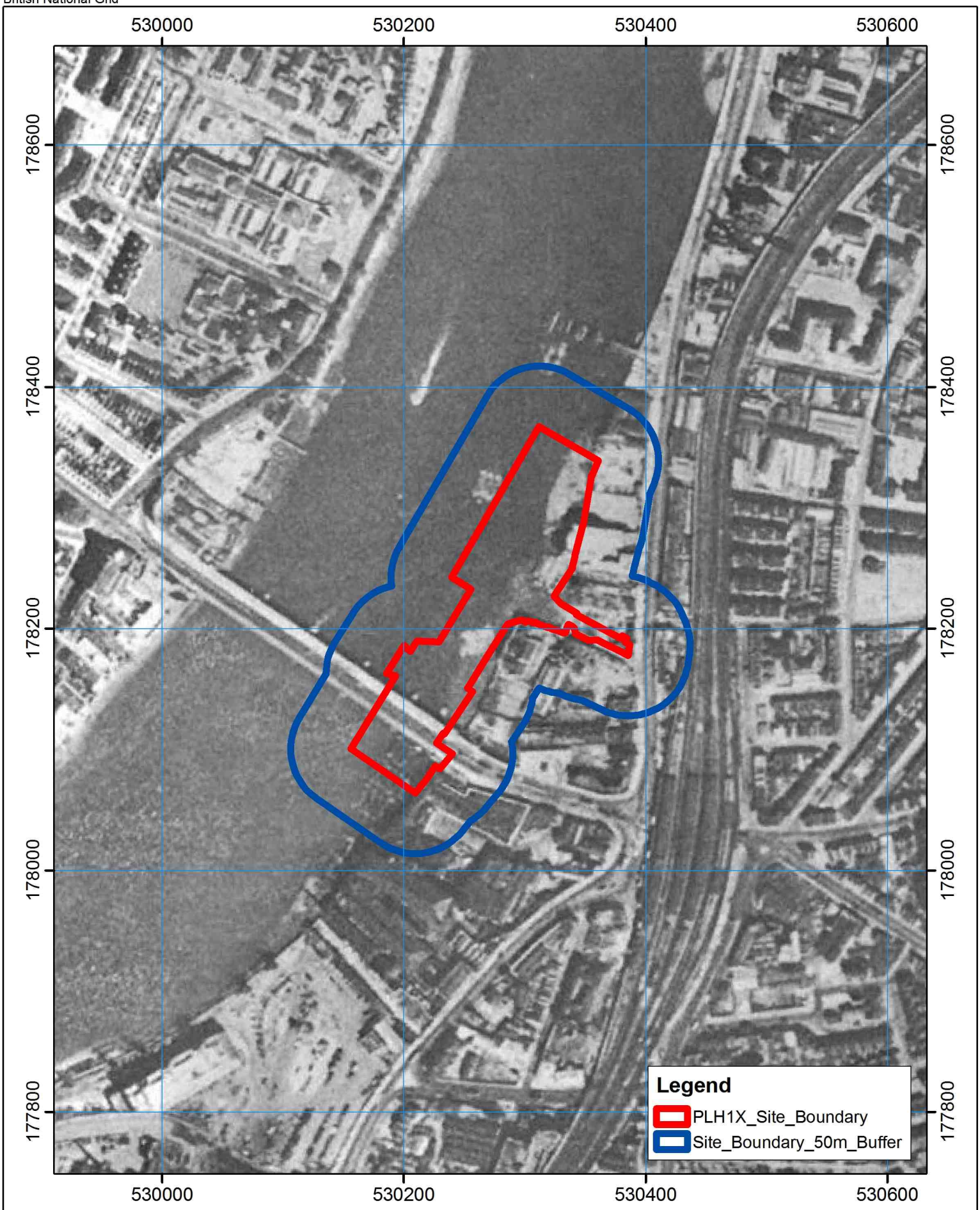

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Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PLH1X
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid

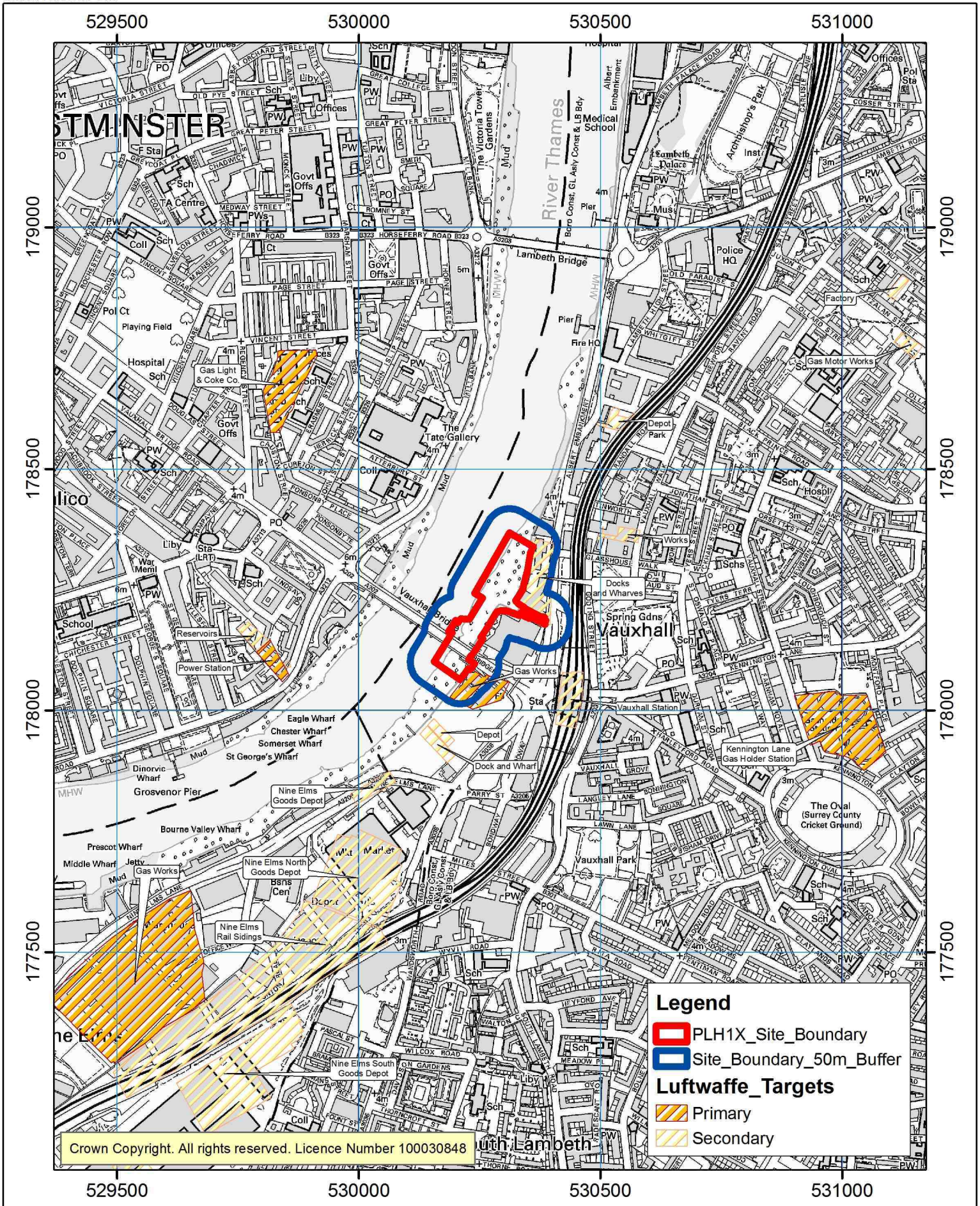

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Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PLH1X
WWII High Explosive Bomb Strikes

Figure 6

British National Grid

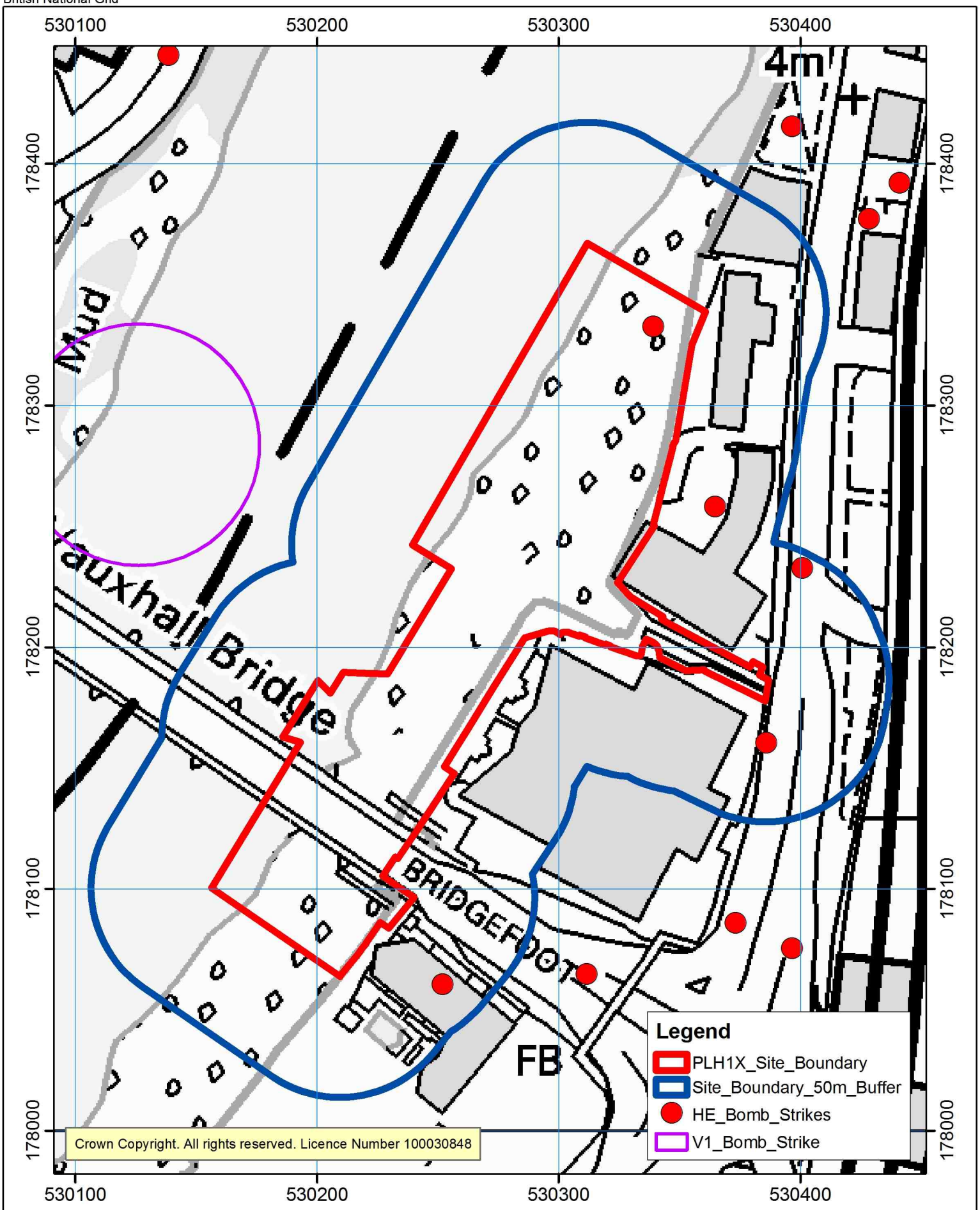

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Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PLH1X
London County Council Bomb Damage Map

Figure 7

British National Grid

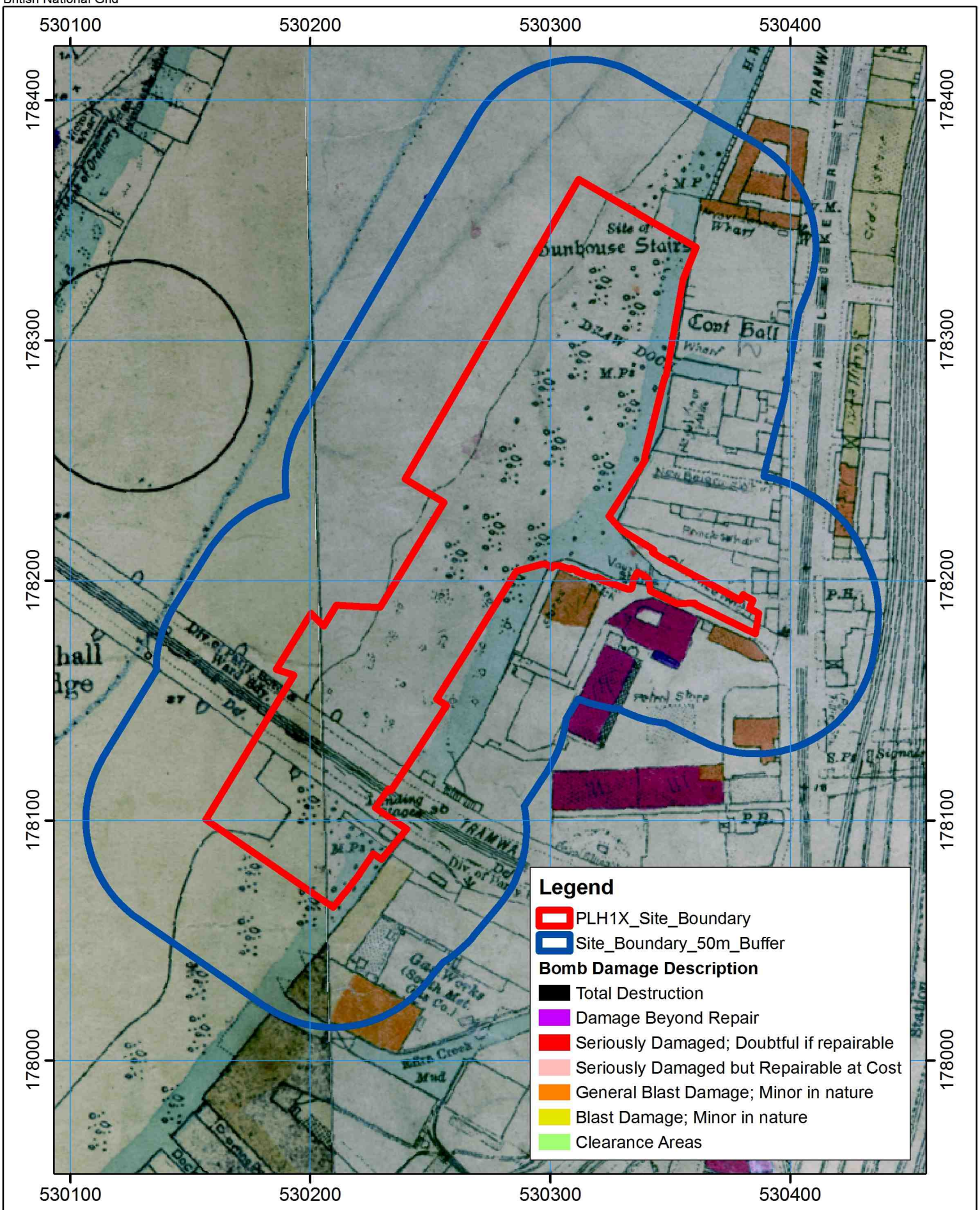

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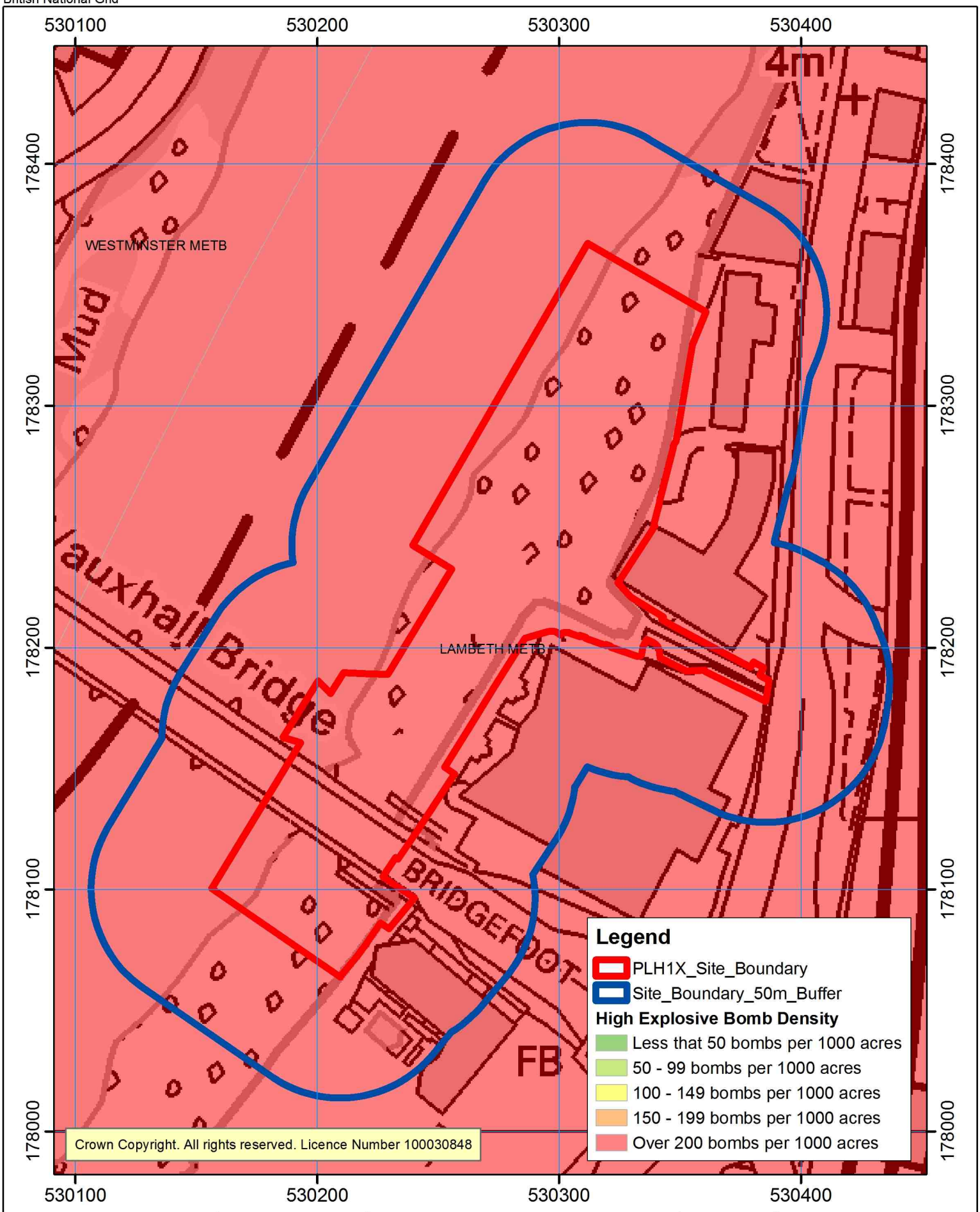
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PLH1X
WWII High Explosive Bomb Density

Figure 8

British National Grid



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[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 from http://www.environment-agency.gov.uk/research/planning/33708.aspx, accessed 25th March 2011.

[3] 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).

[5] London Borough of Lambeth, *Albert Embankment,* Letter Ref: ENV-CONTLAND, 27th April 2011.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore appendices

Appendix G: Noise and vibration

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

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Thames Tideway Tunnel

Environmental Statement

Volume 16 Albert Embankment Foreshore appendices

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, the main 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 receptors to Albert Embankment Foreshore are the dwellings and office buildings close to the site.

Survey methodology

G.1.3 The survey methodology originally covered the collection of weekday daytime measurements only. As the scheme design progressed, additional surveys were undertaken to collect representative weekday evening and night time data, along with representative weekend daytime and night time data. An initial baseline noise survey was completed on 7th April 2011 and additional baseline data was collected on 13th through 15th November 2011. Continuous unattended monitoring was also completed over a three day period (18th-20th December 2011) at one location.

G.1.4 The London Borough (LB) of Lambeth has been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys. A response has not been received (see Vol 5 Section 9.3).

G.1.5 For the initial baseline survey, short term attended noise monitoring was completed at all measurement positions. Measurements were undertaken during the interpeak periods of 10:00-12:00 and 14:00-16:00 so that the baseline data is representative of the quieter periods where any disturbance from construction would be most noticeable.

G.1.6 For the additional baseline survey, further short term attended noise monitoring was completed at all measurement positions. Measurements were undertaken during the interpeak periods of 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.

G.1.7 Vol 16 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 16 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date*
Initial Baseline Survey: 29th March, 2011				
Hand-Held Analyzers	2250	Brüel & Kjær	2626232 2626233	15/02/2010
½ " Microphones	4189	Brüel & Kjær	2621211 2621212	15/02/2010
B&K Sound Calibrator	4231	Brüel & Kjær	2619374 2619375	21/02/2011 12/01/2011
Additional baseline survey: 30th October through 1st November 2011				
Hand-Held Analyzers	2250	Brüel & Kjær	2626232 2626233	15/02/2010
½ " Microphones	4189	Brüel & Kjær	2621211 2621212	15/02/2010
B&K Sound Calibrator	4231	Brüel & Kjær	2619374 2619375	21/02/2011 12/01/2011

**Hand-held analyzers and ½ " microphones valid for two years from the date listed, calibrators valid for one year from the date listed*

G.1.8 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.1.9 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.1.10 The prevailing weather conditions observed for both attended baseline surveys are described in Vol 16 Table G.2.

Vol 16 Table G.2 Noise – weather conditions during baseline noise surveys

Wind speed (ms^{-1})	Wind direction	Temperature (°C)	Precipitation	Description
Initial Baseline Survey – 29th March 2011 (daytime, 10:00-12:00; 14:00-16:00)				
Maximum: 0.9-3.1 Average: 0.3-0.7	E, SE	10-16	Yes - light drizzle observed during 1st measurement (10:16) only	Morning Overcast, generally dry and mild with occasional light breeze Afternoon Sunny, warm, dry with occasional light breeze
Additional baseline survey – 30th October 2011 (daytime, 14:00-18:00)				
Maximum: 1.4-3.7 Average: 0.4-1.5	S, SW	15-16	Yes - light drizzle observed between 15:00-16:30	Overcast and mild with occasional light breeze
Additional baseline survey – 31st October 2011 (night time, 00:00-04:00)				
Maximum: 0.9-3.3 Average: 0-0.8	Southerly	16	No	Overcast, mild and dry with occasional light breeze
Additional baseline survey – 31st October 2011 (evening, 20:00-22:00)				
Maximum: 0.8-2.7 Average: 0-1.2	S, SE	14	No	Generally clear, dry and mild with occasional light breeze
Additional baseline survey – 1st November 2011 (night time, 00:00-04:00)				
Maximum: 0.9-3.0 Average: 0.3-1.1	S, SE	14-15	No	Generally clear, dry and mild with occasional light breeze

Measurement locations

G.1.11 Vol 16 Table G.3 details the measurement locations which are also presented in Vol 16 Figure G.1 Noise – measurement locations (see

separate volume of figures), and shown in Vol 16 Plate G.1 to Vol 16 Plate G.4.

Vol 16 Table G.3 Noise – measurement locations

Measurement location number	Description	Co-ordinates	
		X	Y
AEF01	On public footpath along Thames Path, behind Camelford House	530340	178265
AEF02	On public footpath along Thames Path, adjacent to western corner of Vauxhall Cross	530263	178118
AEF03	On public footbath adjacent to Albert Embankment, in front of the Peninsula Heights Building	530406	178384
AEF04	On public footpath along Crown Reach Riverside Walk, adjacent to Vauxhall Bridge	530021	178233

Results

G.1.12 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 16 Table G.4 to Vol 16 Table G.8.

Vol 16 Table G.4 Noise – sampled noise survey results – AEF01

Location Detail: AEF01, on public footpath along Thames Path, behind Camelford 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)	79	53	56-60	58	61*	60
Evening (20.00-22.00)	72	53	58	58	61*	60
Night (00.00-04.00)	74	49	52-56	54	57*	55
Weekend day (14.00-18.00)	83	55	58-61	60	63*	65
Weekend night (00.00-04.00)	82	47	50-54	53	56*	55

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

Vol 16 Table G.5 Noise – sampled noise survey results – AEF02

Location Detail: AEF02, on public footpath along Thames Path, adjacent to western corner of Vauxhall Cross						
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)	87	58	62-66	64	67*	65
Evening (20.00-22.00)	86	56	62-65	64	67*	65
Night (00.00-04.00)	82	49	56-61	59	62*	60
Weekend day (14.00-18.00)	92	59	63-65	64	67*	65
Weekend night (00.00-04.00)	79	50	57-60	58	61*	60

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

Vol 16 Table G.6 Noise – sampled noise survey results – AEF03

Location Detail: AEF03, on public footbath alongside Albert Embankment, in front of the Peninsula Heights building						
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)	104	65	73-80	77	80*	80
Evening (20.00-22.00)	86	62	71	71	74*	75
Night (00.00-04.00)	83	55	67-70	69	72*	70
Weekend day (14.00-18.00)	103	62	72-76	74	77*	75
Weekend night (00.00-04.00)	84	54	67-68	67	70*	70

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

Vol 16 Table G.7 Noise – sampled noise survey results – AEF04

Location Detail: AEF04, on public footpath along Crown Reach Riverside Walk, adjacent to Vauxhall Bridge						
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)	86	57	61-64	63	66*	65
Evening (20.00-22.00)	84	57	61-62	62	65*	65
Night (00.00-04.00)	70	52	56-57	57	60*	60
Weekend day (14.00-18.00)	76	56	59-61	60	63*	65

Location Detail: AEF04, on public footpath along Crown Reach Riverside Walk, adjacent to Vauxhall Bridge						
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**
Weekend night (00.00-04.00)	81	51	57-58	57	60*	60

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

Vol 16 Table G.8 Noise measurements near embankment (for river-based traffic assessment

Sensitive receptor locations	**Measurement location**	**Measurement period**	**Noise level (dBLAeq, facade)**
Peninsula Heights	AEF02	Day/evening (07.00 -23.00)	67
		Night (23.00 – 07.00)	59
Bridge House	AEF02*	Day/evening (07.00 -23.00)	72
		Night (23.00 – 07.00)	64

**The measurement is undertaken in a screened location from the road, whereas the receptors have a greater view of the road and therefore the levels at this measurement location have been increased by +5dB to better represent the receptor locations*

Plates of noise measurement locations

G.1.13 The following plates (Vol 16 Plate G.1 to Vol 16 Plate G.4) illustrate the noise measurement locations.

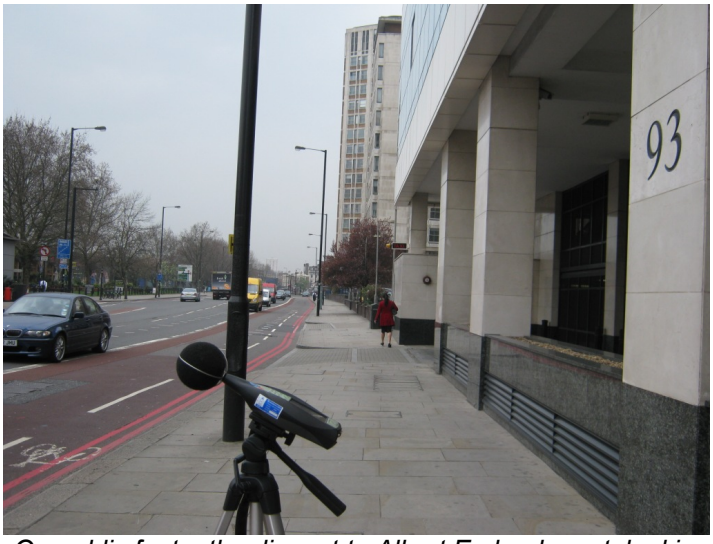
Vol 16 Plate G.1 Noise measurement location AEF01

Note: On public footpath along Thames Path, looking northeast

Vol 16 Plate G.2 Noise measurement location AEF02

Note: On public footpath along Thames Path, adjacent to Vauxhall Bridge, looking northwest

Vol 16 Plate G.3 Noise measurement location AEF03



Note: On public footpath adjacent to Albert Embankment, looking south

Vol 16 Plate G.4 Noise measurement location AEF04

Note: On public footpath along Crown Reach Riverside Walk, looking southeast

G.2 Construction noise prediction results

G.2.1 The construction noise prediction methodology follows the methodology provided in Vol 2.

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 16 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 16 Plate G.5 to Vol 16 Plate G.11.

Vol 16 Table G.9 Noise – typical construction plant schedule

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
Hoarding General site equipment NOT applicable during this phase	Excavator digging post holes for hoarding	1	98	30	BS5228-1[1]: 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	30	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar
	Hand-held percussive breaker	1	111	30	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker
	Waste collection via skip or tipper lorry	1	106	10	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 setup (general site equipment also applicable)	JCB with hydraulic breaker	1	116	50	BS5228-1: Table C.5, Item 1	Backhoe Mounted Hydraulic Breaker
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4,	Fuel tanker lorry

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
					Item 15	
	Well drilling rig	1	107	50	Manufacturer	BauerBBA Well Drilling Rig
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, Item 5	Compressor for hand-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	1	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
Demolition General site equipment also applicable during this	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	22T Excavator c/w hydraulic hammer	1	118	30	BS5228-1: Table C.1, Item 9	Tracked excavator fitted with breaker, 200 kg m

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
phase	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
Cofferdam construction General site equipment also applicable during this phase	150t crawler crane	1	103	60	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Barges	1	101	10	Measured	Barges,
	Generator	1	93	100	BS5228-1: Table C.4, Item 83	Diesel generator,
	Secant pile rig	1	107	60	BS5228-1: Table C.3, Item 16	Crane mounted auger
	400 cfm compressor	1	93	60	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Dewatering pumps cofferdam	4	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Jack-up barge	1	100	10	Measured	Jack-up barge,
	Vibratory piling rig	1	116	60	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	Silent piler	1	91	60	BS5228-1: Table C.3,	Piling, 10 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
					Item 9	
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol),
Diaphragm wall construction	Diaphragm wall rig (grab)	1	114	5	BS5228-1: Table D.4, Item 10	D wall rig,
	Diaphragm wall rig (hydrofraise)	1	110	80	Measured	Hydrofraise D wall rig,
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	150t crawler crane	2	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Diaphragm wall slurry treatment plant	1	100	100	Measured	Slurry treatment plant,
	Concrete deliveries (discharging)	2	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
	Compressor 400cfm	1	98	100	BS5228-1: Table D.6, Item 41	Compressor, 7m^3/min

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
	Waste water treatment plant	1	104	100	Measured	Dirty water plant
Shaft excavation General site equipment also applicable during this phase	Dewatering pump	4	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Long reach excavator	2	106	80	BS5228-1: Table C.7, Item 1	Long reach tracked excavator, 21 m arm / 39 t
	20t excavator with breaker	2	118	50	BS5228-1: Table C.1, Item 8	Breaker mounted on excavator, 15 t
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper 7t
	150t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	40t crawler crane	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Ventilation fans	1	100	100	Estimated	Ventilation fans,
Shaft secondary lining	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

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
						bar
	Service Crane 40T mobile Crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
Piling for culvert support work	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
Culvert works General site equipment also applicable during this phase	Service crane100T mobile crane	1	95	50	BS5228-1: Table C.4, Item 14	Wheeled backhoe loader, 9 t
	Fixed and portable concrete vibrators	2	106	20	BS5228-1: Table C.4, Item 33	Poker vibrator,
	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	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

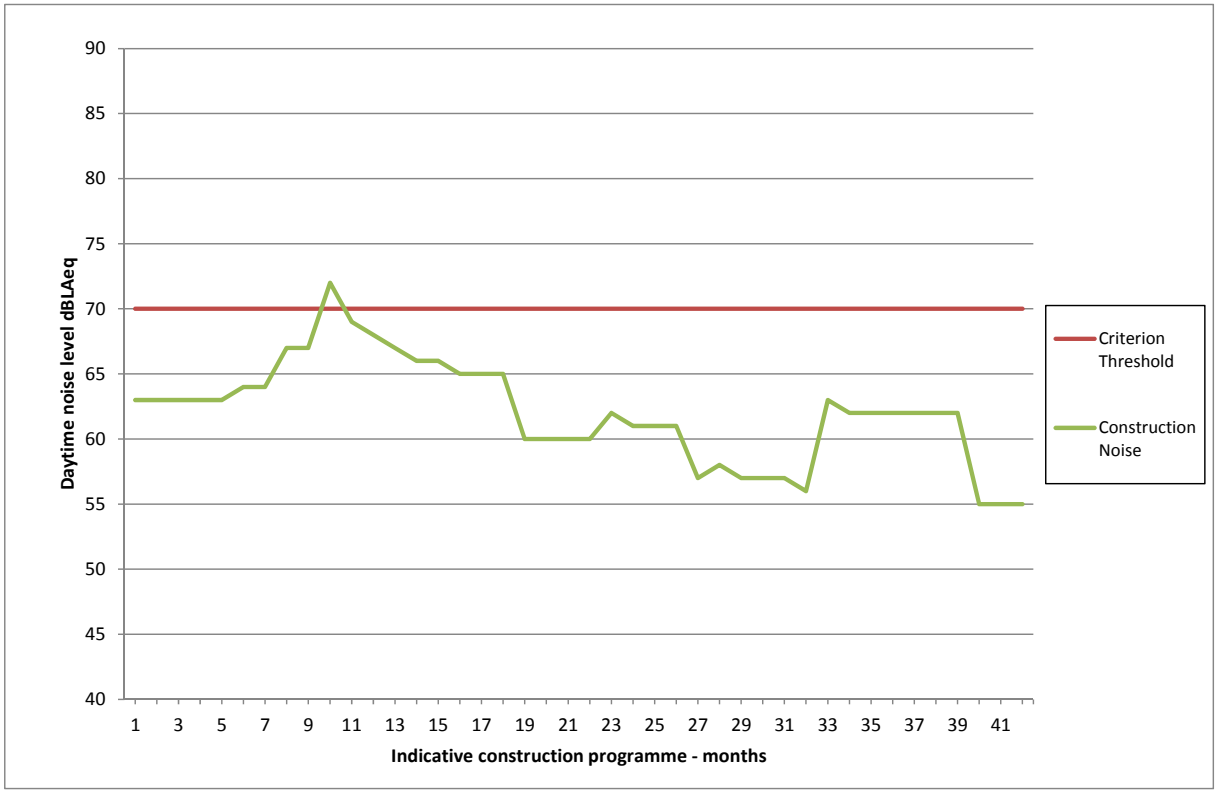
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor,
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	97	50	BS5228-1: 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
	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),
	Vibrating rollers	1	101	70	BS5228-1: Table C.2, Item 38	Roller, 18 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Example equipment used in the assessment
Connection tunnel – pipejack General site equipment also applicable during this phase (items within tunnel are not included as will be attenuated by the shaft and tunnel to less than surface activity levels)	100t crawler crane	1	103	50	BS5228 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
	Ventilation fans	1	100	100	Measured	Ventilation fans,
	Dumper	1	104	25	BS5228 Table C 4, Item 3	Dumper, 7 t
	Grout mixer including silos and feeders	1	95	50	Measured	Batching,
	Loading shovel	1	105	30	BS5228 Table C 4, Item 12	Wheeled excavator, 14 t
	Mains substation	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Waste collection via skip or tipper lorry	1	106	10	BS5228 Table C 8, Item 21	Skip wagon,

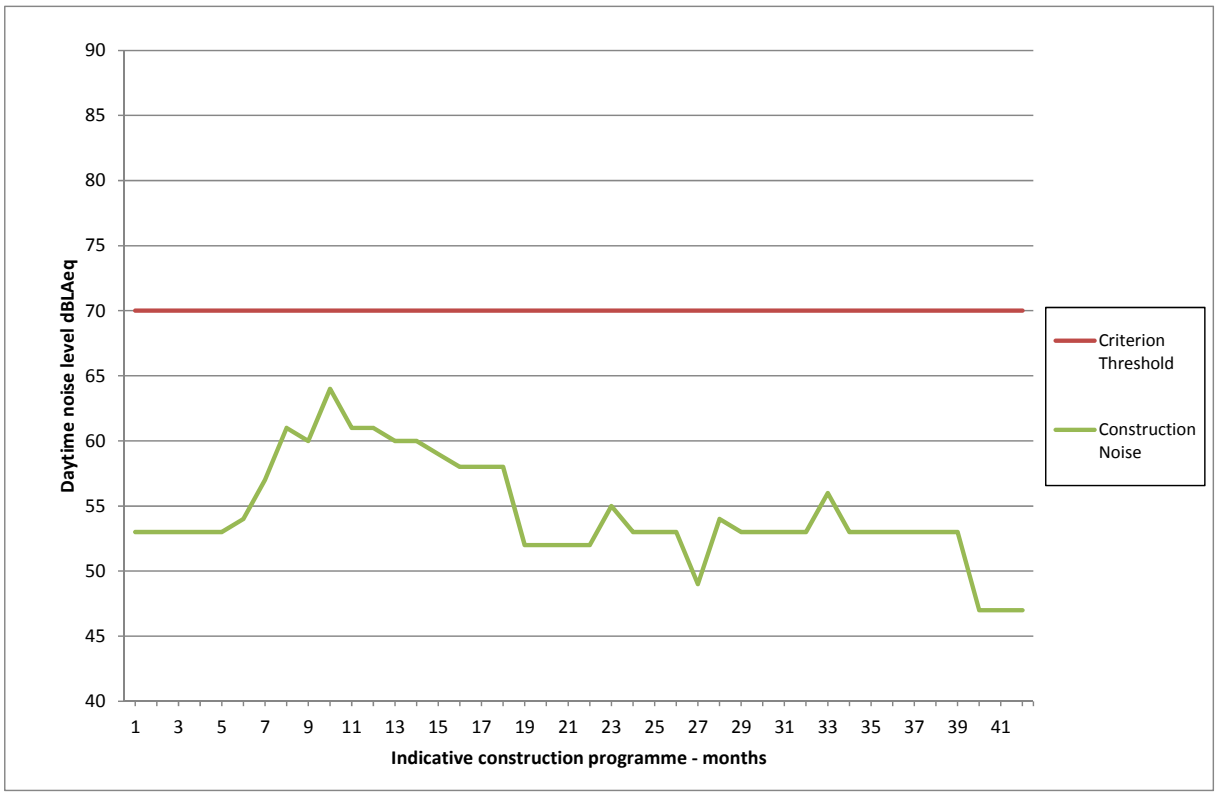
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable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

G.2.5 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 text. 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 text and not presented here.

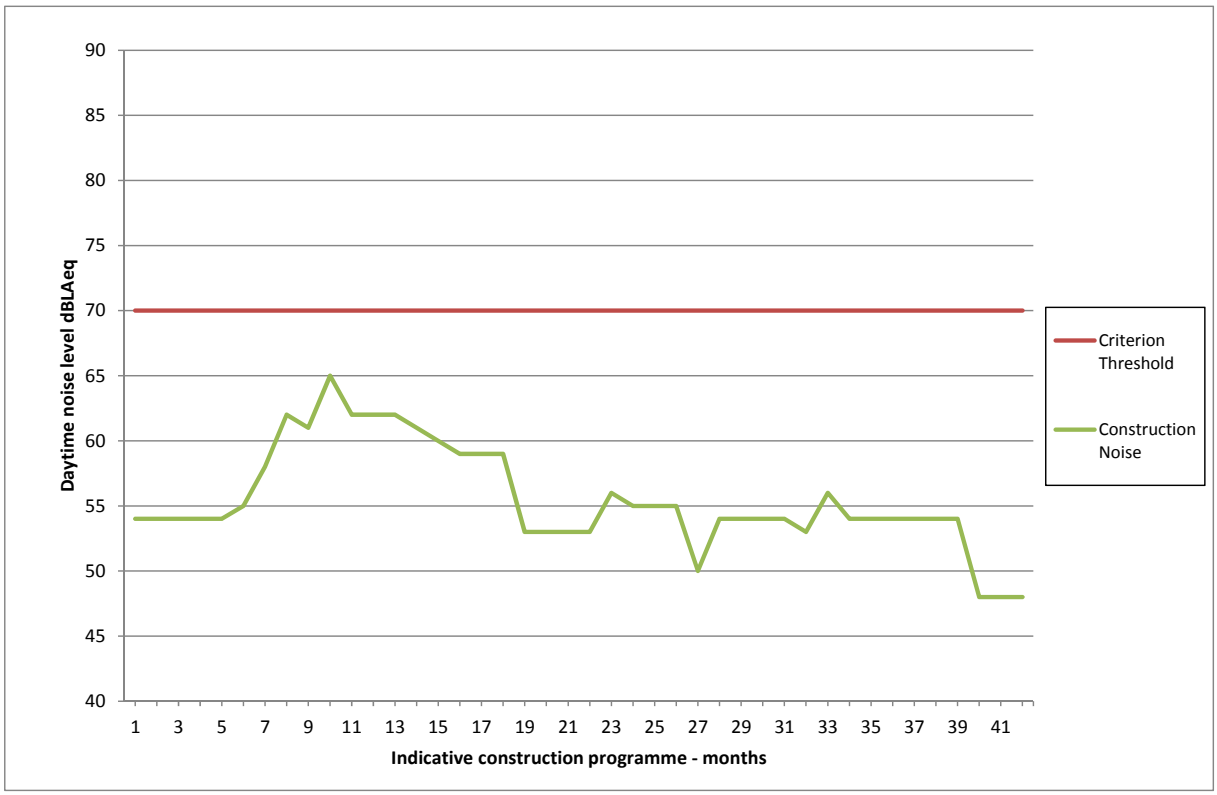
Vol 16 Plate G.5 Average monthly daytime noise level over duration of construction – Peninsula Heights (AE1)



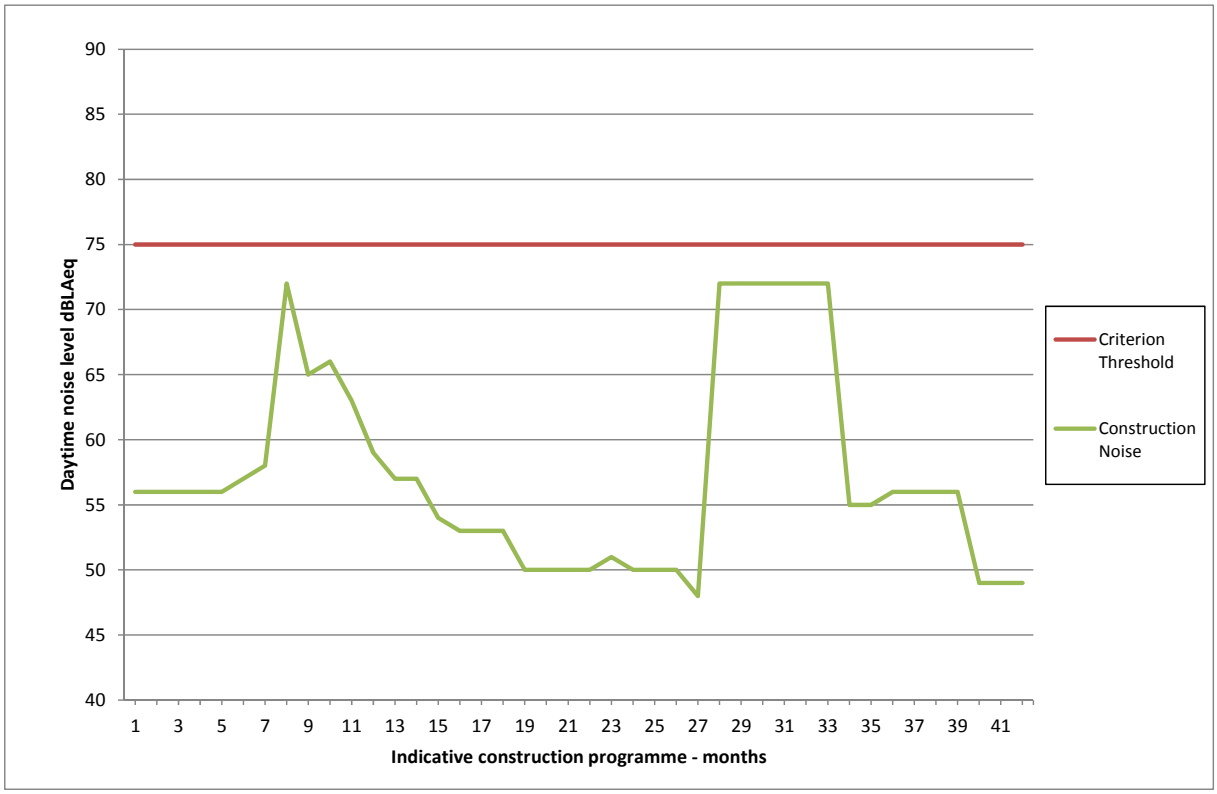
Vol 16 Plate G.6 Average monthly daytime noise level over duration of construction – 151 Rivermill (AE2)



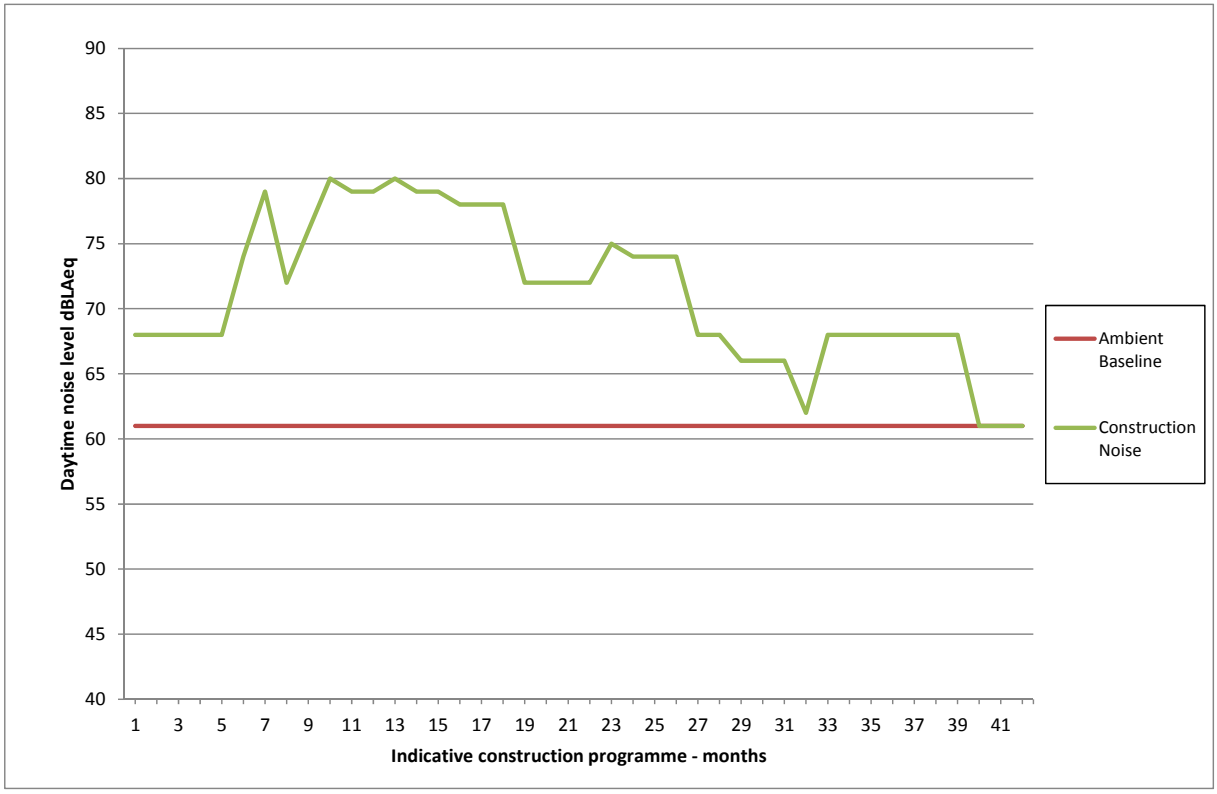
Vol 16 Plate G.7 Average monthly daytime noise level over duration of construction – 48-57 Millbank (AE3)



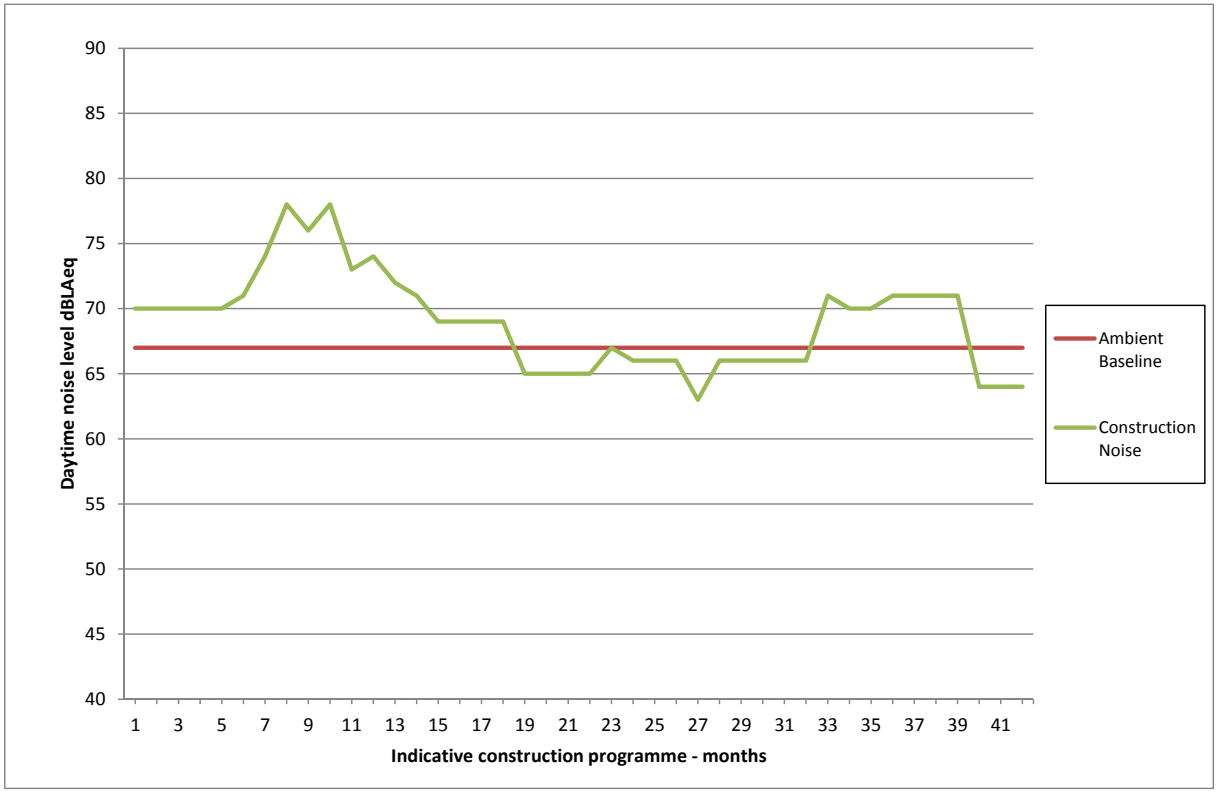
Vol 16 Plate G.8 Average monthly daytime noise level over duration of construction – 1-146 Bridge House (AE4)



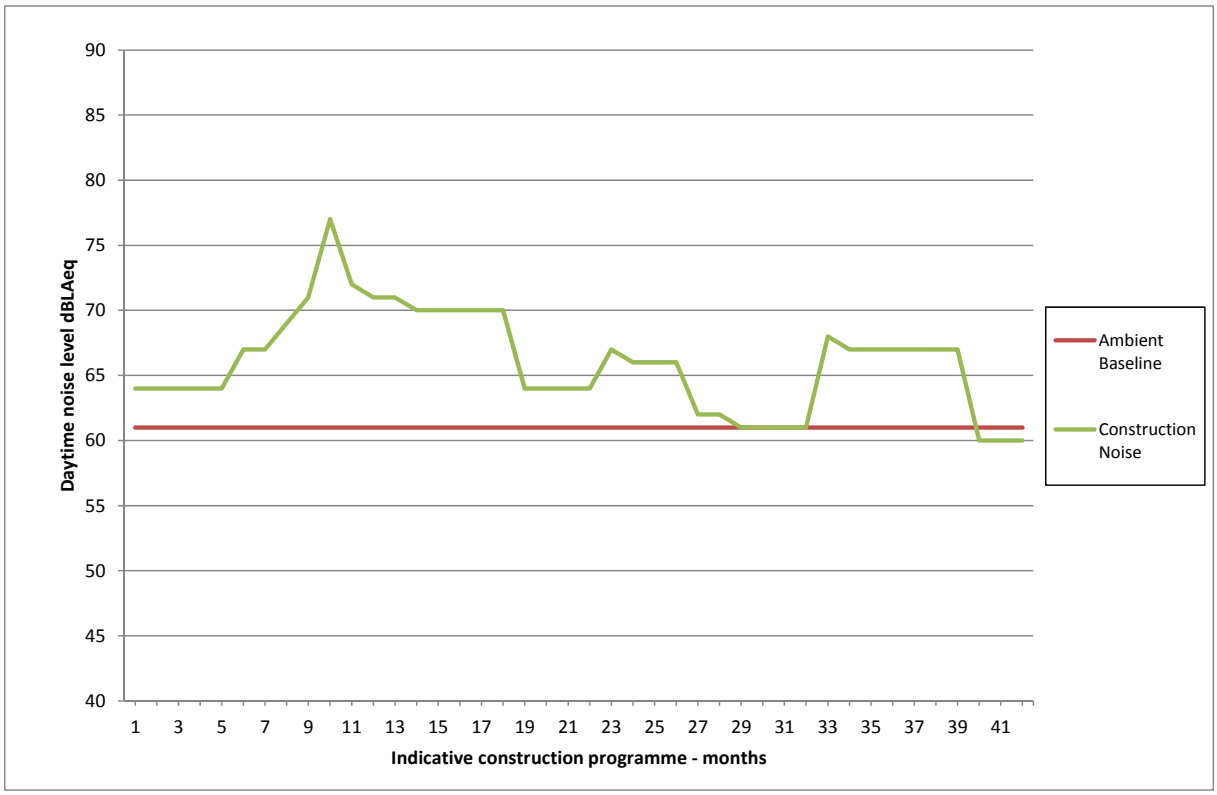
Vol 16 Plate G.9 Average monthly daytime noise level over duration of construction – Camelford House (AE5)



Vol 16 Plate G.10 Average monthly daytime noise level over duration of construction –Vauxhall Cross (AE6)



Vol 16 Plate G.11 Average monthly daytime noise level over duration of construction –Tintagel House (AE7)



References

[1] BRITISH STANDARDS 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: **6.2.16**

Volume 16: Albert Embankment Foreshore appendices

Appendix H: Socio-economics

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

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Thames Tideway Tunnel

Environmental Statement

Volume 16 Appendices: Albert Embankment Foreshore site assessment

Appendix H: Socio-economics

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Appendix H: Socio-economics

H.1 Baseline community profile

H.1.1 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.1.2 On the basis of likely impacts on receptors identified in this socio-economic assessment, the community profile examines the 'immediate area' surrounding the construction site (ie, within an assessment area of 250m), the '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 Lambeth).

H.1.3 The main protected characteristic groups concentrated[iii] within 250m of the site are:

a. persons belonging to Asian and Other ethnic groups
b. persons suffering from a disability
c. persons suffering from overall deprivation.

H.1.4 The main protected characteristic groups concentrated within the wider local area surrounding the proposed construction site are:

a. persons belonging to Asian and Other ethnic groups
b. persons suffering from a long term limiting illness
c. persons suffering from a disability.

Resident population

H.1.5 The resident population was approximately 600 people within 250m of the site and approximately 39,550 within 1km at the time of the last census.

[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 impact assessment.

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

Gender and age

H.1.6 Of the total population within 250m of the site 46.9% of residents are female. This contrasts with the proportion within 1km (50.2%), the LB of Lambeth (50.7%) and Greater London (51.6%) which all have a slight predominance of female residents.

H.1.7 Vol 16 Table H.1 outlines age breakdown by assessment area, it illustrates that within 250m, the proportion of under 16 year olds (13.0%) is slightly lower than within 1km (16.4%) and somewhat lower than within both the LB of Lambeth and Greater London (19.2% and 20.2% respectively).

H.1.8 Within 250m, the proportion of over 65 year olds (12.3%) is similar to that within both 1km (12.3%) and Greater London (12.4%). Within the LB of Lambeth however, the proportion of over 65 year olds (9.3%) is somewhat lower.

Vol 16 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 Lambeth)	Greater London
Under 16 years old	13.0%	16.4%	19.2%	20.2%
Over 65 years old	12.3%	12.3%	9.3%	12.4%

Ethnicity

H.1.9 Vol 16 Table H.2 outlines ethnicity by assessment area, showing that within 250m, White residents comprise almost three quarters of the population (73.1%) with Black and Minority Ethnic (BME) groups comprising the remainder (26.9%). The proportion of White residents within 250m (73.1%) and 1km (70.5%) is similar to that across Greater London (71.2%). However, within the LB of Lambeth the proportion of White residents (62.4%) is slightly lower.

H.1.10 The proportion of Black residents within 250m (16.9%) is similar to that recorded within 1km (17.1%). Relative to within the LB of Lambeth (25.8%) the proportion in both local areas is somewhat lower; whereas relative to Greater London (10.9%) it is somewhat higher.

H.1.11 In contrast, the proportion of Asian residents within 250m (2.8%) and within 1km and at a borough wide level (both 4.6%) is considerably lower than within Greater London overall (12.1%).

Vol 16 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Lambeth)	Greater London
White	73.1%	70.5%	62.4%	71.2%
BME	26.9%	29.5%	37.6%	28.8%
Asian	2.8%	4.6%	4.6%	12.1%
Black	16.9%	17.1%	25.8%	10.9%
Other	4.3%	3.7%	2.4%	2.7%
Mixed	3.0%	4.2%	4.8%	3.2%

Note: The figure for BME data presented in Vol 16 Table H.2 is the sum of data for Asian, Black, Other and Mixed ethnicities.

Religion and belief

H.1.12 Within 250m, 1km and the LB of Lambeth, Christians are the predominant religious group making up 63.3%, 63.2% and 58.8% of residents respectively. The proportion of Christians within these three areas are similar to within Greater London overall (58.2%). Muslims are the second largest religious group accounting for 3.4% of residents within 250m and 7.0% within 1km.

H.1.13 Within 250m, 30.1% of residents do not follow a religion, somewhat higher than the Greater London average of 24.3%.

Health indicators

H.1.14 Vol 16 Table H.3 outlines health indicators by assessment area, noting that within 250m, 13.8% of residents have a long term or limiting illness, somewhat lower than within 1km (16.2%) and Greater London (15.5%).

H.1.15 A considerably higher proportion of residents within 250m claim disability living allowance (8.4%) than within 1km (5.3%), the LB of Lambeth (4.7%) and Greater London (4.5%).

Vol 16 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local are (1km)	Borough wide (LB of Lambeth)	Greater London
Long term limiting sick	13.8%	16.2%	14.7%	15.5%
Disability living allowance	8.4%	5.3%	4.7%	4.5%

H.1.16 In the Middle Layer Super Output Area (MSOA)[iv] (Office of National Statistics, 2012)[5] in which the site falls, levels of adult obesity fall within the middle quintile relative to Greater London. Based on data available at a borough level only, child obesity fell within the second highest (ie, highest being the worst) quintile relative to Greater London.

H.1.17 At a borough level, the number of adults and children undertaking physical activity falls within the middle quintile relative to Greater London.

H.1.18 For death rates by respiratory disease, the local MSOA falls within the lowest quintile (ie, the lowest being the best) relative to other MSOAs in Greater London. For deaths caused by stroke, it falls within the middle quintile and for deaths from heart disease and circulatory disease it falls within the second highest quintile. Deaths by cancer are more prevalent still and the MSOA falls within the highest quintile.

H.1.19 For female life expectancy, the local MSOA falls in the lowest quintile (ie, the lowest being the worst) and for male life expectancy it falls in the second lowest quintile relative to Greater London. Average female life expectancy is 74.6 to 80.3 years old and for males it is 80.3 to 81.9.

Lifestyle and deprivation indicators

H.1.20 Vol 16 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that within 250m, 55.2% of households do not own a car, similar to the proportion within 1km (59.9%). At a borough wide level, the proportion (50.9%) is slightly lower than within both 250m and 1km. Within all of these assessment areas, the proportion is considerably higher than for Greater London (37.5%).

H.1.21 The incidence of income deprivation[v] within 250m (12.4%) considerably lower than within 1km (35.0%), the borough level (36.0%) and the Greater London level (30.8%). By contrast overall deprivation within 250m (73.8%) is considerably higher than within 1km (27.1%), the LB of Lambeth (31.8%) and Greater London (24.5%).

Vol 16 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 Lambeth)	Greater London
No car households	55.2%	59.9%	50.9%	37.5%
Income	12.4%	35.0%	36.0%	30.8%

[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.

[v] Income deprivation and overall deprivation in this instance both refer to the percentage of the population which fall within the top 20% of deprived areas nationally. Percentages therefore refer to the proportion of residents within each assessment area who fall within the highest quintile of deprivation within England.

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Lambeth)	Greater London
Overall	73.8%	27.1%	31.8%	24.5%

H.2 Baseline economic profile

H.2.1 This section presents a profile of the economy local to the proposed construction site at Albert Embankment Foreshore.

H.2.2 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 Lambeth) and for Greater London.

H.2.3 Data is sourced from Experian's National Business Database (2012)[6], which draws primarily on regularly updated records from Companies House.[vi]

Employment and businesses

H.2.4 Within 250m of the site there are approximately 4,900 jobs.[vii] Vol 16 Table H.5[viii] 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 5% of total employment within approximately 250m. It can be seen that:

a. Human Health and Social Work Activities account for 21% of jobs within 250m of the site, a considerably greater proportion than within the LB of Lambeth (13%) and Greater London (8%).

b. Accommodation and Food Services Activities account for 14% of employment within 250m, somewhat more than within the LB of Lambeth (10%) and considerably more than within Greater London (8%).

c. Wholesale and Retail Trade Activities / Repair of Motor Vehicles and Motorcycles account for 14% of employment within 250m, slightly more than within the LB of Lambeth (11%) though slightly less than within Greater London (16%).

vi 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.

vii 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.

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

d. Administration and Support Services, and Information and Communication Activities, account for 7% to 8% of employment at all three geographical levels.

e. Real Estate Activities account for 7% of employment within 250m, more than double that within both the LB of Lambeth and Greater London (both 3%).

f. Professional, Scientific and Technical Services account for 6% of employment within 250m, somewhat less than within the LB of Lambeth (8%) and considerably less than within Greater London (11%).

g. Education accounts for 6% to 8% of employment at all three geographical levels.

Vol 16 Table H.5 Socio-economics – employment by top eight sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (LB of Lambeth)**	**Greater London**
Human Health and Social Work Activities	21%	13%	8%
Accommodation and Food Service Activities	14%	10%	8%
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	14%	11%	16%
Administrative and Support Services	7%	8%	8%
Information and Communication	7%	8%	7%
Real Estate Activities	7%	3%	3%
Professional, Scientific and Technical Services	7%	8%	11%
Education	6%	8%	7%
Other (including unclassified)	17%	31%	32%

H.2.5 Within 250m of the site there are approximately 420 businesses (defined here as business locations[ix]). The split of businesses by sector within approximately 250m broadly reflects the breakdown of employment by sector set out in Vol 16 Table H.5, with a relatively high number of businesses in Administration and Support Services (17% of businesses), Human Health and Social Work Activities (9%), Professional Scientific and Technical Activities (11%), Information and Communication (9%), and

[ix] 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.

Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles (9%).

H.2.6 Vol 16 Table H.6 illustrates the size of businesses in terms of the number of employees on site. At all geographical levels, businesses within the smallest size band (1 to 9 employees) account for the greatest proportion. However, there appears to be a greater proportion of larger businesses within approximately 250m of the site than within the wider geographical area. Within 250m, 77% of business units have 1 to 9 employees on site, compared to 89% within the LB of Lambeth and 88% within Greater London. Businesses with 25 or more employees account for 10% of all businesses within 250m of the site, more than within LB of Lambeth (4%) and Greater London as a whole (4%).

H.2.7 For the sectors accounting for the greatest proportions of jobs and businesses within approximately 250m, the size banding of businesses varies. 90% of businesses in Administrative and Support Service Activities have 1 to 9 employees, compared to an average across all sectors of 77%; however for all other locally important sectors less than 77% of businesses fall within the 1 to 9 employee band. In total, 30% of Human Health and Social Work businesses employ over 25 employees and 8% employ over 100, which are considerably higher proportions respectively than within both LB of Lambeth and Greater London.

Vol 16 Table H.6 Socio-economics – businesses by size band (employees at site)

Assessment area / sector		Size band (employees at site)					
		1-9	10-24	25-49	50-99	100-249	250+
Immediate area (250m)		77%	14%	4%	3%	2%	1%
	Human Health and Social Work	*50%*	*21%*	*8%*	*13%*	*8%*	*0%*
	Administrative and Support Services	*90%*	*7%*	*1%*	*1%*	*0%*	*0%*
	Accommodation and Food Services	*42%*	*33%*	*13%*	*8%*	*0%*	*4%*
	Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	*59%*	*26%*	*8%*	*5%*	*0%*	*3%*
Borough wide (LB of Lambeth)		89%	7%	2%	1%	1%	0%
Greater London		88%	8%	2%	1%	1%	0%

H.3 Baseline usage surveys

H.3.1 Refer to Vol 2 Appendix H for details on the methodology used for the open space usage surveys and subsequent analysis.

Survey dates and times

H.3.2 Surveys were undertaken as follows.

Summer

a. Monday 22nd August 2011, 12pm to 2pm (sunny, 22OC).

b. Saturday 27th August 2011, 2pm to 4pm (partly sunny, 17OC).

c. Friday 9th September 2011, 12pm to 2pm (partly sunny, 20OC).

d. Wednesday 14th September 2011, 4pm to 6pm (cloudy, 20^{O}C).

Autumn

a. Friday 21st October 2011, 1pm to 2pm and 3pm to 5pm (partly sunny, 16OC).

b. Saturday 29th October 2011, 2pm to 4pm (sunny, 16^{O}C).

Survey points and zones

H.3.3 Vol 16 Figure H.1 (see separate volume of figures) shows the location of the survey areas listed in Vol 16 Table H.7 below.

Vol 16 Table H.7 Socio-economics – survey zones and duration of survey period

Name	Location	Survey times	Frequency
Survey zone 1	Thames Path and amenity space fronting the Vauxhall Cross building	30 minutes	Hourly
Survey zone 2	Albert Embankment Gardens	15 minutes (20 minutes on Friday 21st October)	Hourly
Survey point 3	Amenity space (along Thames Path) outside St George's Wharf	Point in time observations	Half hourly
Survey point 4	Amenity space (along Thames Path) by Tintagel House	Point in time observations	Hourly

Site specific considerations

H.3.4 On Friday 9th September 2011 at approximately 2pm a security alert on Vauxhall Bridge resulted in the cordoning off of the area and the survey

being abandoned. The remainder of the survey was completed on Wednesday 14th September 2011.

Key findings and observations

Survey zone 1 – Thames Path and amenity space fronting the Vauxhall Cross building

H.3.5 On weekdays, the area is well used, particularly during lunchtimes when the Thames Path is used by office workers for local journeys and the seats are used for eating lunch. User numbers per hour (walkers, joggers and cyclists combined) peaked at 496 per hour.

H.3.6 User numbers declined after 2pm in the weekday afternoons, to around 100 to 200 users per hour (walkers, joggers and cyclists combined) before increasing somewhat after approximately 4.30pm.

H.3.7 The seating areas experience a lower level of usage on weekends with usage of the Thames Path also being also lower but regular and steady (50 to 150 users per hour).

H.3.8 The majority of users (over 75% on each survey day) were young adults (18 to 39 years old) and from White ethnic backgrounds (over 80% of users on each day). See Vol 16 Table H.8 for more details.

Vol 16 Table H.8 Socio-economics – usage level by type at survey zone 1

Day	Time of survey	Number of users traversing through				Number of users p/hr	Passive recreation
		Walkers	Joggers	Dog walkers	Cyclists		
Summer							
Monday 22nd August 2011	12:00 - 12:30	125	19	3	3	300	6
	13:00 - 13:30	178	21	-	3	404	29
Sunday 27th August 2011	14:00 - 14:30	14	6	2	2	48	4
	15:00 – 15:30	55	7	-	7	138	6
Friday 9th September 2011	12:00 - 12:30	80	17	1	1	198	-
	13:00 - 13:30	215	31	-	2	496	-
Wednesday 14th September 2011	16:00 - 17:30	56	3	-	8	134	3
	17:00 - 17:30	67	11	1	5	168	3
Autumn							
Friday 21st October 2011	13:00 - 13:30	184	26	2	1	426	9

Day	Time of survey	Number of users traversing through				Number of users p/hr	Passive recreation
		Walkers	Joggers	Dog walkers	Cyclists		
	15:00 - 15:30	44	3	-	2	98	-
	16:00 - 16:30	19	-	-	3	44	2
Saturday 29th October 2011	14:00 - 14:30	32	5	1	4	84	5
	15:00 - 15:30	57	4	1	2	128	1

Survey zone 2 – Albert Embankment Gardens

H.3.9 On weekdays, Thames Path user numbers were generally 50% lower than survey zone 1, though usage at weekends was similar to zone 1.

H.3.10 Over 50% fewer users were recorded during weekday survey periods in autumn than in summer.

H.3.11 The majority of users (over 70% on each survey day) were young adults (18 to 39 years old) including over 80% of joggers and cyclists.

H.3.12 The majority of users were White (over 60% on each survey day). See Vol 16 Table H.9 for more details.

Vol 16 Table H.9 Socio-economics – usage level by type at survey zone 2

Day	Time of survey	Number of users				Estimated number of users p/hr	Passive recreation
		Walkers	Joggers	Dog walkers	Cyclists		
Summer							
Tuesday 2nd August 2011	12:40 - 12:55	45	25	2	1	292	11
	13:40 - 13:55	49	12	-	8	276	-
Sunday 14th August 2011	14:40 - 14:55	22	2	-	3	108	-
	15:45 - 16:00	27	4	3	2	144	1
Friday 9th September 2011	12:35 - 12:50	26	15	-	2	172	10
	13:45 - 14:00	19	5	-	2	104	8
Wednesday 14th September 2011	16:45 - 17:00	25	5	-	3	132	2
	17:40 - 17:55	13	8	1	9	124	2

Day	Time of survey	Number of users				Estimated number of users p/hr	Passive recreation
		Walkers	Joggers	Dog walkers	Cyclists		
Autumn							
Friday 21st October 2011	13:40 - 14:00	35	8	-	-	129	8
	15:40 - 16:00	12	2	-	1	45	2
	16:40 - 17:00	9	1	-	4	42	4
Saturday 29th October 2011	14:40 - 14:55	28	2	-	2	128	2
	15:40 - 15:55	30	1	-	6	148	5

Survey point 3 – amenity space (along Thames Path) outside St George's Wharf

H.3.13 Over 90% of users were either walkers, joggers or cyclists.

H.3.14 Usage of the space for passive recreation was low throughout the surveys, reflecting that the area has few opportunities for such activities to take place, in contrast to the areas further north along Albert Embankment.

Survey point 3 – amenity space (along Thames Path) by Tintagel House

H.3.15 The wall seating was well used for passive recreation on weekday lunch times. This appeared to be overspill usage from survey zones 2 and 3.

H.3.16 After 2pm, user numbers were significantly lower surveys, with no people being recorded as using the space for passive recreation on either of the weekend surveys.

Other findings

H.3.17 Use of the river foreshore area itself was observed, for walking, passive recreation, and beach combing. However the space is not always accessible due to tidal conditions.

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[6] Experian. *National Business Database* (Database of employment and enterprise statistics). Accessed: September 2012.

[7] Office of National Statistics. *UK Standard Industrial Classification of Economic Activities 2007 (SIC 2007)*, 2009. Available at: http://www.ons.gov.uk/ ons/guide-method/classifications/current-standard-classifications/index.html. Accessed 5/9/12.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore 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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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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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 Albert Embankment Foreshore site is shown in Vol 16 Table K.1.

Vol 16 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
			Harwich
	Palaeocene	Lambeth	Upper Shelly Beds
			Upper Mottled Beds
			Laminated Beds
			Lower Shelly Beds
			*Mid-Lambeth Hiatus**
			Lower Mottled Beds
			Upnor
		No group	Thanet Sand

** Not a Formation but an important depositional feature*

K.1.2 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS) (British Geological Survey, 2009)[1], is shown in Vol 16 Figure 13.4.1 and Vol 16 Figure 13.4.2 respectively (see separate volumes of figures).

K.1.3 The ground investigation undertaken for the Thames Tideway 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 overwater ground investigation boreholes drilled on site; these are boreholes SR5004 to SR5007 inclusive. A further overwater borehole SR2095 was used to gauge the lateral continuity of strata in the general area. The locations of these boreholes are shown in Vol 16 Figure 13.4.2 (see separate volumes of figures). The depths and thicknesses of geological layers encountered are summarised in Vol 16 Table K.2.

Vol 16 Table K.2 Groundwater - anticipated ground conditions

Formation	Top elevation* (mATD)**	Depth below river bed (m)	Thickness (m)
Alluvium	101.20	0.00	1.20
River Terrace Deposits	100.00	1.20	2.90
London Clay	97.10	4.10	27.90
Harwich	69.20	32.00	0.40
Lambeth Group			
USB	68.80	32.40	1.30
UMB	67.50	33.70	5.30
Sand Channel	62.20	39.00	2.30
LtB/LSB	59.90	41.30	0.40
LMB	59.50	41.70	4.40
LMB (Gv)	55.10	46.10	3.20
UPN	51.90	49.30	1.10

** Top elevation of over-water boreholes is approximately 4m below assumed ground level*

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

USB–Upper Shelly Beds; UMB–Upper Mottled Beds; LtB–Laminated Beds; LSB-Lower Shelly Beds; LMB-Lower Mottled Beds; LMB (Gv)-Lower Mottled Beds(Gravel); UPN (Gv)-Upnor Formation(Gravel); UPN-Upnor Formation.

K.1.4 The combined sewer overflow (CSO) drop shaft at the Albert Embankment Foreshore site would extend down to approximately 57.47mATD and would pass through the Alluvium, River Terrace Deposits, London Clay Formation, Harwich Formation and into the Lower Mottled Beds of the Lambeth Group. The base slab would extend to approximately 54.74mATD and would be constructed within the Lower Mottled Beds (Gravel).

K.1.5 As assumed for the purpose of this assessment the culvert connection to the shallow interception chamber, approximately 6.78m would extend down to 98mATD into the River Terrace Deposits and the culvert connection to the deep interception chamber, approximately 19.5m would extend down to 86mATD into the London Clay Formation.

K.1.6 The connection tunnel would be constructed within the Lower Mottled Beds, a sand channel and the Laminated Beds/ Lower Shelly Beds of the Lambeth Group.

K.1.7 The Alluvium, comprising silty clay and clayey silt with occasional scattered pebbles and granules, is expected to be 1.2m thick at the Albert Embankment Foreshore 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 2.9m thick at the Albert Embankment Foreshore site.

K.1.9 The London Clay is described by the BGS as “fine, sandy, silty clay/silty clay, glauconitic at base”[2] and is comprised of clayey silt beds at the Albert Embankment Foreshore site. 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 27.9m thick at the Albert Embankment Foreshore site.

K.1.10 The Harwich Formation comprises fine-grained glauconitic sand and rounded black flinty pebble beds. The Harwich formation is expected to be 0.4m at the Albert Embankment Foreshore site.

K.1.11 The Upper Shelly Beds (USB) of the Lambeth Group comprises grey, shelly clays with scattered glauconite grains. The Upper Shelly Beds are approximately 1.3m thick at the Albert Embankment Foreshore site.

K.1.12 The Upper Mottled Beds (UMB) of the Lambeth Group comprises silty clay and clay, generally un-bedded, fissured and blocky. The Upper Mottled Beds are expected to be 5.3m thick at the Albert Embankment Foreshore site.

K.1.13 A sand channel was identified between the Upper Mottled Beds and the Laminated Beds of 2.3m thickness.

K.1.14 The Laminated Beds (LtB) / Lower Shelly Beds (LSB) of the Lambeth Group comprises thinly interbedded fine to medium grained sand, silt and clay with shells and dark grey to black clay with abundant shells respectively. The Laminated Beds/ Lower Shelly Beds are expected to be 0.4m thick at the Albert Embankment Foreshore site.

K.1.15 The Lower Mottled Beds (LMB) of the Lambeth Group comprises silty clay and clay, generally un-bedded, fissured and blocky. The Lower Mottled Beds are expected to be 7.6m thick at the Albert Embankment Foreshore site.

K.1.16 The Upnor Formation forms the basal beds of the Lambeth Group and is described by the BGS as “mainly variably glauconitic fine- to medium-grained sand with beds and stringers of well-rounded, black flint pebbles” with “a persistent pebble bed at the top” and “a basal flint pebble bed”2. The Upnor Formation is expected to be 1.1m thick at the Albert Embankment Foreshore site.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions anticipated at the Albert Embankment Foreshore site is shown in Vol 16 Table K.3.

Vol 16 Table K.3 Groundwater - anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial deposits	(Made ground) Alluvium	Hydraulic continuity with upper aquifer
	River Terrace Deposits	Upper aquifer
Thames	London Clay	Aquiclude*
	Harwich	Aquitard** /aquifer
Lambeth	Upper Shelly Beds Upper Mottled Beds Laminated Beds Lower Shelly Beds ---Mid Lambeth Hiatus***- Lower Mottled Beds Upnor	Aquitards/ aquifers
		Lower aquifer

** Aquiclude - a hydrogeological unit which, although porous and capable of storing water, does not transmit it at rates sufficient to furnish an appreciable supply for a well or spring (USGS, 1989)*[3]

*** Aquitard - a poorly-permeable geological formation that does not yield water freely, but may still transmit significant quantities of water to or from adjacent aquifers (EA, 2012)*[4]

**** Not a Formation but an important depositional feature*

K.2.2 The Alluvium overlies the River Terrace Deposits or upper aquifer. The ground investigation boreholes indicate that the Alluvium was drilled dry.

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"4.

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 Tideway Tunnel project at the Albert Embankment Foreshore site. However the separation distance between the base slab and the top of the Upnor Formation would be 2.84m only.

K.2.5 The CSO drop shaft would pass through the London Clay Formation. 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.2.6 Above the Lambeth Group, the thin fine-grained sand and pebble beds of the Harwich Formation. The Harwich Formation may form a minor aquifer unit where it is isolated from the lower aquifer (Chalk / Thanet Sands) by the Lambeth Group. There may be limited connection via erosive features to the lower aquifer.

K.2.7 Within the Lambeth Group, several confined groundwater layers are expected to be encountered. Groundwater is expected during the excavation of through the Upper Shelly Beds (at the top of the Lambeth Group); and more significantly at sub-artesian pressures within the Laminated Beds (formerly part of the Woolwich Formation).

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 two off site ground investigation boreholes (SR1078 and SR1070). These boreholes have response zones[i] and monitor groundwater levels in the Alluvium/ River Terrace Deposits and in the Thanet Sand Formation respectively. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 16 Table K.4. The logger data collected from these monitoring boreholes is shown in Vol 16 Table K.5.

Vol 16 Table K.4 Groundwater - monitoring boreholes

Borehole	Response zone depths mATD	Strata	Monitoring
SR1078	96.80-102.70	Alluvium/ River Terrace Deposits	Fortnightly dips and logger
SR1070	39.90-45.60	Thanet Sand	Fortnightly dips and logger
TQ27 334	-	Chalk	Sporadic dips

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

Vol 16 Table K.5 Groundwater – summary level data

Borehole	Period of record	Maximum month year		Minimum month year		Average over the period of record	
		mbgl	mATD	mbgl	mATD	mbgl	mATD
SR1078	*23/10/2009 – 03/04/2012*	*4.34* (March 2010)	99.86 (March 2010)	5.54 (Nov. 2011)	98.66 (Nov. 2011)	4.94	99.26
SR1070	23/10/2009 – 03/04/2012	31.35 (Nov. 2010)	74.25 (Nov. 2010)	37.27 (Nov. 2011)	68.33 (Nov. 2011)	34.59	71.01
TQ27_334	30/10/1992 – 27/04/2012	25.85 (Apr. 2000)	79.65 (Apr. 2000)	48.17 (Dec. 2011)	57.33 (Dec. 2011)	34.70	70.80

K.3.3 The recorded water levels in the Alluvium/ River Terrace Deposits at SR1078 range from 98.63mATD to 99.66mATD. These water levels consistently remain below the top of the River Terrace Deposits at 100mATD, indicating that this formation is not fully saturated here.

K.3.4 The recorded water levels (piezometric head) in the Thanet Sand Formation range from 68.33mATD to 74.25mATD. These levels remain above the top of the Thanet Sand indicating that this formation is confined by the overlying Lambeth Group and London Clay Formation. The piezometric levels in the Upnor Formation are likely to be similar as these units are in hydraulic continuity, forming the lower aquifer. These levels remain above the anticipated depth of the base slab at 54.74mATD; therefore dewatering within the lower aquifer is anticipated to be required.

K.3.5 A plot of groundwater levels within the River Terrace Deposits in the vicinity of the site and the Thanet Sands Formation is shown in Vol 16 Figure 13.4.3 (see separate volumes of figures). There is only one borehole in the upper aquifer near the site (SR1078) and as such it is difficult to determine the direction of groundwater flow. However it is anticipated that the direction of groundwater movement is from southeast to northwest, towards the River Thames, in these shallow deposits.

K.3.6 The EA network does not include any monitoring boreholes sufficiently close by to provide representative water level in the upper aquifer at the site.

K.3.7 The nearest EA groundwater level observation borehole in the lower aquifer, with records up to 2012, is located at Western Roads Pumping Station (Ref: TQ27_334; NGR 528649 178029), approximately 200m to the northeast of the site. This borehole records levels in the Chalk aquifer; the average, minimum and maximum recorded levels are shown in Vol 16 Table K.5. A groundwater level hydrograph from this observation borehole is shown in Vol 16 Figure 13.4.4 (see separate volumes of figures).

K.3.8 The recorded water levels (piezometric head) remain above the top of the Chalk at 41mATD (see Vol 16 Table K.2) confirming that confined conditions exist within the Chalk. In addition, the piezometric levels here show a very similar trend to the piezometric levels recorded in the Thanet Sands at SR1070. This suggests that these units are in hydraulic continuity.

K.3.9 The EA have produced regional groundwater contour plots which display the groundwater flowing in a northwest direction across site (EA, 2011)[5]. However, as the site is in Source Protection Zone 2 (SPZ2), the local groundwater gradient may be in a southwest direction drawn towards this abstraction, particularly during peak demand periods.

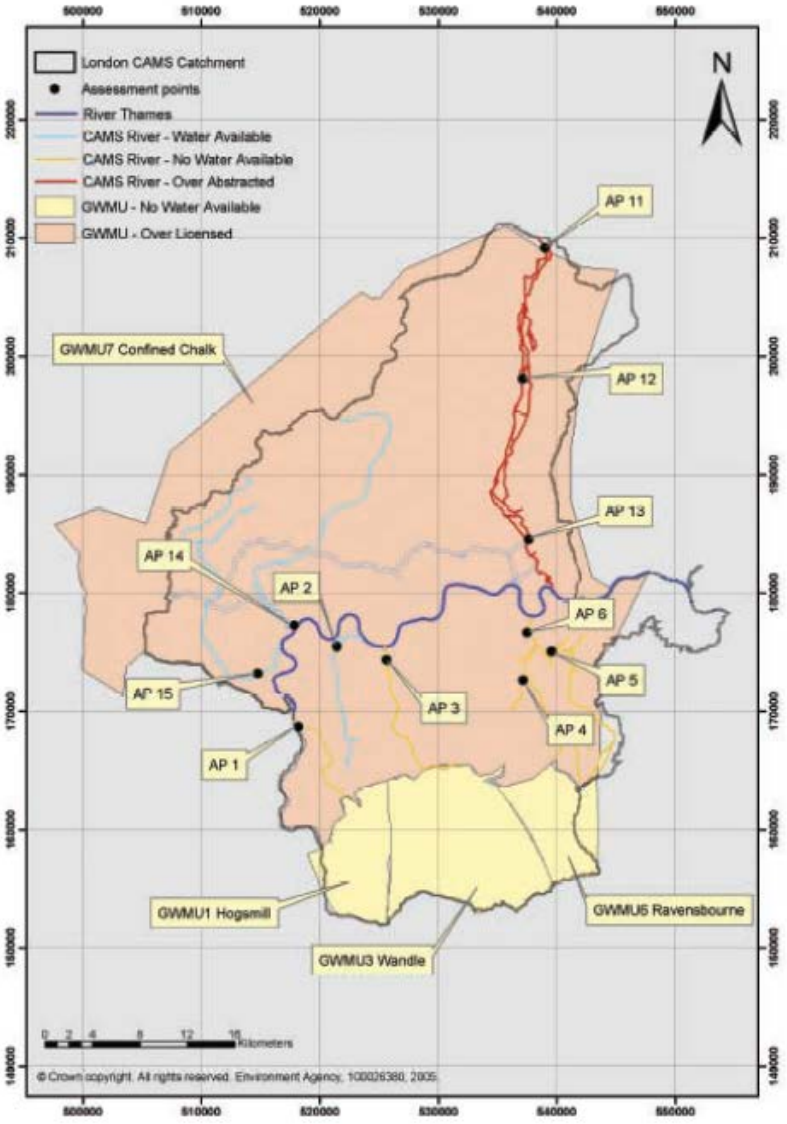
K.4 Groundwater abstractions and protected rights

Groundwater licensing policy

K.4.1 The London Catchment Abstraction Management Strategy (CAMS) (EA, 2006)[6] does not identify a condition status for the upper aquifer.

K.4.2 The EA identifies a condition status for the lower aquifer and defines a policy through its London CAMS, which restricts new abstractions in central, east and south London and further abstraction in areas approaching their sustainable limit6. The Albert Embankment Foreshore site is located within the confined Chalk groundwater management unit GWM7, which is classified as being over-licensed (see Vol 16 Plate K.1) (EA, 2006). Within this area, there is a limit on the availability of groundwater resources such that large abstractions (>1-2Ml/d) would generally not be granted unless the applicant can demonstrate that the resources are available (EA, 2006). In addition, large abstractions may also have a time limit shorter than the London CAMS common end date of 2013 (EA, 2006).

Vol 16 Plate K.1 Groundwater - confined Chalk licensing



**Reproduced from EA, 2006*
Note: GWMU – groundwater management unit, AP – assessment point

K.4.3 The CAMS policy also states that, “every application would be assessed on its own merits, be subject to a detailed local hydrogeological assessment and require the submission of the necessary supporting justification and reports for a decision to be made on an individual scheme” (EA, 2006). A preliminary hydrogeological assessment, following guidance provided in the CAMS policy, has been completed for the proposed development in Vol 16 Table K.6.

Vol 16 Table K.6 Groundwater - licensing policy

No.	Question	Preliminary response
1.	Has there been any long-term (several years) downward trend in the groundwater level in the vicinity of the application?	The hydrograph in Vol 16 Figure 13.4.4 (see separate volumes of figures) for an EA observation borehole 200m from the Albert Embankment Foreshore site exhibits an increase in levels from 2008 to December 2010 and then a decline in levels until October 2011 (end of record).
2.	The groundwater level in relation to the base of the London Clay. If the groundwater level is near the base of the London Clay, then the EA would be unlikely to grant the abstraction licence. The EA would use discretion if there is a significant thickness of the Lambeth Group below the London Clay, but the aim is to manage abstraction to keep groundwater levels above the Thanet Sands.	The EA data confirms that groundwater levels measured in the Chalk have remained above the top of the Thanet Sands since at least 1992. The dewatering of the lower aquifer for construction at Albert Embankment Foreshore would not involve lowering the groundwater levels to below the top of the Thanet Sands.
3.	Any recent abstraction development in the same area. If groundwater levels have not yet responded to a recent change in abstraction, the EA may not grant further licences in that area.	No recent developments are known.
4.	Other proposals in the area that have been refused for water resource reasons in the last five years	No refusals known.
5.	Proximity of the proposal to an existing or proposed Artificial Recharge Scheme (ARS). Artificial Recharge scheme proposals would be treated as a special case as they involve the management of groundwater levels to provide additional resource to the scheme operator.	No known ARS in the vicinity.

K.4.4 The estimated average rate of dewatering required at Albert Embankment Foreshore from the Lambeth Group (including the Upnor Formation) is less than 200m^3/d, which is within the most restrictive abstraction licensing limit set by the EA of 0.2Ml/d (200m^3/d) for Central and South London (EA,

2006). Therefore a detailed local assessment is unlikely to be required by the EA.

Licensed abstractions

K.4.5 The EA licences abstraction from groundwater within London for all sources in excess of 20m^3/d. Groundwater abstractions within 1km of the site have been identified and are displayed in Vol 16 Figure 13.4.5. The locations of public water supply sources are not presented due to restriction on the display of this information.

K.4.6 There are several licensed groundwater abstractions from the Chalk (lower aquifer) located within 1km of the Albert Embankment Foreshore site, mainly to the west and northwest of the site.

K.4.7 The nearest licensed groundwater abstraction (28/39/39/0139) is held by Panoramic Management Co. Ltd, is located approximately 0.35km to the west and is used for non-evaporative cooling purposes only. This licence has two abstractions points, both of which are used to function as an open loop ground source heat pump (GSHP) scheme.

K.4.8 Groundwater abstraction (28/39/39/0209) is held by Westminster Gardens Limited, is located <1km to the north, and is used for water supply purposes.

K.4.9 The licensed groundwater abstraction 28/39/42/0033 is held by Allied Distillers Limited, is located approximately 0.85km to the southeast and is used for evaporative cooling purposes.

K.4.10 The licensed abstraction source 28/39/39/0013 is held by Total Concept Solutions Ltd, is located approximately 0.9km to the north and is used to operate an open loop GSHP scheme.

K.4.11 The licensed abstraction source 28/39/39/0141 is held by Mantilla Limited, is located <1km to the southwest and is used for water supply purposes. This licence has five abstractions points, all of which are used for water supply.

K.4.12 The licensed abstraction source 28/39/42/0072 is held by Thames Water Utilities, is located approximately >1kmkm to the southwest and is used for public water supply purposes. This licensed abstraction source is included here as the Albert Embankment Foreshore site is located within the SPZ 2 designated for this source (see Section K.5).

K.4.13 Consent number TP07/005 (licence pending) allows the licence holder St George South London Limited to abstract from the Chalk at a distance of approximately 0.2km south west of the site. This licence has three abstractions points and two discharge points used for an open loop GSHP scheme.

K.4.14 Further details of these licensed groundwater abstractions are given in Vol 16 Table K.7.

Vol 16 Table K.7 Groundwater - licensed abstractions

Licence number	Distance (km)	Licence holder	Purpose	Aquifer
28/39/39/0139	0.35	Panoramic Management Co. Ltd	Non-evaporative cooling purposes (open loop system)	Chalk
28/39/39/0209	<1km	Westminster Gardens Limited	Water supply	Chalk
28/39/42/0033	0.85	Allied Distillers Ltd	Evaporative cooling	Chalk
28/39/39/0013	0.9	Total Concept Solutions Ltd.	Unknown active open loop system	Chalk
28/39/39/0141	<1km	Mantilla Limited	Water supply	Chalk
28/39/42/0072	>1km	Thames Water Utilities	Public water supply	Chalk
None (consent number: TP07/005)*	0.2	St George South London Ltd	Evaporative cooling purposes (open loop system)	Chalk

** Licence pending*

K.4.15 There are no known unlicensed groundwater abstractions from the upper or lower aquifers within 1km of the Albert Embankment Foreshore site.

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 The site is located within a modelled SPZ 2 (400 day travel time to the source) for the Thames Water Utilities source, which abstracts from the Chalk and is located over one kilometre to the southwest of Albert Embankment Foreshore. The SPZ 1 (50 day travel time to the source) for the Thames Water Utilities source is within 670m of the Albert Embankment Foreshore site to the southwest.

K.5.3 There is a second SPZ 1 at 520m to the southwest of the Albert Embankment Foreshore site, which is designated for the Mantilla Limited source, which is located at <1km to the west.

K.5.4 Neither of these sources are in the direction of regional groundwater flow anticipated beneath the site (towards the northwest), although the seasonal demand led abstraction from the Thames Water Utilities source at Battersea Pumping Station may affect the regional gradient.

K.6 Environmental designations

K.6.1 There are no designated sites relevant to groundwater such as SSSI, SAC and SNCIs within 1km of the Albert Embankment Foreshore site.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical land use mapping at the Albert Embankment Foreshore site reviewed as part of the land quality assessment identified no potentially contaminative onsite or nearby land uses (Vol 11 Section 8). Land quality may impact on groundwater quality through the creation or promotion of preferential pathways for existing contamination during construction of the proposed development.

K.7.2 The groundwater quality data presented in Vol 16 Table K.7 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tideway Tunnel project and includes data from monitoring boreholes located off site and up to 1km away (SR1078, SR1072A, PR1074, SR1074A, PR1085 and SA1082) these locations are listed in Vol 16 Figure 13.4.1 (see separate volume of figures) and within the River Terrace Deposits, the Thanet Sands and the Chalk. Any exceedances of the UK drinking water standards *(The Water Supply Regulations,* 2000)[7] or relevant Environmental Quality Standards (EQS)) (*River Basin Districts Typology* ..., 2010)[8] are shaded in blue in this table.

K.7.3 The data shows exceedances of the relevant standards within the River Terrace Deposits at SR1078 (located at 464m from the site) and at SA1074A (located at 549m from the site) with respect to nitrate and PR1085 (located at 935m from the site) with respect to ammonia, chloride, heavy metals, polycyclic aromatic hydrocarbons (PAH's) and turbidity. The data shows exceedances within the Thanet Sands at SR1072A (located at 498m from the site) with respect to magnesium and sulphate. . PAH's may be formed during a range of human activities, including incomplete combustion of carbon-based fuels and other industrial processes (EA, 2010)[9]. In addition, PAH's are considered to be Priority Hazardous Substances under the Water Framework Directive (Commission of the European Communities, 2009)[10].

K.7.4 The EA monitors groundwater quality at a number of points across London. The nearest EA monitoring point is at Dolphin Square at approximately 250m from the Albert Embankment Foreshore site, on the opposite side of the River Thames. The data here shows exceedances of the UK drinking water standard within the Chalk with respect to ammonia, heavy metals, sulphate, potassium, benzene, organics and a range of pesticides.

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show no exceedances of the human health screening values (EA, 2009)[11] (soil guideline values designed to be protective of human health) within the River Terrace Deposits but exceedances with respect to heavy metals in the London Clay Formation and with respect to total petroleum hydrocarbons in the Laminated Beds

(Lambeth Group). Further detail is provided in the land quality assessment (see Vol 16 Appendix F).

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Vol 16 Table K.8 Groundwater – groundwater quality

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	SI
Name				SR1078	SR1072A	PR1074	SA1074A	PR1085	PR1085	PR1085	PR1085	PR1085	SA1082
Hydrogeological unit**				RTD	TSF	TSF	RTD	ALV	ALV	ALV	ALV	ALV	CK
Distance from site	EQS Criteria			464m	498m	546m	549m	935m	935m	935m	935m	935m	1055m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/2011	13/1/2012	20/4/2012	31/5/2012	1/1/2010
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-	-	-	-	-	<0.08	<0.08	-	< 0.08	-
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-	-	-	-	-	<0.2	<0.2	-	< 0.2	-
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-	-	-	-	-	<0.12	<0.12	-	< 0.12	-
1,2,4 - Trimethylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.7
1,3,5 - Trimethylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.8
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	-	-	-	0.00170	-	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	-
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	-
2,4,6 - Trichlorophenol	-	ug/l	None	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	-
2,6 - Dichlorophenol	-	ug/l	None	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	-
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	-
4 - Chlorotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.9
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	-	-	-	<0.0500	-	-
Acenaphthene	-	ug/l	None	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	<0.015
Acenaphthylene	-	ug/l	None	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	<0.011
Acenapthene	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-
Acenapthylene	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-
Aliphatics >C10-C12	-	ug/l	None	2	<1	<1	1	<1	-	-	-	-	<10
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	5	3	3	4	<1	-	-	-	-	<10
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	9	5	6	8	2	-	-	-	-	<10
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	23	7	7	8	4	-	-	-	-	<10
Aliphatics >C6-C8	-	ug/l	None	<0.1	<0.1	<0.1	38	<0.1	-	-	-	-	<10
Aliphatics >C8-C10	-	ug/l	None	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	<10
Aliphatics C5-C6	-	ug/l	None	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	<10
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	-	-	-	-	<4	-	-	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	180	220	230	290	420	510	422	-	392	-
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	-	-	-	0.35	-	-
Aluminium Total	200	ug/l as Al	DWS 2010	-	-	-	-	-	240	0.06	-	0.31	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	-	-	-	-	20.1	13	-	9.89	-
Ammoniacal nitrogen	-	mg/l	None	0.13	1.2	0.28	0.07	9.4	-	-	-	-	0.948
Anthracene	0.1	ug/l	SW WFD	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.015
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	-	-	-	1.9	-	-
Aromatics >C7-C8	50	ug/l	WFD 2010	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	<10
Aromatics >EC10-EC12	-	ug/l	None	2	3	4	7	2	-	-	-	-	<10
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	5	4	6	7	3	-	-	-	-	<10
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	15	6	8	12	3	-	-	-	-	<10
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	None	28	14	17	20	13	-	-	-	-	<10
Aromatics >EC8-EC10	-	ug/l	None	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	<10
Aromatics C6-C7	1	ug/l	DWS 2010	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	<10
Arsenic Total	10	ug/l as As	DWS 2010	1	<1	<1	<1	<1	2	3.2	-	2.3	<0.75

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	SI
Name				SR1078	SR1072A	PR1074	SA1074A	PR1085	PR1085	PR1085	PR1085	PR1085	SA1082
Hydrogeological unit**				RTD	TSF	TSF	RTD	ALV	ALV	ALV	ALV	ALV	CK
Distance from site	EQS Criteria			464m	498m	546m	549m	935m	935m	935m	935m	935m	1055m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/2011	13/1/2012	20/4/2012	31/5/2012	1/1/2010
Atrazine { }	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.08000	-	<0.00800	-
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	-	-	37	-	-
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	-	-	37	-	-
Bentazone	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00800	<0.00800	-	<0.00800	-
Benz[a]-Anthracene	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-
Benzene	1	ug/l	DWS 2010	<1	<1	<1	<1	<1	0.13	0.1	<0.07	< 0.07	<10
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	-	-	-	<0.06	-	-
Benzo (a) anthracene	-	ug/l	None	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	-	<0.009
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.01	<0.01	<0.01	<0.01	<0.01	0.01230	<0.00500	<0.01	<0.00500	<0.009
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.023
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.016
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.027
Bifenthrin	-	ug/l	None	-	-	-	-	-	-	-	0.00910	-	-
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	-	-	-	74	-	-
Boron Total	1000	ug/l as B	DWS 2010	200	410	430	390	350	160	120	-	0.12	-
Bromate	10	ug/l as BrO3	DWS 2010	-	-	-	-	-	<0.5	<0.5	-	< 5.0	-
Cadmium Total	5	ug/l as Cd	DWS 2010	<2	<2	<2	<2	<2	3	<1.5	<1.5	< 1.5	<0.22
Calcium Total	250	mg/l as Ca	DWS 2010	-	-	-	-	-	190	140	-	140	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	-	-	-	-	-	-	-	<0.00500	-
Carbetamide	-	ug/l	None	-	-	-	-	-	-	-	-	<0.01000	-
Carbon Dioxide	-	ug/l	None	-	-	-	-	-	-	-	97600	-	-
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	-	-	-	4.6	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-	-	-	-	-	<0.07	<0.07	-	< 0.070	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	-
Chloride	250	mg/l as Cl	DWS 2010	50	110	92	66	210	259	192	-	173	-
Chloroform	100	ug/l	WS Regs 20	-	-	-	-	-	<0.6	<0.6	-	< 0.600	-
Chlortoluron	2	ug/l	FW List II	-	-	-	-	-	<0.05000	<0.05000	-	<0.01000	-
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	-	-	-	10	-	-
Chromium Total	50	ug/l as Cr	DWS 2010	<5	<5	<5	<5	<5	15	14	-	19	1.16
Chrysene	-	ug/l	None	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.013
Clopyralid	-	ug/l	None	-	-	-	-	-	<0.01900	<0.01900	-	<0.01900	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	580	1190	932	1230	1440	-	-	-	-	997
Copper Total	2000	ug/l as Cu	DWS 2010	<2	<2	<2	<2	<2	<5.5	<5.5	-	7	1.86
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	<0.00500	-	-
Cresols	-	ug/l	None	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	-
Cyanazine	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.12000	<0.06000	-	<0.00800	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20	<20	<20	<20	<20	-	-	-	-	-
Cyanide (Total)	50	ug/l as CN	DWS 2010	<40	<40	<40	<40	<40	-	-	-	-	-
Cypermethrin	0.0001	ug/l	WFD 2010	-	-	-	-	-	<0.1	<0.1	-	< 0.100	-
Cypermethrin ID	-	Code	None	-	-	-	-	-	-	-	12	-	-
Dalapon	-	ug/l	None	-	-	-	-	-	<0.05000	<0.05000	-	<0.05000	-
Diazinon	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	-
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.016
Dichloromethane	20	ug/l	WFD 2010	-	-	-	-	-	<3	<3	-	< 3.0	-
Dichlorprop	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.01100	<0.01100	-	<0.01100	-
Diuron	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.05000	<0.05000	-	<0.01000	-
Enterococci (Species)	-	Nr/100ml	None	-	-	-	-	-	-	-	>100	-	-

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	SI
Name				SR1078	SR1072A	PR1074	SA1074A	PR1085	PR1085	PR1085	PR1085	PR1085	SA1082
Hydrogeological unit**				RTD	TSF	TSF	RTD	ALV	ALV	ALV	ALV	ALV	CK
Distance from site	EQS Criteria			464m	498m	546m	549m	935m	935m	935m	935m	935m	1055m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/2011	13/1/2012	20/4/2012	31/5/2012	1/1/2010
Escherichia coli (Confirmed)	0	Nr/100ml	WS Regs 20	-	-	-	-	-	-	-	4	-	-
Ethofumesate	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-
Ethylbenzene	-	ug/l	None	<1	<1	<1	<1	<1	-	-	-	-	<10
Fenuron	-	ug/l	None	-	-	-	-	-	-	-	<0.01	-	-
Fluoranthene	0.2	ug/l	EEC MAC	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.014
Fluorene	-	ug/l	None	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.014
Fluoride	1.5	mg/l as F	DWS 2010	-	-	-	-	-	0.06	0.07	-	0.326	-
Glyphosate	-	ug/l	None	-	-	-	-	-	<0.01400	<0.01400	-	<0.01400	-
GRO C4-C12	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Hardness Total - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	-	-	-	170	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	-	<0.014
Iodide Ion	-	ug/l as I	None	-	-	-	-	-	-	-	59	-	-
Irgarol 1051	-	ug/l	None	-	-	-	-	-	-	-	<0.00500	-	-
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	-	-	-	5.3	-	-
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	-	-	-	5.4	-	-
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.05000	<0.05000	-	<0.00800	-
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	-	-	-	<5.00	-	-
Lead Total	10	ug/l	WS Regs 20	<4	<4	<4	<4	<4	11	<5	-	23	0.666
Lithium Dissolved	-	ug/l as Li	None	-	-	-	-	-	-	-	<0.0006	-	-
Lithium Total	-	ug/l as Li	None	-	-	-	-	-	-	-	<0.0006	-	-
Magnesium Dissolved	50	mg/l as Mg	EEC MAC	-	-	-	-	-	-	-	3.7	-	-
Magnesium Total	50	mg/l as Mg	EEC MAC	5	54	26	13	13	13	9.2	-	10	-
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	-	-	-	0.31	-	-
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	-	-	-	0.31	-	-
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	-
Mecoprop { }	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.01000	<0.01000	-	<0.01000	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.05	<0.05	<0.05	<0.05	<0.05	0.003	<0.002	-	0.005	<0.01
Metazachlor	-	ug/l	None	-	-	-	-	-	<0	<0	-	< 0	-
Methane	-	ug/l	None	-	-	-	-	-	-	-	<10.0	-	-
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	-	-	-	<5	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<1	<1	<1	<1	<1	-	-	-	-	<10
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	-	-	-	<0.10000	-
Naphthalene	1.2	ug/l	WFD D 10	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	0.29	-	<0.1
Nickel Total	20	ug/l as Ni	DWS 2010	<10	<10	13	<10	<10	11	4	-	6	3.61
Nitrate - N	11.3	mg/l as N	WS Regs 20	19	<0.1	<0.1	27	<0.1	<0.043	<0.043	-	< 0.068	0.0678
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	-	-	-	<0.081	-	-
Orthophosphate	-	mg/l as P	None	-	-	-	-	-	-	-	<0.18	-	-
Oxamyl	-	ug/l	None	-	-	-	-	-	-	-	<0.00500	-	-
o-Xylene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
PAH 16 Total	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.1
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	0.29	-	-
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	-	-	-	<0.01000	<0.10000	-	-	-
pH	10	pH units	DWS 2010	7.2	7.9	7.3	7.1	7.5	-	-	-	-	8.15
Phenanthrene	-	ug/l	None	<0.01	0.02	<0.01	0.01	0.02	-	-	<0.01	-	<0.022
Phenol	0.5	ug/l	EEC MAC	<0.1	<0.1	<0.1	<0.4	<0.4	-	-	-	-	<2.0
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	-	-	-	-	<0.00900	<0.00900	-	<0.00900	-

Source of data*				SI	SI	SI	SI	SI	TT	TT	TT	TT	SI
Name				SR1078	SR1072A	PR1074	SA1074A	PR1085	PR1085	PR1085	PR1085	PR1085	SA1082
Hydrogeological unit**				RTD	TSF	TSF	RTD	ALV	ALV	ALV	ALV	ALV	CK
Distance from site	EQS Criteria			464m	498m	546m	549m	935m	935m	935m	935m	935m	1055m
Chemical	Value	Units	Source	2009	2009	2009	2009	2009	14/11/2011	13/1/2012	20/4/2012	31/5/2012	1/1/2010
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	-	-	-	-	<800.0	459.0	-	<2,500.0	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	<0.2	<0.2	<0.2	<0.2	<0.2	-	-	-	-	-
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	-	-	-	6.4	-	-
Potassium Total	-	mg/l as K	None	-	-	-	-	-	14	11	-	13	-
Preparation (Purge And Trap)	-	Text	None	-	-	-	-	-	-	-	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.04000	-	<0.00500	-
Propetamphos	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00500	<0.00500	-	<0.00500	-
Pyrene	-	ug/l	None	<0.01	0.03	<0.01	<0.01	0.02	-	-	<0.01	-	<0.015
Selenium	10	ug/l as Se	DWS 2010	<3	<3	<3	<3	<3	-	-	<0.4	-	1.3
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	-	-	-	18	-	-
Simazine	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.08000	-	<0.00400	-
Sisumxylene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Sodium Total	200	mg/l as Na	DWS 2010	32	190	73	43	120	140	100	-	100	-
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	-	-	-	0.28	-	-
Strontium Total	-	ug/l as Sr	None	-	-	-	-	-	-	-	0.29	-	-
Sulphate	250	mg/l as SO4	DWS 2010	53	290	170	160	11	<1.7	8.37	-	48.2	183
Sulphide	-	ug/l	None	<10	<10	<10	<10	<10	-	-	<29.0	-	-
Sum of BTEX	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Terbutryn	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.08000	<0.04000	-	<0.00500	-
Tetrachloroethylene	-	ug/l	None	-	-	-	-	-	<0.09	<0.09	-	< 0.09	-
Tetrachlorothioanisole	-	ug/l	None	-	-	-	-	-	-	-	<0.00500	-	-
Tin Total	0	ug/l as Sn	GW Regs 98	-	-	-	-	-	-	-	<5	-	-
Titanium	0	ug/l as Ti	GW Regs 98	-	-	-	-	-	-	-	0.032	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<1	<1	<1	<1	<1	-	-	<0.55	-	<10
Total Aliphatic TPH	-	ug/l	None	39	15	16	59	<10	-	-	-	-	-
Total Aliphatics & Aromatics >C12-C44 (Aqueous)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Total Aliphatics >C12-C35 (Aqueous)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Total Aliphatics C5-C12	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Total Aromatic TPH	-	ug/l	None	50	28	35	47	22	-	-	-	-	-
Total Aromatics >EC12-EC35 (Aqueous)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Total Aromatics C6-C12	1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<10
Total Chemical Oxygen Demand	-	mg/l	None	<10	<10	26	<10	80	-	-	-	-	-
Total Monohydric Phenols (W)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<15.0
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-	-	-	-	-	<0.07	<0.07	-	< 0.07	-
Trietazine	-	ug/l	None	-	-	-	-	-	<0.04000	<0.02000	-	<0.00800	-
Trifluralin	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.01000	<0.01000	-	<0.01000	-
Turbidity	1	FTU	WS Regs 20	-	-	-	-	-	238	121	-	49.9	-
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	-	-	-	0.2	-	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<1	<1	<1	<1	<1	<0.09	<0.09	<0.180	-	<10
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	-	-	-	<0.09	-	-
Zinc Total	50	ug/l as Zn	DWS 2010	<1	6	18	2	4	<5	<5	-	10	<5

Notes:

xx	GAC1 exceedance
' - '	Not tested
' < '	Less than MDL

** Origin of data: SI – Groundwater quality data collected during site investigation works by Thames Tideway Tunnel project (2009-2011), TT – Groundwater quality data collected during ongoing monitoring works by Thames Tideway Tunnel project (2009-2012)*
*** Hydrogeological unit: LCK – Lewes Nodular Chalk, CK – Chalk, SCK – Seaford Chalk, RTD – River Terrace Deposits, ALV - Alluvium*

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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 (EA, 2009)[12] shows that the Lambeth Group, Thanet Sands and Chalk Formation in the area of the Albert Embankment Foreshore site are designated as the Greenwich Chalk and Tertiaries groundwater body.

K.8.1 The baseline assessment for groundwater status classification for the Greenwich Chalk and Tertiaries shows poor quantitative status with respect to impact on surface waters and saline intrusions, good quantitative status with respect to groundwater dependent terrestrial ecosystems and resource balance for 2009. The baseline assessment also shows poor chemical status with respect to saline intrusions and drinking water protected area status and good chemical status with respect to general chemical assessment, groundwater dependent terrestrial ecosystems and impact on surface water chemical/ ecological status.

K.8.2 The predicted quantitative and chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.3 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.8.4 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).

K.8.5 The Thames Tideway 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):

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 Albert Embankment Foreshore assessment is given in Vol 16 Table K.9.

Vol 16 Table K.9 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 tunnel alignment
EA	Designated source protection zones (SPZ)	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 Tideway 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 Tideway	Groundwater monitoring strategy	Draft strategy Feb 2012	

Source	Data	Date received	Notes
Tunnel project			
Thames Tideway Tunnel project	Land quality data	February 2011	
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 (February 2009).

[2] British Geological Survey. The BGS Lexicon of Named Rock Units (Accessed May 2012). Available at: http://www.bgs.ac.uk/Lexicon/

[3] United States Geological Survey (USGS). Office of Water Data Coordination. *Glossary of Hydrologic Terms in the Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport* (August 1989).

[4] Environment Agency. Environment Agency Website (Accessed April 2012). Available at: http://www.environment-agency.gov.uk/homeandleisure/117020.aspx.

[5] Environment Agency. *Groundwater levels contours in Chalk*. Received from Environment Agency (June 2011).

[6] 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.

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

[8] 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/

[9] Environment Agency. REACH Annex XVII Restrictions Polycyclic-aromatic Hydrocarbons (PAHs) Guidance Note Part 1 (October 2010). Available at: http://www.environment-agency.gov.uk/static/documents/Business/Part_1_PAH_Guidance_Note.pdf

[10] Commission of the European Communities. *Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC* (2009). Available at: http://ec.europa.eu/environment/water/water-dangersub/pdf/com_2006_397_en.pdf?lang=_e.

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

[12] 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.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

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Doc Ref: **6.2.16**

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Appendix L: Water resources - surface water

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

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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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Appendix M: Water resources - flood risk

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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 Albert Embankment Foreshore is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The site lies within the London Borough (LB) of Lambeth. The LB of Lambeth Borough produced a Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) (Scott Wilson Ltd , 2008)[2], which outline the main flood sources in the borough. The SFRAs also detail the results of hydrodynamic modelling undertaken to assess the residual risk of a breach in the local River Thames tidal flood defences.

M.1.5 The Lambeth SFRAs confirm that the Thames Tidal Defence network (Thames Barrier and Tidal flood defence walls) reduces the annual probability of flooding from the Thames to less than 0.1%. The existing frontage is protected against large scale flood events by raised embankments and hard defences. The risk of flooding is a residual risk associated with a breach in the defences.

M.1.6 According to the SFRA:

a. The majority of the borough overlies London Clay.

b. Tidal flooding is the primary source of flooding within the Borough.

c. The site is within the Lambeth Tidal Flood Warning Area, and EA Flood Zone 3.

d. There have been '0-10 (low)' sewer flooding incidents recorded by Thames Water in the last ten years in the vicinity. Surface water and foul water sewer flooding incidents have been low '0-2' and combined sewer flooding incidents have been low '0-10'.

e. The area of land adjacent to the Albert Embankment Foreshore site is designated as an area of low to high residual risk hazard in the event of a breach in the local defence wall or overtopping as a result of a failure of the Thames Barrier.

f. There is a record of groundwater flooding close to the site.

g. The site is situated within an area identified as having major development opportunities.

h. There are a number of schools within the locality which could act as rest centres during times of flood during construction.

M.1.7 The SFRAs promote 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. The majority of the site lies within the foreshore.

M.1.9 According to the SWMP:

a. The site does not lie within a Critical Drainage Area (CDA)[i].

b. A flow path exists to the south-west of the site for the 1% AEPii + 30% climate change rainfall event. This area has an extreme (danger for all) surface water flood hazard rating.

c. The 'Lost River' Effra flows into the Thames to the south-west of the site. Significant surface water flood risk is identified along the paths of the 'lost rivers'. However the area near Vauxhall Bridge is not specifically highlighted.

d. The Lambeth SWMP shows there have been between one and five sewer flooding incidents recorded by Thames Water in the post code area in which the site is situated, which covers a significant area.

Regional policy

Thames Estuary 2100

M.1.10 The Albert Embankment foreshore site lies within the Wandsworth to Deptford 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 mitigate the impact of climate change.

M.1.11 The TE2100 Plan outlines that the local sources of flood risk (relative to the Albert Embankment foreshore site) as including:

a. tidal flooding from the River Thames

b. fluvial flooding from the River Wandle

c. pluvial (heavy rainfall) and urban drainage sources

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

[i] Area susceptible to surface water flooding

[ii] A rainfall event with a 1% Annual Exceedance Probability (AEP) has a one in 100 year probability of occurring in a given year.

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. defences along the lower reach of the River Wandle

c. 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 are sensitive to 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 a vision to increase flood risk awareness within the area.

M.1.14 It is acknowledged within the TE2100 Plan that accretion of the river bed is occurring at Lambeth.

London Regional Flood Risk Appraisal

M.1.15 For the reach between Hammersmith Bridge and the Thames Barrier (City Reach) the London Regional Flood Risk Appraisal (RFRA) (GLA, 2009)[5] 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.1.16 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. This should be taken into consideration during the re-development process.

M.1.17 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] Scott Wilson Ltd. *London Borough of Lambeth Level 1 Strategic Flood Risk Assessment Final Report*. (Jun 2008). Scott Wilson Ltd. *London Borough of Lambeth Level 2 Strategic Flood Risk Assessment Final Report*. (Aug 2008).

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[5] Greater London Authority. *London Regional Flood Risk Appraisal.* (Oct 2009).

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Appendix N: Development schedule

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Environmental Statement

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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 16 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.

N.1.2 Appendix N.2 presents specific information regarding the Northern Line Extension and assumptions made for the Thames Tideway Tunnel environmental impact assessment.

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Vol 16 Table N.1 Development schedule for Albert Embankment Foreshore

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
2-14 Tinworth Street, and 108 - 110 Vauxhall Walk	120m northeast	11/04510/FUL	Spring Mews Ltd	Redevelopment of 2-16 (evens) Tinworth Street and 100-110 Vauxhall Walk to provide a mixed use scheme comprising a range of buildings up to 8 storeys in height; providing a 120 bedroom hotel (4,353sqm GIA), student accommodation and associated support facilities including 402 student bedrooms (11,355sqm GIA), a convenience retail store (245sqm GIA), a series of small business units (use class B1 - totalling 469sqm GIA) a replacement community centre (561sqm GIA), associated basement servicing area, new public realm, public realm improvements and disabled parking. Improvements are proposed to the public realm and pavements along Vauxhall Walk to the front of these properties.	B	100% complete & operational	100% complete & operational	100% complete & operational	Information provided by LB Lambeth. Developer hopes to start work in 2013. Two years build time.	Base case (all years)
Eastbury House, 30 - 34 Albert Embankment	150m northeast	12/01768/FU	St James Group	Demolition of the existing building and the erection of a part 14, part 21, part 28 storey building to provide a mixed use scheme incorporating: ground floor cafe/retail unit (A1/A3) and public piazza, office accommodation (B1) and 48 residential units, together with basement car and cycle parking and plant equipment (revised description)	B	100% complete & operational	100% complete & operational	100% complete & operational	Application documents	Base case (all years)
Riverwalk House, Millbank	Approx 160m west	11/09680/FUL	Derwent Valley Central Limited (parent company Derwent London plc)	Demolition of the existing building and erection of two buildings of 17 and 7 storeys linked by a central podium for use as 121 residential units (Class C3); dual/alternative use of part of the ground floor as a cafe/restaurant/gallery (Class A1/A3/D1); three levels of basement including car parking and plant area; replacement stair linking the river walk with Vauxhall Bridge and other associated works to the river walk and adjacent public landscape; works of hard and soft landscaping and other works incidental to the application.	B	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – no phasing information available in application documentation	Base case (all years)

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
1-9 Bondway and 4-6 South Lambeth Place	Approx 185m southeast	10/03151/FUL	Salmon Harvester Properties Ltd	Redevelopment of the site involving the demolition of the existing buildings and the erection of a 6 storey building (plus lower ground floor level) to provide a hotel comprising of 148 bedrooms (Use Class C1) with ancillary bar/restaurant facilities along with commercial floorspace at ground floor level in either Use Classes A1 (retail), A2 (financial and professional services), A3 (restaurants and cafes), A4 (drinking establishments) and formation of roof level plant.	A	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – no phasing information available in application documentation	Base case (all years)
St Georges Wharf (Vauxhall Tower)	Approx 200m south	03/01501/FUL	St George South London Limited	Revised proposal for redevelopment of part of St George Wharf site to provide 666 residential units, of which 200 units would be provided in a 50-storey tower, (resulting in an overall increase of 386 residential units). Approval of details pursuant to condition 24 (details of the use of the London aquifer, and specification of wind turbine) of planning permission ref: 03/01501/FUL of Appeal ref: APP/N5660/A/03/1129667 (Revised proposal for redevelopment of part of St George Wharf Approved Jan 2010 Approval of details pursuant to condition 24 (Details of the use of the London aquifer, and specification of wind turbine) of planning permission ref: 03/01501/FUL of Appeal ref: APP/N5660/A/03/1129667 (Revised proposal for redevelopment of part of St George. Approved Dec 2010. Linked to approval of details – 05/03119/DET – car parking. Variation of condition 2 (the development shall not be carried out other than in accordance with the drawings and particulars hereby approved and as subsequently approved under conditions of the planning permission) of planning permission ref: 03/01501/FUL (redevelopment of part of St George Wharf site to provide 666 residential units, of which 200 units would be provided in a 50-storey tower, including office (B1) use, retail (A1) use, restaurant (A3) use, health and fitness (D2) together with a riverside walkway, public space, access and car parking). The variation to condition 2 applied for is to allow the development to be carried out in accordance with the approved plans and details, or	A	100% complete & operational	100% complete & operational	100% complete & operational	Information provided by LB Lambeth. Expected completion date of 2014.	Base case (all years)

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
				other such plans which indicate amendments to the floorplans of the residential units in the tower, which have been submitted to and approved by the local planning authority.						
Hampton House, 20 Albert Embankment	Approx 230m northeast	07/04264/FUL 10/03287/FUL	Newlands Enterprises Ltd	Redevelopment of the site involving the demolition of existing buildings and erection of three buildings of between 13 and 27 storeys to provide a mixed use development comprising ground floor commercial units (flexible Use Class A1, A2, A3, A4, B1, D2), and 167 room apart-hotel, 242 self contained residential units comprising 93 x 1 bed, 77 x 2 bed, 65 x 3 bed and 7 x 4 bed, along with associated parking and landscaping including first floor podium and roof gardens. Variation of conditions 4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 24, 25, 26, 27, 30, 31, 32, 42, 44, 47, 50, 51 and 52 of Planning permission ref 07/04264/FUL (Redevelopment of the site involving the demolition of existing buildings and erection of three buildings of between 13 and 27 storeys to provide a mixed use development comprising ground floor commercial units (flexible Use Class A1, A2, A3, A4, B1, D2), an 167 room apart-hotel, 242 self contained residential units comprising 93 x 1 bed, 77 x 2 bed, 65 x 3 bed and 7 x 4 bed, along with associated parking and landscaping including first floor podium and roof gardens) granted on 27/03/2008.	B	100% complete & operational	100% complete & operational	100% complete & operational	Information provided by LB Lambeth. Application implemented but revised scheme expected shortly. Developers expect to complete by 2016.	Base case (all years)
Vauxhall Square Cap Gemini Site (plot bounded by Parry Street, Bondway, Miles Street and Wandsworth Road)	Approx 250m south	11/04428/FUL	Vauxhall Cross Ltd	Demolition of existing buildings (except for the listed buildings on site) to provide a mixed use scheme comprising eight blocks ranging between 6, 9, 11, 16, 21, 26, 48 and 50 storeys, which include 604 dwellings 14,722sqm Gross Internal Area (GIA) of new office floor space (B1), 3047sqm GIA of A1-A5 retail, 438 bedroom hotel (C1), 40 bedroom replacement homeless hostel (sui generis), 416 student rooms (C2), new multi-screen cinema (D2), 1167sqm GIA Gym (D2), associated basement car parking and servicing; new public square and children's play area and associated public realm improvements.	C	Under construction	Under construction	100% complete & operational	Information provided by LB Lambeth. If approved, lease on site does not run out until 2014, so works expected to start 2014/2015 and take up to five years.	**2017 & 2018**: Cumulative **2023:** Base case
Market Towers	Approx 300m southwest	2012/0380	Kish Six Limited	Demolition of existing buildings and structures. Erection of two new buildings of 58 storeys (up to 200m above ground) and 43 storeys (up to 161m above ground) high to include the following uses with floorspace of up to: 77,548 sq.m. of residential	B	100% complete & operational.	100% complete & operational.	100% complete & operational.	ES NTS. Section 6.	Base case (all years)

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
				floorspace (up to 491 units); 721 sq.m. of retail uses (classes A1-A4); 10,986 sq.m. of office space (class B1); 11,617 sq.m. hotel (class C1) together with a high level viewing space; provision of private and public open spaces; vehicular access and reconfigured vehicular access routes; provision of cycle, motorcycle and car parking, servicing and energy centre within two level basement; landscaping; excavation works; and other associated works. An Environmental Statement has been submitted with the planning application under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 2011						
Island Site Vauxhall Gyratory	Approx 300m south	10/02060/FUL	Kylun Ltd	Erection of two towers, Tower A rising to 42 storeys (approx 140m) and Tower B rising to 32 storeys (approx 115m), plus 4 basement levels below ground; to provide a mixed use development comprising 291 residential units (made up of 225 market units, 42 socially rented, 42 intermediate, which makes 23% of the units affordable, , 663sqm of floorspace for food and drink commercial uses, 2162sqm of floorspace for employment commercial uses , a 179 room hotel and 1371sqm of floorspace for community facilities/assembly and leisure (consisting of a dentist surgery, a soft play facility, a digital cinema and a community space – use classes D1 and D2); together with 30 car parking spaces, 10 motorbike parking spaces, 490 cycle parking spaces, refuse storage facilities, the provision of a public space/landscaping at street level, the formation of a new vehicular access from Parry Street and a new vehicle egress to Bondway, and other works incidental to the redevelopment of the site.	C	Under construction	100% complete & operational	100% complete & operational	Appeal in progress Works are expected to start in 2014 and take 2-3 years.	**2017**: Cumulative **2018 & 2023**: Base case
30-60 South Lambeth Road	Approx 320m southeast	11/04181/FUL	GMD Developments Limited	Redevelopment of the existing site to provide a 32 storey mixed-use building comprising new leisure uses (swimming pool & gymnasium) and 572 units for student residential accommodation. Provision of refuse and cycle storage, disabled parking and associated landscaping.	C	Under construction	100% complete & operational	100% complete & operational	Professional judgement – no phasing information available in application documentation	**2017:** Cumulative **2018 & 2023:** Base case
10 Albert Embankment (Wah Kwong House)	Approx 350m northeast	08/01136/FUL	G&G Properties	Demolition and rebuilding to provide for the erection of a 15 storey (including basement), 102 room apart-hotel together with restaurant and 3 residential penthouses	B	100% complete and operational	100% complete and operational	100% complete and operational	Information provided by LB Lambeth. Revised scheme expected converting building to residential. Expected	Base case (all years)

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
									to take 2-3 years to build out. Given it has permission, construction assumed to finish in 2016.	
8 Albert Embankment and land to rear (bounded by Lambeth High St, Whitgift St, the railway viaduct, Southbank House and land corner of Black Prince Road and Newport St)	Approx 390m northeast	10/04473/FUL	Albert Embankment LLP and London Fire and Emergency Planning Authority (LFEPA)	Refurbishment, alteration and extension to the grade II listed fire station to provide a fire station and associated functions for the London Fire Brigade (sui generis) on part basement and ground floors, with residential (class C3) above, including demolition of the communication mobilising centre. Demolition of the brigade workshop/office buildings to the rear of the fire station. Construction of 7 new buildings ranging in height from 5 to 15 storeys for mixed use purposes, including residential dwellings (class C3); office/business space (class B1); ground floor units for shops, financial and professional services, restaurants and cafes, and/or drinking establishments (classes A1, A2, A3 and/or A4); and ancillary facilities. Refurbishment and internal alterations to the grade II listed drill tower associated with the new fire station. Construction of basements to provide servicing, parking, energy centre, plant and storage. Creation of areas of open space and alterations to the existing vehicular and pedestrian accesses and highway arrangements within and around the site. The development would provide a total of 265 residential units, a 2,721 sqm fire station, 8,554 sqm of commercial floorspace (use Class B1), 696 sqm of retail/A Class floorspace and 92 car parking spaces.	C	100% complete & operational	100% complete & operational	100% complete & operational	ES, Non-technical summary – states 3.5 year construction period. Assuming that construction commences in 2013, it would be complete by 2017. Application refused but appeal in progress.	Base case (all years)
81 Black Prince Road (Parliament House)	Approx 420m northeast	08/04454/FUL	Ristoia Ltd	Redevelopment of the site involving the demolition of the existing building and the erection of a 23 storey building (including basement) to contain 1770 square metres (GEA) of commercial floorspace (flexible use for B1 or A2) together with 101 self contained flats (41 x 1 bed, 44 x 2 bed, 8 x 3 bed, 4 x 4 bed and 4 x 5 bed) on upper floors of which 28 are affordable housing units made up of 16 social rented units 12 intermediate units – 28 % affordable housing overall.	C	100% complete and operational	100% complete and operational	100% complete and operational	Information provided by LB Lambeth. Appeal in progress Works expected to start in 2013 and take two years to build out.	Base case (all years)
Vauxhall Sky Gardens, 143-161 Wandsworth Road	Approx 520m south	09/04322/FUL	Frasers Property Developments Ltd	Redevelopment of the site involving the demolition of existing buildings and the erection of a part one storey, part eight storey and part 36 storey plus basement building to provide a mixed use development comprising ground floor commercial units (flexible use class A1, A2, A3 and D1) of 257	B	100% complete & operational	100% complete & operational	100% complete & operational	Assumptions made on basis that ES (2009) assumes	

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
				square metres, 4722 square metres of office floorspace (use class B1), 239 residential units, 3220 square metres of amenity space and landscaped amenity areas, 23 car parking spaces, 278 cycle parking spaces, refuse storage, public realm improvements at street level and the formation of new vehicular access from Wyvil Road.					2011 opening year (ie, two year construction period). As application was granted permission in Sept 2010 it is a reasonable assumption that it will be complete by Site Year 1 of construction.	Base case (all years)
US Embassy - Land on south side of Nine Elms Lane incorporating Ponton Road	Approx 590m southwest	2009/1506 & (2009/1507) realignment of Pontoon Road Several non material amendment application and amendments to conditions	US Department of State	**2009/1506** Redevelopment of an area of 2.15 hectares to provide a new United States Embassy, to a maximum possible height of 97m, associated buildings, and new access road from Nine Elms Lane. **2012/2759 (reserved matters)** Details of external appearance of the building, including facing materials, layout of the building, scale of the building and landscaping of the site (condition 3), site levels (condition 4), a scheme to implement mitigation measures within the flood risk assessment (condition 8), a surface water drainage scheme (condition 9), an inclusive access strategy (condition 13), establishment of a Design Review Panel (condition 18), detailed energy strategy (condition 19), details of docking station for cycle hire scheme (condition 20) of outline planning permission ref 2009/1506 dated 12/10/2010 for the redevelopment of an area of 2.15ha to provide a new United States Embassy, associated buildings and access from Nine Elms Lane. Public Art Strategy and details of Design Review Panel pursuant to Clause 2 and Clause 5 of the S106 agreement dated 12/10/2010 relating to planning permission 2009/1506. Details of visitor cycle parking pursuant to condition 9 of planning permission ref 2009/1507 dated 12/10/2010 for formation of new junctions and new road to replace Pontoon Road.	B	100% complete & operational	100% complete & operational	100% complete & operational	Environmental Statement (Chapter 6 Development Programme and Construction page 1)	Base case (all years)
Nine Elms Sainsbury's, Wandsworth Road	Approx 600m southwest	11/02326/OUT	Sainsbury's Supermarkets Ltd	A part detailed and part outline planning application comprising: Full detailed planning permission for the demolition of the existing retail store and petrol station to allow for the erection of a replacement retail store (7,432msq net trading floorspace (13,059msq gross internal floor area), childrens	B	100% complete & operational	100% complete & operational	100% complete & operational	Information provided by LB Lambeth - if approved in 2012 the development is expected to take 2-3 years to construct.	Base case (all years)

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
				tutoring facility (298msq), lobby/circulation space (1,707msq), energy centre (779msq), flexible retail, community floorspace (787msq), business, office floorspace (1,860msq) and 671 residential units with ancillary gymnasium (369msq) arranged in seven blocks including towers of 19, 28 and 37 storeys. Also proposed are 363 retail and 148 residential parking spaces, 882 cycle spaces together with associated open space, childrens play space, landscaping and public realm improvements along Wandsworth Road and a new route from Wandsworth Road to New Covent Garden. Outline planning permission (with appearance, landscaping and access to be Reserved Matters) for 105msq of flexible A1, A2, A3, A4, D1 floorspace and 66 dwellings within 2 blocks. In addition outline planning permission is also sought for a further 1736msq of flexible floorspace for use in association with either the proposed Nine Elms Northern Line station or A1, A2, A3, A4, D1 use. This application is accompanied by an Environmental Statement					Would therefore be complete and operational by 2016.	
Embassy Gardens (land to the south of Nine Elms Lane comprising DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane)	Approx 620m southwest	2011/1815		An outline planning application for demolition of all existing buildings and construction of a mixed use redevelopment comprising 9 building plots with buildings to a maximum height of 23 storeys (approximately 80m AOD) and a maximum overall floorspace of 263,030sq.m. GEA (including 18,571 sq m basement) including: 163,605 sq.m. and 192,825 sq.m. of residential use (equating to between 1626 and 1982 residential units, including affordable housing, and 6050sq.m. of serviced apartments); up to 7,834sq.m. of retail, financial and professional services, café/restaurant, bar and takeaway uses (A1 to A5); up to 1,886sq.m. GEA of car showroom (Sui Generis); between 21,329sq.m. and 49,159sq.m. of office floorspace (B1); up to 10,400sq.m. of hotel use (C1); 750sq.m. of community uses (D1); 1130sq.m. of assembly and leisure uses (D2).	B	Buildings A09, A10 & A11 complete & operational. Buildings A01, A02, A03, A04, A05 & A07 under construction.	Buildings A02, A05, A09, A10 & A11 complete & operational. Buildings A01, A03, A04 & A07 under construction.	100% complete & operational	Environmental Statement (Chapter 6 Development Programme and Construction page 2-3). Phasing information taken from application drawings (Phasing Diagrams)	**2017:** Base case = Buildings A09, A10 & A11 Cumulative = Buildings A01, A02, A03, A04, A05 & A07 **2018:** Base case = Buildings A02, A05, A09, A10 & A11 Cumulative = Buildings A01, A03, A04 & A07 **2023:** Base case = all buildings

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
										No cumulative
10 Pascal Street	Approx 750m southeast	11/03931/FUL	Banham Security	Demolition of existing building and redevelopment of the site involving the erection of a part 13, part 6 and part 3 storey building to provide 3,964 sq m office space (Use Class B1) at ground, first and second floor levels and 63 residential units (Use Class C3) on the upper floors together with a basement level to provide 31 car parking spaces, 5 motor bike spaces and 68 cycle spaces.	C	100% complete & operational	100% complete & operational	100% complete & operational	No construction programme information available in application documentation. Given the size of the development it is assumed that it will be complete by Site Year 1 of construction.	Base case (all years)
Nine Elms Parkside	Approx 880m southwest	2011/2462	Royal Mail Estates Ltd	An outline planning application for demolition of all existing buildings and construction of a mixed use redevelopment comprising 7 building plots with buildings to a maximum height of 23 storeys (approximately 76m AOD) and a maximum overall floorspace of 222,120sq.m.	B	Plots B, C & D under construction	Plots B, C & D under construction	Plots A, B, C & D complete & operational. Plots, E, F & G under construction.	Environmental Statement (Chapter 6 Demolition and Construction page 6-1). 2014 start on site assumption.	**2017 & 2018:** No base case Cumulative = Plots B, C & D **2023:** Base case = Plots A, B, C & D Cumulative = Plots E, F & G
Northern Line Extension	Approx 1.4km SW (Battersea Power Station) 750m SW (Nine Elms Station) Kennington: Approx 865m southeast (Cottingh	N/A	TfL	Extension of the Northern Line (Charing Cross Branch) from Kennington to Battersea, with the creation of two new stations: one at Nine Elms near Wandsworth Road and the other at Battersea Power Station. To will include the construction of three permanent shafts at Cottingham Road (intervention shaft), Kennington Green (ventilation shaft) and Kennington Park (ventilation shaft). In addition two temporary shafts would be built at Radcot Street and Harmsworth Street near to Kennington station.	Not submitted	Under construction	Under construction	100% complete & operational	Information provided by TfL in August 2012. In the absence of publically available information, see Assumptions note used by EIA team at the end of the Development Schedule.	**2017 & 2018:** Cumulative **2023:** Base case

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)	2018 (peak construction year for T&V assessment)	2023 (Year 1 of operation)		
	am Road intervention shaft) Approx 815m east (Kennington Green ventiliation shaft) Approx 1.2km east (Kennington Park ventilation shaft) Approx 1km east (to Radcot Street temporary shaft) Approx 1.1km east (Harmsworth Street temporary shaft)									

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

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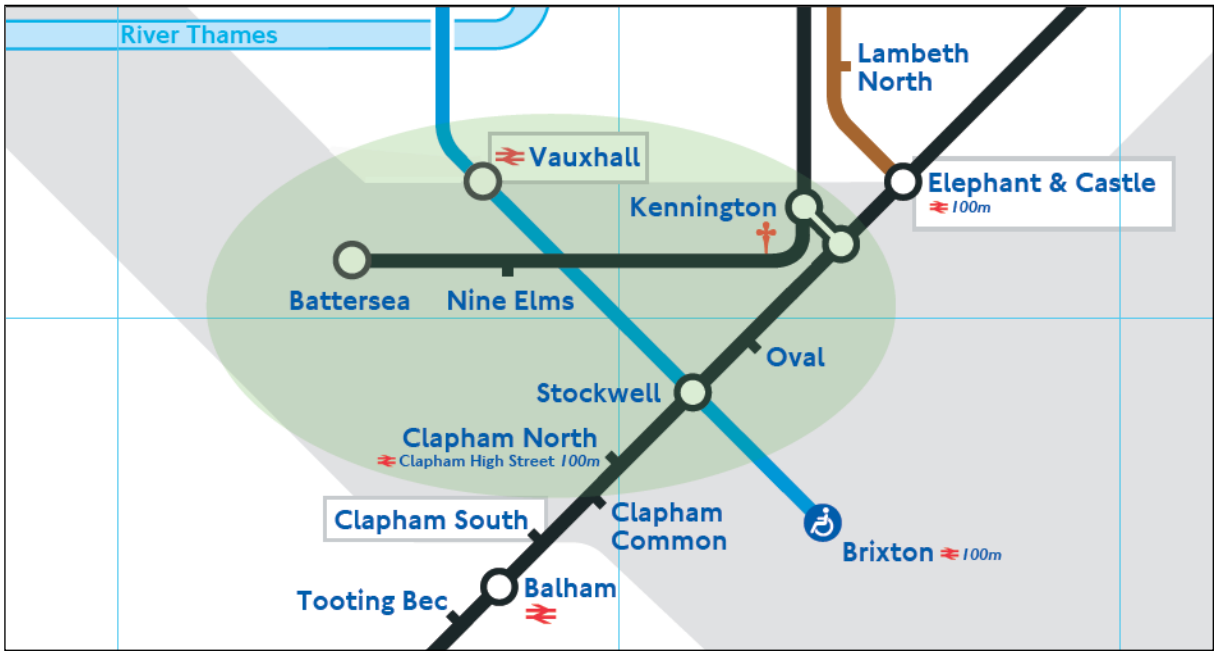
N.2 Northern Line Extension – assumptions for Thames Tideway Tunnel EIA

N.2.1 This note has been produced to inform Thames Tideway Tunnel EIA specialists of the proposed Northern Line Extension (NLE) development, to be considered in the topic base case and cumulative effect assessments as appropriate.

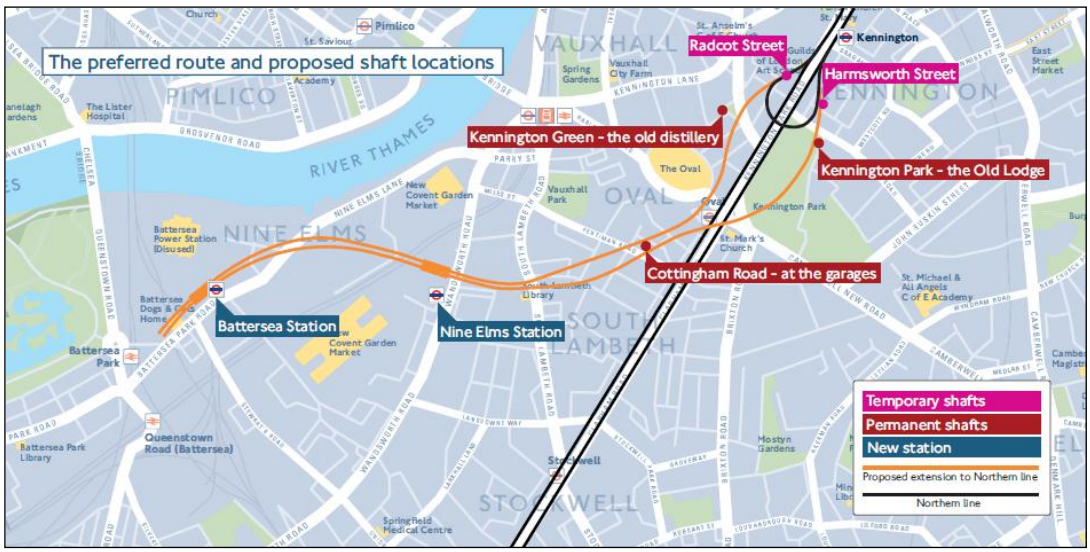
N.2.2 The NLE would extend the Northern Line from Kennington (Charing Cross branch) to Battersea, as shown in Vol 16 Plate N.1 below.

Vol 16 Plate N.1 Tube map showing proposed Northern Line extension



N.2.3 The NLE would include the creation of two new stations: one at Nine Elms near to Wandsworth Road, and the other at Battersea Power Station, as well as the construction of three permanent shafts at Cottingham Road/Claylands Road (intervention shaft), Kennington Green (ventilation shaft) and Kennington Park (ventilation shaft). In addition two temporary shafts would be built at Radcot Street and Harmsworth Street near to Kennington station. The preferred route and proposed shaft locations are shown in Vol 16 Plate N.2 below.

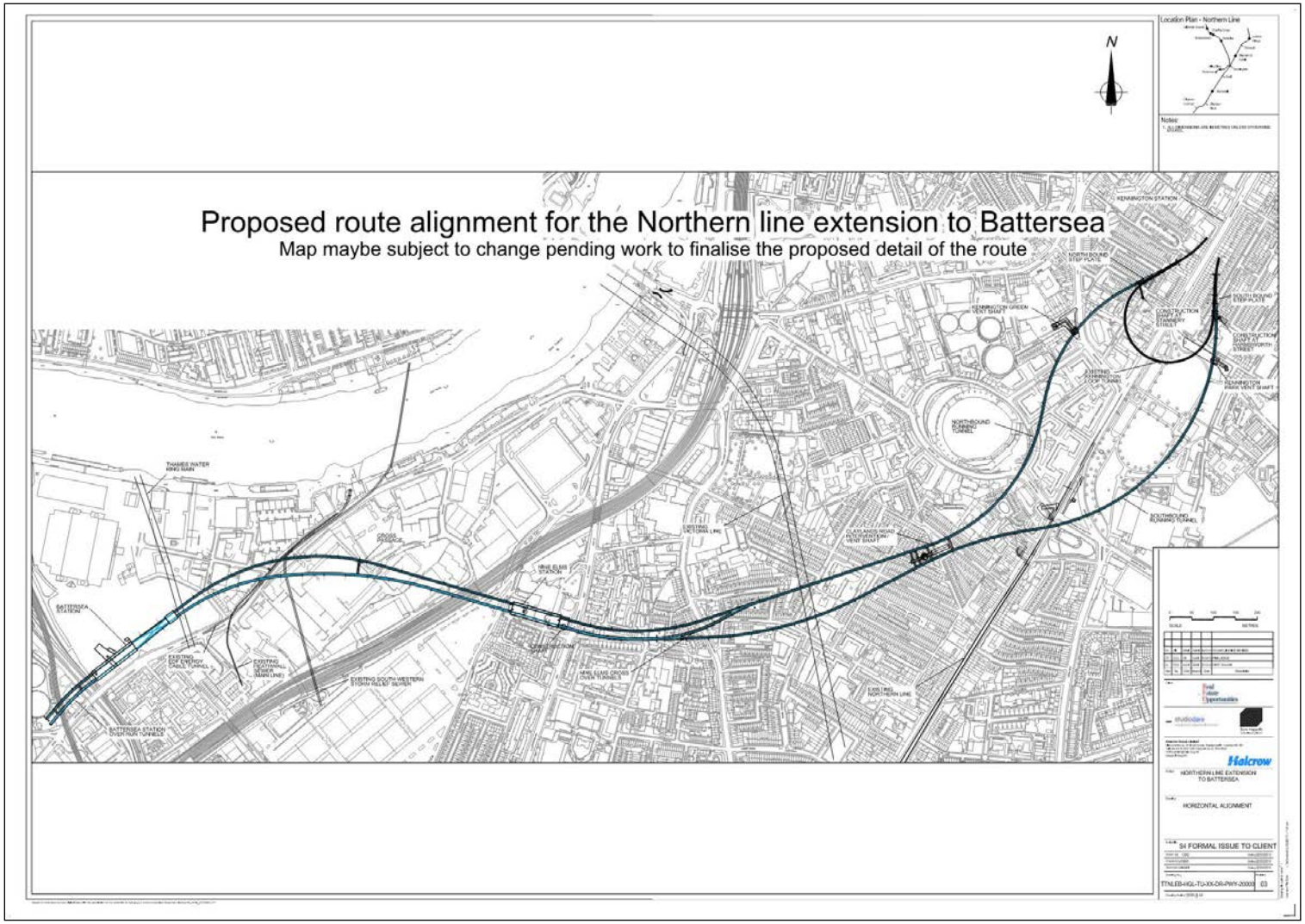
Vol 16 Plate N.2 Preferred route and proposed shaft locations of the Northern Line extension



N.2.4 The NLE would pass through the London Borough (LB) of Wandsworth, LB of Lambeth, and has a temporary shaft within LB of Southwark. It is also close to the City of Westminster, although it is separated by the River Thames.

N.2.5 A detailed proposed route alignment map can be seen in Vol 16 Plate N.3 below.

Vol 16 Plate N.3 Proposed route alignment



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N.2.6 A number of phasing scenarios are currently being considered by the NLE project as there are a number of uncertainties, including the development programme for the redevelopment of Battersea Power Station. However, the most likely scenario is that the NLE project would begin construction in late 2015/early 2016 and last about four years becoming operational in 2019. This is therefore assumed for the purposes of the Thames Tideway Tunnel EIA.

N.2.7 The current assumption for the NLE project (and therefore used for the Thames Tideway Tunnel EIA) is that inbound materials such as tunnel linings, would be brought in by road while excavated material would be removed by river.

N.2.8 To facilitate this, the project would use the Battersea Power Station jetty, which is anticipated to involve moving the existing cranes and installing a conveyor. It is estimated that 100m^3 (average) to 2000m^3 (maximum) of material would be transported in a 25 hour period (ie, over two tides).

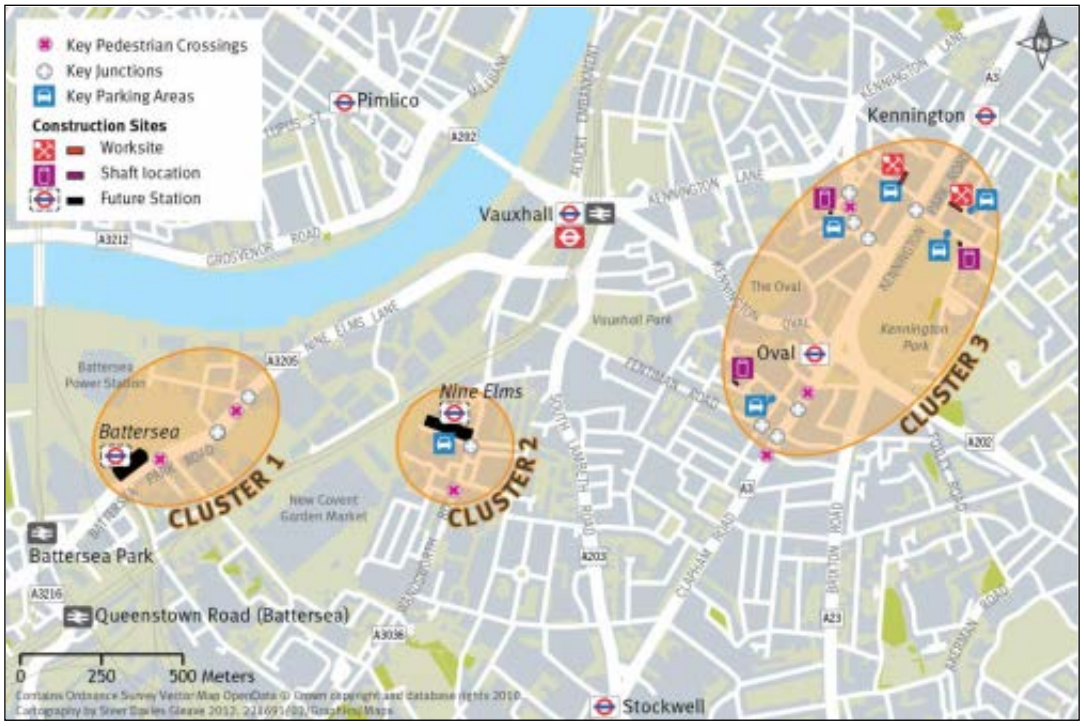
N.2.9 It is however noted that this remains subject to discussions with the Port of London Authority. Additionally, investigations are ongoing as to whether there can be greater use of rail and/or river, as well as the feasibility of on-site manufacturing.

N.2.10 TfL has produced a report outlining the proposed approach to transport and parking impact assessments, in which they break down the NLE construction sites into clusters as follows:

d. Cluster 1 – Battersea Park Road/Nine Elms Lane
    i Battersea Power Station
e. Cluster 2 – Wandsworth Road
    i Nine Elms Station (including Banham site)
f. Cluster 3 – Kennington Park Road
    i Claylands Road (Garages) intervention shaft
    ii Kennington Park (Old Lodge) ventilation shaft
    iii Kennington Green (Distillery) ventilation shaft
    iv Northern site (Radcot Street) temporary grouting shaft
    v Southern site (Harmsworth Street) temporary grouting shaft.

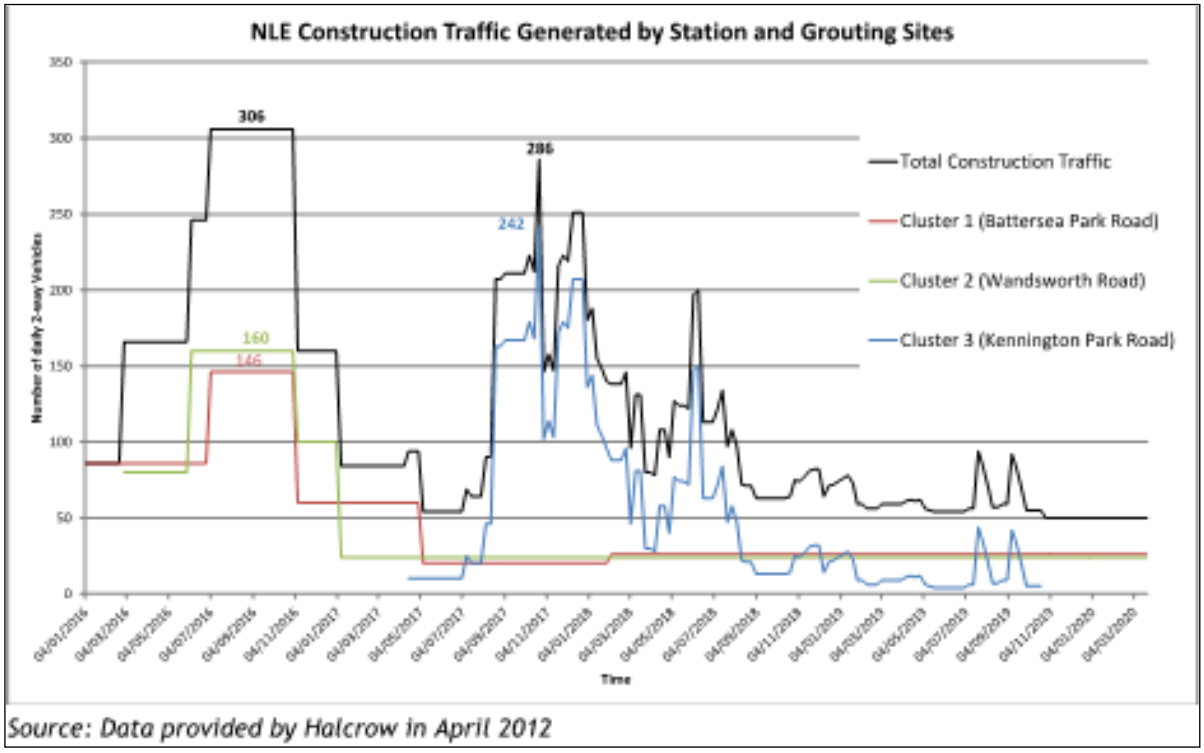
N.2.11 The aforementioned clusters are shown on Vol 16 Plate N.4 below:

Vol 16 Plate N.4 Northern Line Extension construction site clusters



N.2.12 Daily two-way construction traffic, which includes all traffic going in and out of the construction sites in each cluster are shown in Vol 16 Plate N.5 below.

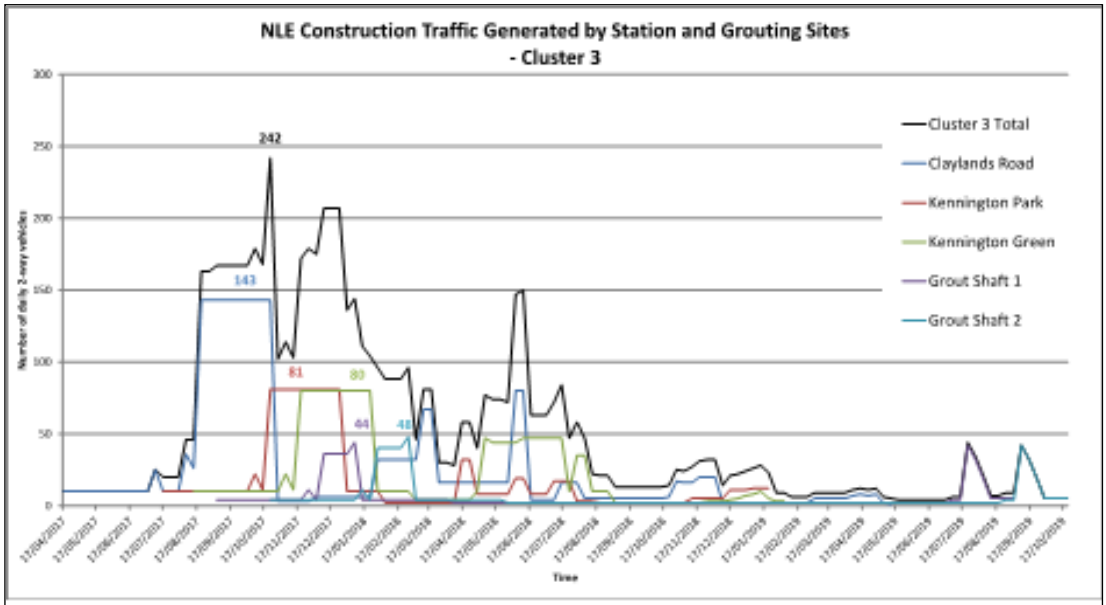
Vol 16 Plate N.5 Daily two-way construction traffic by all clusters



Source: Data provided by Halcrow in April 2012

N.2.13 As cluster 3 includes five separate construction sites, Vol 16 Plate N.6 illustrates the traffic generated by each of these sites, both separately and in total.

Vol 16 Plate N.6 Daily two-way construction traffic in cluster 3



Source: Data provided by Halcrow in April 2012

N.2.14 It has been assumed in the above assessment that construction work would commence on 4 January 2016.

N.2.15 Peak construction activity in term of traffic generation is expected to occur between July and November 2016, with a total of 306 two-way vehicles generated every day.

N.2.16 A secondary peak of construction is expected to take place in November 2017, with a total of 242 two-way daily vehicles.

N.2.17 Of the total outgoing and incoming traffic from/to the construction sites, 30% would have an origin/destination in north London and 70% in south London.

N.2.18 All construction traffic would head to/from the M25 via the most easily accessible arterial routes located within the vicinity of each construction site.

N.2.19 During the construction period it is assumed that construction activity would take place for ten hours during the day, with construction traffic spread out equally across the day.

N.2.20 The main site at Battersea Power Station would not require any diversions, road closures, or parking suspensions; however Kirtling Street would be subject to a high number of vehicle movements.

N.2.21 Road closures/diversions would be required on two small residential streets in the vicinity of Kennington station in order to accommodate the temporary grouting shafts. Buses would be rerouted, and one bus lane may need to be removed in the vicinity of Kennington Green. A small but significant number of parking spaces would need to be suspended,

although this will be concentrated around the Kennington Road sites as well as by the proposed Nine Elms station on Wandsworth Road.

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