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

Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea 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 13 Chelsea 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

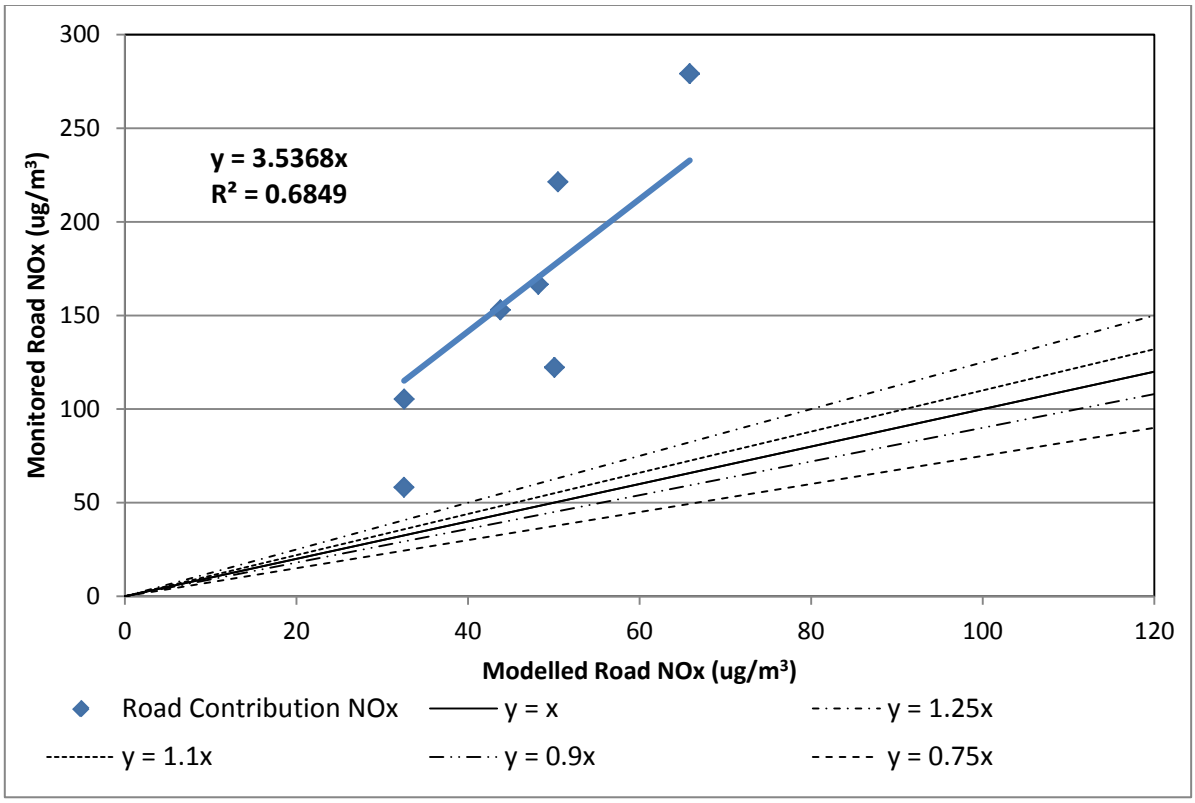
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at seven diffusion tube sites (CEFM1-CEFM6 and KC50) as shown in Vol 13 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between 14% and 45%. 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.

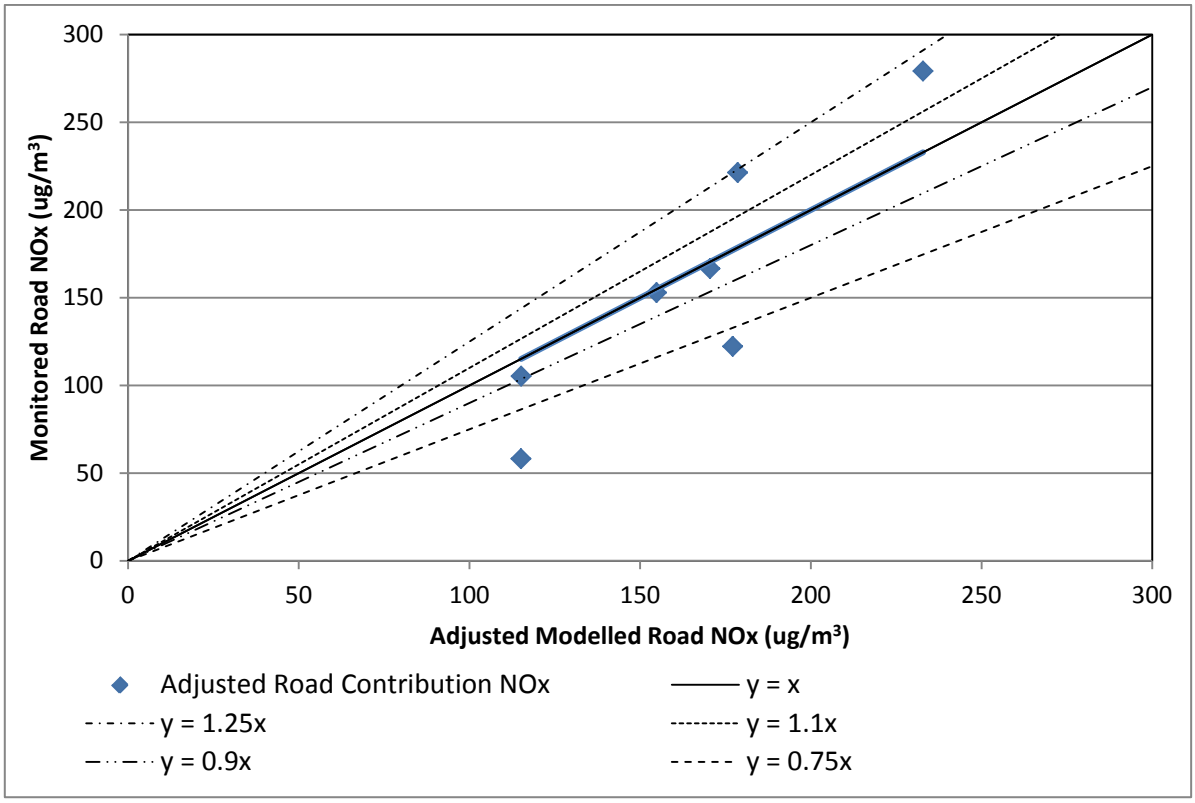
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 13 Plate B.1 below). An adjustment factor of 3.54 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09)[1] 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 13 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 13 Plate B.3, indicated that five of the seven modelled concentrations were within 10% of the measured value and that the other two were within 25% of the modelled value.

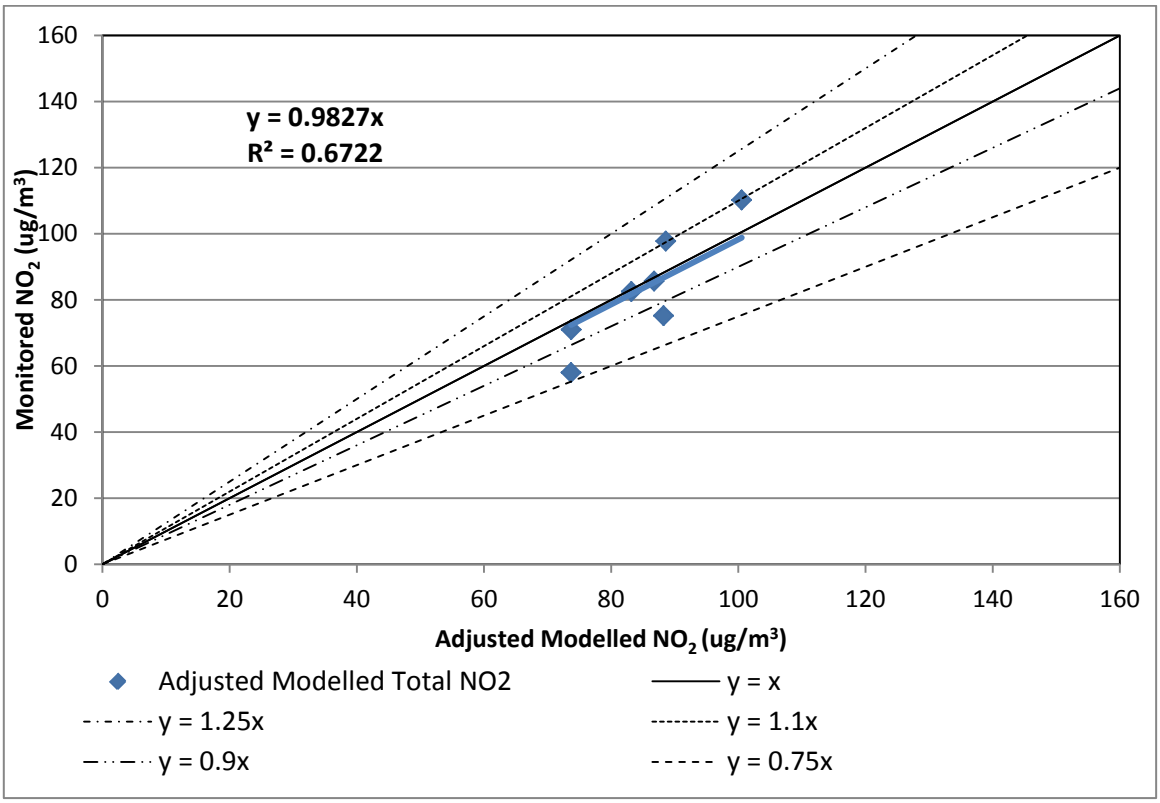
Vol 13 Plate B.1 Air quality - monitored road NO_X vs. modelled road NO_X



Vol 13 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 13 Plate B.3 Air quality – total monitored NO_2 vs. total adjusted modelled NO_2



B.2 Traffic data

B.2.1 The traffic data used in the air quality modelling for the Chelsea Embankment Foreshore site are shown in Vol 13 Table B.1.

Vol 13 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** survey	Chelsea Embankment A3212	39317	13.4%	30	27.1	8.7%	42751	3	42769	13.4%
CTC*** survey	Chelsea Bridge Road A3216	41723	7.4%	30	9.1	8.7%	45367	2	45369	7.4%
CTC survey	Grosvenor Road A3212	41708	5.2%	30	27.1	8.7%	45352	0	45366	5.2%
CTC survey	Chelsea Bridge Road A3216	28039	9.1%	30	8.7	8.7%	30488	0	30488	9.1%
CTC survey	Ebury Bridge Road B313	10096	9.2%	30	12.9	8.7%	10978	0	10978	9.2%
CTC survey	Chelsea Bridge Road A3216	16374	10.4%	30	11.0	8.7%	17804	0	17804	10.4%
CTC	Royal Hospital	16759	4.8%	30	13.0	8.7%	18222	0	18223	4.8%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
survey	Road A302									
CTC survey	Lower Sloane Street A 3216	18138	12.1%	30	9.1	8.7%	19722	0	19725	12.1%
CTC survey	Pimlico Road A3214	19945	7.5%	30	10.4	8.7%	21687	0	21701	7.5%

** AADT – annual average daily traffic. ** ATC – Automatic traffic count. *** CTC – Classified traffic count.*

B.3 River tug emission factors

B.3.1 Emissions of NO_X and PM_{10} from tugs pulling the barges were calculated using the data shown in Vol 13 Table B.2 for the Chelsea Embankment Foreshore site.

Vol 13 Table B.2 Air quality - tug assessment model inputs

Parameter	Value	Units
Total tugs	191	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***	1980	m^2
NO_X emissions per tug	2.8×10^{-04}	$g/s/m^2$
PM_{10} emissions per tug	2.8×10^{-04}	$g/s/m^2$

* 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.4.1 For the purpose of the assessment, the following listed equipment in Vol 13 Table B.3 has been modelled for the peak construction year at the Chelsea Embankment Foreshore site.

Vol 13 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 ($g/s/m^2$)
Hoarding	Ground level behind hoarding	Excavator digging post holes for hoarding	1	30	301	2.7×10^{-7}	1.7×10^{-8}
	Ground level behind hoarding	Generator 35kVA	1	100	28	1.3×10^{-6}	1.3×10^{-7}
	Ground level behind hoarding	Cutting equipment (diamond saw)	1	10	2.3	1.7×10^{-9}	3.8×10^{-9}
	Ground level behind hoarding	Compressor 250cfm*	1	30	104	9.3×10^{-8}	5.8×10^{-9}
Site set up and general site	Ground level behind hoarding	Compressor 250cfm	1	50	104	1.5×10^{-7}	9.7×10^{-9}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	4.8×10^{-7}	3.0×10^{-8}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	1.0×10^{-7}	6.2×10^{-9}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	3.5×10^{-9}	7.6×10^{-9}
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	5.4×10^{-8}	3.4×10^{-9}

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	Hiab*** lorry/crane	1	5	50	6.1×10^{-8}	4.7×10^{-10}
Shaft secondary lining	Ground level behind hoarding	100t crawler crane	1	50	240	3.6×10^{-7}	2.2×10^{-8}
	Ground level behind hoarding	Service Crane 40t mobile Crane	1	25	275	2.0×10^{-7}	1.3×10^{-8}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	1.3×10^{-7}	8.3×10^{-9}
	Ground level behind hoarding	Concrete pump	2	20	223	2.7×10^{-7}	1.7×10^{-8}
Culvert works	Ground level behind hoarding	Service crane – 100t mobile crane	1	50	280	4.2×10^{-7}	2.6×10^{-8}
	Ground level behind hoarding	25t excavator	1	50	125	1.9×10^{-7}	1.2×10^{-8}
	Ground level behind hoarding	Dumper	1	50	81	1.2×10^{-7}	7.5×10^{-9}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	1.3×10^{-7}	8.3×10^{-9}
	Ground level behind hoarding	Concrete boom pump	1	20	223	1.3×10^{-7}	8.3×10^{-9}
Landscaping	Ground level behind hoarding	25t excavator	1	50	125	1.9×10^{-7}	1.2×10^{-8}
	Ground level behind hoarding	Dumper	1	70	81	1.7×10^{-7}	1.1×10^{-8}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
	Ground level behind hoarding	Telescopic Handler / FLT	1	30	60	5.4×10^{-8}	3.4×10^{-9}
	Ground level behind hoarding	Hiab*** lorry/crane	1	5	50	6.1×10^{-8}	4.7×10^{-10}
	Ground level behind hoarding	Compressor for hand-held breaker	1	10	6	2.9×10^{-8}	2.7×10^{-9}
	Ground level behind hoarding	Plate compactors	2	10	3	4.6×10^{-9}	9.9×10^{-9}
	Ground level behind hoarding	Vibrating rollers	1	20	145	8.6×10^{-8}	5.4×10^{-9}

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

References

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

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Appendix C: Ecology - aquatic

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Appendix C: Ecology – aquatic

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.1.1 A Phase 1 Habitat Survey was carried out on 29 October 2010 at the Chelsea Embankment Foreshore site as shown on Vol 13 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

c. invasive plants.

D.1.2 The purpose of the surveys is to determine the presence or likely absence of these species from the site.

D.1.3 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 (see paras. D.1.5 - D.1.9). The results from the surveys are then presented (see paras. D.1.10 - D.1.16). The final section provides an interpretation of the results (paras. D.1.17 - D.1.25). Figures referred to in this report are contained within Vol 13 Chelsea Embankment Foreshore Figures.

D.1.4 Information on legislation, policy, methodology can be found in Vol 2 of the *Environmental Statement*. Information on site context can be found in Section 3 of this volume.

Survey area

Bats

D.1.5 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.1.6 A remote recording (bat triggering) survey using a remote Anabat™ recording device was undertaken. Based on the habitat types identified during the Phase 1 habitat survey and their potential to support commuting and foraging bats, one location was chosen for the installation of the remote recording device (shown on Vol 13 Figure 6.4.3, see separate volume of figures). This location was selected to capture bat activity along the avenue of trees on site and along the river corridor on and adjacent to the site.

Wintering birds

D.1.7 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. The survey area, as shown in Vol 13 Figure 6.4.4 (see separate volume of figures), comprises intertidal foreshore with shoals of stones of various sizes and silt, exposed at low tide. These habitats are suitable for foraging and resting wintering birds.

Invasive plants

D.1.8 Invasive plants that are listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) can be found in almost any habitat, although these are more likely to occur in areas of disturbed ground, where material contaminated with seeds and rhizomes (sections of root that can re-grow) may have been imported into the area, and/or along watercourses where they are readily spread by water.

D.1.9 The invasive plants survey area, as shown on Vol 13 Figure 6.4.5 (see separate volume of figures) comprises the proposed development site, and an area within 10m of the proposed development site boundary. The 10m zone beyond the site boundary was surveyed to record any invasive plants present adjacent to the site that could potentially spread onto the site, or that could have roots that extend into the site below ground (eg Japanese knotweed (*Fallopia japonica*)).

Results

D.1.10 The results of the desk study, notable species surveys and plant surveys are presented here. The results are then interpreted in para. D.1.17 to D.1.25.

Desk study

D.1.11 Vol 13 Table D.1 indicates species recorded within 500m of the site within the last ten years, as supplied by Greenspace Information for Greater London (GIGL).

Vol 13 Table D.1 Terrestrial ecology – species recorded within 500m of the site between 2011 – 2011

Common name	Species name (Latin)	Record count
Mammals (all bats)		
Common pipistrelle	*Pipistrellus pipistrellus*	5
Soprano pipistrelle	*Pipistrellus pygmaeus*	4
Daubenton's bat	*Myotis daubentonii*	1
Nathusius' pipistrelle	*Pipistrellus nathusii*	1
Noctule bat	*Nyctalus noctula*	1
Pipistrelle sp.	*Pipistrellus*	22
Birds		
Tundra swan	*Cygnus columbianus*	2
Whooper swan	*Cygnus cygnus*	1
Greylag goose	*Anser anser*	9

Common name	Species name (Latin)	Record count
Northern pintail	*Anas acuta*	9
Greater scaup	*Aythya marila*	15
Common goldeneye	*Bucephala clangula*	8
Eurasian hobby	*Falco subbuteo*	1
Peregrine falcon	*Falco peregrinus*	4
Northern lapwing	*Vanellus vanellus*	3
Green sandpiper	*Tringa ochropus*	1
Common gull	*Larus cachinnans*	4
Herring gull	*Larus argentatus*	5
Black tern	*Chlidonias niger*	1
Sandwich tern	*Sterna sandvicensis*	1
Common tern	*Sterna hirundo*	18
Arctic tern	*Sterna paradisaea*	1
Common cuckoo	*Cuculus canorus*	3
Sand martin	*Riparia riparia*	3
Common kingfisher	*Alcedo atthis*	5
Lesser spotted woodpecker	*Dendrocopos minor*	1
Sky lark	*Alauda arvensis*	5
Tree pipit	*Anthus trivialis*	3
Yellow wagtail	*Motacilla flava*	6
Dunnock	*Prunella modularis*	14
Black redstart	*Phoenicurus ochruros*	12
Common starling	*Sturnus vulgaris*	11
House sparrow	*Passer domesticus*	10
Brambling	*Fringilla montifringilla*	6
Lesser redpoll	*Carduelis cabaret*	1
Common redpoll	*Carduelis flammea*	3
Common crossbill	*Loxia curvirostra*	3
Common bullfinch	*Pyrrhula pyrrhula*	18
Ring ouzel	*Turdus torquatus*	2
Fieldfare	*Turdus pilaris*	5
Song thrush	*Turdus philomelos*	13
Redwing	*Turdus iliacus*	11

Common name	Species name (Latin)	Record count
Wood warbler	*Phylloscopus sibilatrix*	8
Firecrest	*Regulus ignicapilla*	22
Spotted flycatcher	*Muscicapa striata*	28
Eurasian golden oriole	*Oriolus oriolus*	1
Yellowhammer	*Emberiza citrinella*	1
Reed bunting	*Emberiza schoeniclus*	1
Amphibians		
Common frog	*Rana temporaria*	2
Common toad	*Bufo bufo*	2
Smooth newt	*Lissotriton vulgaris*	2
Invertebrates		
Stag beetle	*Lucanus cervus*	7
Plants		
Cornflower	*Centaurea cyanus*	2
Mistletoe	*Viscum album*	2
Annual knawel	*Scleranthus annuus*	2
Chamomile	*Chamaemelum nobile*	8
Stinking goosefoot	*Chenopodium vulvaria*	1

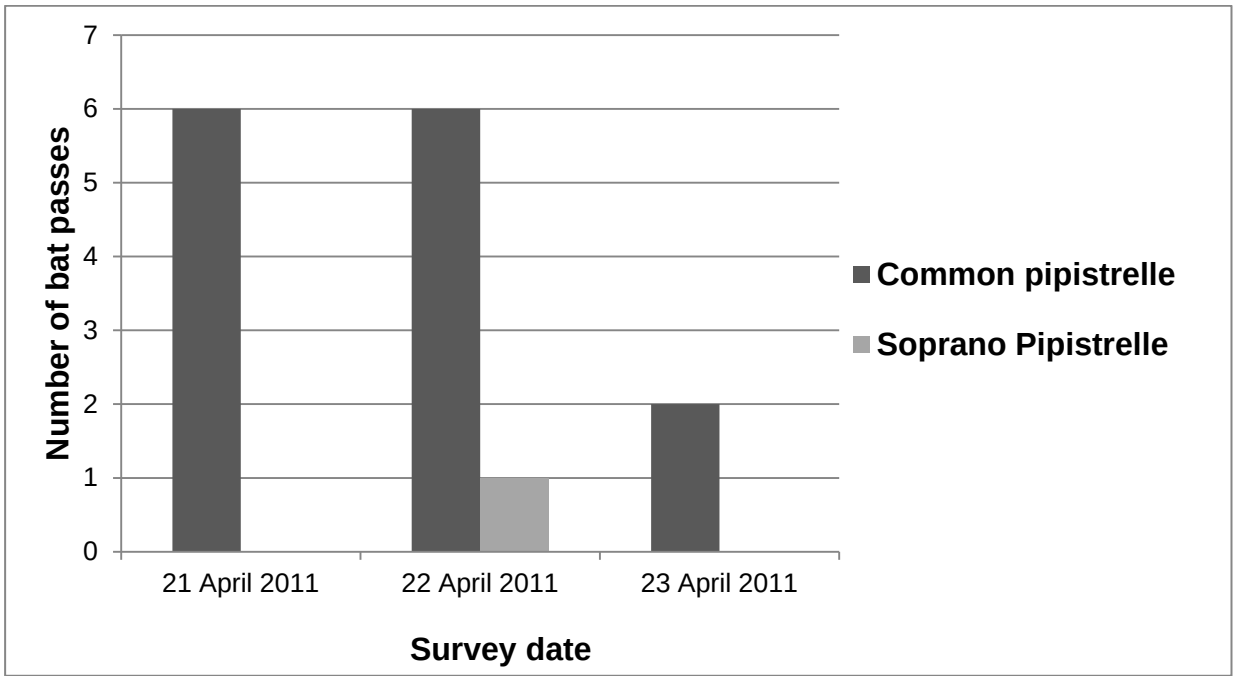
Bats

D.1.12 The remote recording surveys recorded two species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)* and soprano pipistrelle (*Pipistrellus pygmaeus*) (Vol 13 Table D.2). A maximum count of six common pipistrelle bats was recorded on the first two nights of the survey (21 and 22 April 2011), with two recorded on the third night (23 April 2011). There was one record within one hour of dawn (5:12am). One soprano pipistrelle bat was recorded during the survey and this was on the second survey night (22 April 2011).

Vol 13 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
21 April 2011	13^{o} C, light breeze, 100% cloud cover, no precipitation
22 April 2011	14^{o} C, light breeze, 100% cloud cover, no precipitation
23 April 2011	12^{o} C, calm, 100% cloud cover, no precipitation

Vol 13 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording survey at Chelsea Embankment Foreshore



Wintering birds

D.1.13 A total of six survey visits were undertaken by an experienced ornithologist (bird specialist) at monthly intervals between December 2010 and November 2011 (from an hour before low tide to at least one hour after low tide). The survey visits were undertaken in suitable weather conditions (Vol 13 Table D.3). The main foraging and resting areas for wintering birds are indicated on Vol 13 Figure 6.4.4 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 13 Table D.4.

D.1.14 A total of 11 waterbird[i] species were recorded on the foreshore on or in close proximity to the site including the following:

a. One individual teal *(Anas crecca)* was recorded foraging on the foreshore on one survey visit in November 2011.

b. Two gadwall *(Anas strepera)* were recording foraging on the muddy foreshore on one survey visit in March 2011.

c. Mallard *(Anas platyrhynchos)* were recorded foraging on the muddy foreshore and along the water's edge as the tide receded.

d. Black-headed gull *(Larus ridibundus)*, common gull *(Larus canus)*, lesser black-backed gull (*Larus fuscus)* and herring gull *(Larus argentatus)* were recorded resting on the CSO spillway.

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

D.1.15 High numbers of carrion crow *(Corvus corone)* (a terrestrial bird species) were recorded on the foreshore habitat on site during each of the survey visits.

Vol 13 Table D.3 Terrestrial ecology – wintering bird survey weather conditions

Survey number	Date
15 December 2010	2^{o}C, light easterly breeze, 100% cloud cover, dry
24 January 2011	3^{o}C, light northerly breeze, 100% cloud cover, dry
23 February 2011	10^{o}C, calm, 50% cloud cover, dry
24 March 2011	14^{o}C, calm, no cloud cover, dry
17 October 2011	14^{o}C, light southwesterly breeze, no cloud cover, dry
11 November 2011	10^{o}C, light southeasterly breeze, 100% cloud cover, dry

Vol 13 Table D.4 Terrestrial ecology - species and numbers of wintering waterbirds recorded during monthly wintering bird surveys

Species name	Latin name	Conservation designation[ii]	Monthly wintering waterbird counts					
			15 December 2010	24 January 2011	23 February 2011	24 March 2011	17 October 2011	11 November 2011
Cormorant	*Phalacrocorax carbo*	Green List	8	15	1	3	3	4
Grey heron	*Ardea cinerea*	Green List	1	-	-	-	-	1
Egyptian goose	*Alopochen aegyptiaca*	Green List	-	-	2	-	-	-
Canada goose	*Branta canadensis*	Green List	-	2	-	-	-	-
Gadwall	*Anas strepera*	Amber List	-	-	-	2	-	-
Teal	*Anas crecca*	Amber List	-	-	-	-	-	1
Mallard	*Anas platyrhynchos*	Amber List	18	7	8	4	-	46
Black-headed gull	*Chroicocephalus ridibundus*	Amber List	10	45	58	-	76	26
Common gull	*Larus canus*	Amber List	2	3	2	5	-	1

[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.

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

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Species name	Latin name	Conservation designation[ii]	Monthly wintering waterbird counts					
			15 December 2010	24 January 2011	23 February 2011	24 March 2011	17 October 2011	11 November 2011
Lesser black-backed gull	*Larus fuscus*	Amber List	3	5	3	5	11	1
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	4	10	11	37	5	16

Invasive plants

D.1.16 The invasive plant survey was undertaken on 19 October 2011. No invasive plant species listed on Schedule 9 of the Wildlife and Countryside Act were recorded.

Interpretation and conclusions

Bats

D.1.17 During the remote recording surveys, small numbers of common pipistrelle and soprano pipistrelle bats were recorded.

D.1.18 There was one record of a common pipistrelle bat within an hour of dawn (37 minutes before sunrise). The bat triggering criteria have not been applied strictly at this site. A record within one hour of dawn would trigger the need for a dawn survey at this site. However, given the low numbers of bats recorded overall, that only one bat was recorded within an hour of dawn, and the lack of bat roosting opportunities within trees on or adjacent to the site, it is considered unlikely that a roost is present on or in close proximity to the site. Therefore, no further surveys for bats were undertaken. However, a bat roost may be present within the wider Ranelagh Gardens, which provides optimal foraging habitat for bats and trees with bat roost potential.

D.1.19 The maximum number of common pipistrelle passes recorded in one survey was six. This number of passes suggests that a small number of individuals were passing through the site along the River Thames and the trees on Chelsea Embankment.

D.1.20 A single soprano pipistrelle bat pass was recorded on 22 April 2011. This suggests that this species occasionally passes through the site commuting along the River Thames and trees on Chelsea Embankment.

Wintering birds

D.1.21 Of the 11 waterbird species that were recorded within the survey area, seven are of nature conservation importance and are included in the Birds of Conservation Concern Red or Amber List and/or UK BAP Priority Species: gadwall, teal, mallard, black-headed gull, common gull, lesser black-backed gull and herring gull.

D.1.22 Within the survey area, the intertidal foreshore and outfall was used for foraging by gadwall, teal, mallard, black-headed gull, common gull, lesser black-backed gull and herring gull.

D.1.23 High numbers of carrion crow were recorded on the foreshore on both sides of the River Thames at this location. The carrion crow is a common terrestrial bird species and is not a species of conservation importance. Carrion crows are opportunistic feeders, feeding on carrion, insects, worms, seeds, fruit and any scraps of food. The presence of high numbers of this species at this location is likely to be due to temporary localised availability of one of these food resources, most likely due to bird feeding by humans.

D.1.24 The embankments on both banks of the River Thames are paved and are well-used by pedestrians, and backed by busy roads with heavy vehicle

use. Therefore, existing sources of potential disturbance to wintering birds is high. However, the results indicate that this level of potential disturbance did not result in the displacement of wintering birds at this location.

Invasive plants

D.1.25 No invasive plants listed on Schedule 9 of the Wildlife and Countryside Act 1981 were present on or within 10m of the site boundary.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea Embankment Foreshore appendices

Appendix E: Historic environment

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

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Thames Tideway Tunnel

Environmental Statement

Volume 13 Chelsea 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 13 Table E.1 below, with their location shown on the historic environment features map (Vol 13 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 13 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	Deposit of peat/organic clay recorded by the 1990s Thames Archaeological Survey (TAS) at Chelsea Embankment foreshore. The Museum of London Archaeology (MOLA)/Thames Discovery Programme (TDP) site visit as part of the Thames Tideway Tunnel project in Spring 2011 noted that this was still visible.	FKN04 A102
1B	Unclassified structure comprising a line of timber posts at right angles to river, possibly representing a drain of post-medieval date, recorded by the TAS in the 1990s. The MOLA/TDP site visit as part of the Thames Tideway Tunnel project in Spring 2011 noted that this was still visible.	FKN04 A103
1C	Sewer outfall and apron across the foreshore, dating to 1883. Originally the outfall of the Ranelagh Sewer and incorporated into the Bazalgette scheme for the Embankment, but enlarged in 1883 to incorporate the outfall of the King's Scholars' Pond Outfall Sewer. Noted by the TAS in the 1990s and also on the MOLA/TDP site visit as part of the Thames Tideway Tunnel project in Spring 2011.	FKN04 A104
1D	Chance find of a post-medieval padlock and a post-medieval mount, recorded by the PAS.	LON-CF02B1 LON-7323A0
1E	Possible post-medieval mooring post represented by a timber recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore. The MOLA/TDP	FKN04 A106

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	site visit as part of the Thames Tideway Tunnel project in Spring 2011 noted that this was still no longer present or visible.	
1F	Royal Hospital Chelsea and Ranelagh Gardens. Grade II registered park. The site of 17th century formal gardens laid out around Sir Christopher Wren's Royal Hospital, Chelsea by George London and Henry Wise. Ranelagh Gardens, to the east, were developed as public pleasure gardens in the mid 18th century but reverted to the Royal Hospital in the early 19th century. Both areas underwent major remodelling in the mid 19th century and retain this form in the 20th century.	DLO32886
1G	Line of the Bazalgette Lower Level Sewer.	---
1H	Chance find of a post-medieval coin recorded by the Portable Antiquities Scheme (PAS).	LON-454BB4
1I	Line of Chelsea Embankment. Unlisted section of the river embankment, dating to the mid to late 19th century.	---
2	Grosvenor Waterside Phase II, Grosvenor Road, Chelsea. 2004 Pre-Construct Archaeology (PCA) watching brief revealed modern backfill of the Grosvenor canal and dock were observed. Natural strata were not reached.	GVW04
3	93 Ebury Bridge Road. 1995 Museum of London Archaeology (MoLAS; now MOLA) evaluation. A complex alluvial sequence was recorded in the estuary formed by the confluence of the former Rivers Westbourne and Tyburn, at the point where they entered the Thames. This included a sandbank from which prehistoric flintwork and pottery had been eroded into an adjacent channel system, which had in turn been influenced by what was probably the main Thames channel. The sequence of erosion and deposition covers an extensive period from the later Mesolithic to the Iron Age and later. In its final stages the channel system became a marsh. Substantial 18th- and 19th-century reclamation deposits overlay the alluvium.	EBR95 083654
4	Western Pumping Station, Grosvenor Road. 2003. Standing building recording. The pumping station was opened in 1875 for lifting the western sewerage into the northern low-level sewer. It comprised brick structures, including an engine and a boiler house, coal vaults, chimney shaft, reservoirs, dwelling houses and sewers etc. A Mess Shed was added against the western boundary wall in the 1880s. In 1967-1970 the former workshops were altered to	GSV03

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	accommodate offices and in 1987-1990 the Western Deep Sewer was constructed, with the associated demolition of the workers' houses and erection of new buildings, including transformer, penstock valves and a control room. Landscaping, with a new roadway, lamp standards and ornamental railing to the central bridge across the cooling pond, was also carried out as part of the 1987-1990 works.	
5	Battersea Wharf. Bronze Age Peat recorded on the Greater London Historic environment Record (GLHER).	MLO22487 / 0211151
6	Chelsea Bridge (area of). The GLHER records the possible site of an early Iron Age / Roman ford and battlefield at this location as well as the chance find of a Neolithic Axe and a Palaeolithic axe.	MLO18386 / 081615 112053 112058
7	The chance find of a post-medieval pot sherd, recorded by the PAS.	LON-80E617
8	The GLHER notes an undated garden soil and post-medieval cobbled road associated with Ranelagh House. Presumably recorded by an unknown archaeological observation.	MLO77056 MLO77058
9	Chelsea Bridge (near). A number of finds are recorded on the GLHER and were presumably dredged from the river: Roman Anchor, two spearheads, a shoe and a sheath ; Bronze Age to Iron Age sword, spear, dagger; Neolithic to Bronze Age vessel and Roman vessel; Iron Age to Roman human remains; Prehistoric lithic implement, Mesolithic lithic implement and Neolithic lithic implement.	MLO180051 12068 112066 112067 112069 112071 112062 112063 112064 112072 112065 112073
10	Battersea Park. Grade II* registered. One of the earliest mid 19th century public parks, much developed in the mid 20th century.	DLO32826
11	A pair of gate piers to the south east of the main buildings at the Royal Hospital. Grade II listed.	1226385
12	Entrance gates (the Bull Ring Gates) on main axis from Chelsea Embankment Royal Hospital. Grade II listed. Circa 1850? Wrought iron gates with stone piers.	1265846

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
13	Lister Institute of Preventative Medicine. Grade II listed.	1066261
14	Sewer vent at western end of Chelsea Bridge. Grade II listed. 1874 for the Metropolitan Board of Works, George Vulliamy supervising architect to the northern outfall sewer extension engineered by Sir Joseph Bazalgette and opened that year. Cast iron columns of great height to draw off vapours from the sewer and distribute their foul odours high above the embankment.	1265101
15	Memorial obelisk, Royal Hospital. Grade II listed. 1849 granite obelisk and WI gates with stone piers.	1226474
16	Entrance Gates at northeast entrance to Battersea Park. Grade II listed.	1225990
17	Chimney to western pumping station behind number 124 Grosvenor Road. Grade II listed.	1357059
18	Chelsea Bridge. Grade II listed. Dates from 1934-7 and was designed by London County Council Engineers under the leadership of Sir T Peirson Frank. Chelsea Bridge is a suspension bridge with a central span of 107.3m, side spans of 52.4m, giving a total length of 212.7m, and is 25m wide. The bridge replaced an earlier suspension bridge, built in the 1850s.	MLO99270List entry Number: 1393009 1393010
19	124 Grosvenor Road. The site of the Western Pumping Station, constructed between 1873-5 in order to lift sewage from the Pimlico, Fulham and Hammersmith areas into the northern Low Level Sewer. It was originally run with a steam powered beam engine.	MLO99521
20	Chelsea Bridge – Grosvenor Bridge. Location of a pontoon recorded by Seazone.	486000006148874
21	The chance find of a medieval horse mount, recorded by the PAS.	LON-0935B5
22	Deposit of peat/organic clay recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FKN04 A107
23	Deposit of peat/organic clay recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FKN04 A108
24	Possible post-medieval mooring and unclassified timber noted by the TAS in the 1990s.	FKN04 A109 A110

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
25	Drain of post-medieval date comprising an outfall with apron recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FKN04 A117
26	Drain of post-medieval date comprising an outfall with apron recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FKN04 A118
27	Post-medieval mooring block represented by possible mooring posts recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FKN04 A119
28	Post-medieval mooring block represented by two pairs of close set vertical timbers approximately 1.5m apart recorded by the 1990s Thames Archaeological Survey on the foreshore beneath Chelsea Bridge.	FWM01 A101
29	An undated Peat/organic clay, recorded by TAS in the 1990s.	FKN04 A111
30	Post-medieval timber barge bed at the foot of river wall, now covered with concrete. Recorded by the 1990s Thames Archaeological Survey on the foreshore by Chelsea Bridge.	FWM01 A102
31	Possible bargebed, recorded by TAS in the 1990s.	FHN04 A112
32	Post-medieval mooring block represented by a line of posts in front of riverfront defence noted by the 1990s Thames Archaeological Survey on the foreshore by Chelsea Bridge.	FWM01 A103
33	Post-medieval mooring block represented by mooring posts or dolphin predating A106 and recorded by the 1990s Thames Archaeological Survey on the foreshore by Chelsea Bridge.	FWM01 A104
34	Post-medieval dock representing the brick and stone entrance to Grosvenor Dock, recorded by the 1990s Thames Archaeological Survey on the foreshore by Chelsea Bridge.	FWM01 A105
35	Post-medieval mooring block represented by one dolphin either side of the dock entrance. Noted by the 1990s Thames Archaeological Survey on the foreshore by Chelsea Bridge.	FWM01 A106
36	Drain of 19th-century date comprising an outfall built into the brick river wall with timber and concrete apron. Recorded by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FWM01 A107

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
37	Drain of 19th-century date comprising four outfalls built into the brick river wall. Noted by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FWM01 A108
38	Grosvenor Pumping Station 19th century outfall drain built into the brick river wall with a timber and concrete apron. Noted by the 1990s Thames Archaeological Survey at Chelsea Embankment foreshore.	FWM01 A109
39	Post-medieval riverfront landing steps comprising a gated closed stair. Noted by the 1990s Thames Archaeological Survey at the north/eastern corner of Battersea Park.	FWW14 A101
40	Post-medieval bargebed with revetted timber, noted by the 1990s Thames Archaeological Survey at the foreshore of Battersea Park.	FWW14 A102
41	Possible post-medieval bargebed noted by the 1990s Thames Archaeological Survey at the foreshore of Battersea Park.	FWW14 A103
42	The chance find of a Bronze Age sword, two Roman coins, a post-medieval token and a post-medieval seal cloth recorded by the PAS.	LON-39AAC1 LON-BC2AD0 LON-45C7D1 LON-87C033 LON-D9EA16
43	Post-medieval mooring feature represented by four vertical timbers, noted by the 1990s Thames Archaeological Survey at the foreshore of Battersea Park.	FWW14 A105
44	Post-medieval outfall with timber revetments, noted by the 1990s Thames Archaeological Survey at the foreshore of Battersea Park.	FWW14 A106
45	Chance find of a post-medieval mount, recorded by the PAS.	LON-ED2A56
46	The Embankment from Battersea Bridge to a point opposite the southwestern corner of the Royal Hospital ground. Grade II listed. Circa 1874. Esplanade retaining wall built of granite with 64 cast iron lamp posts.	1294183

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
47	The site of Chelsea Barracks. A MOLA geoarchaeological watching brief of geotechnical investigations in 2009 revealed a waterlogged area of peat and river and flood deposits, an extinct watercourse and an area that may have been an osier bed.	MLO98889
48	Chelsea Royal Hospital (Grade I Listed Building) – List entry 1226301: The Royal Hospital: Main Hospital Buildings Seven three-storey connected blocks - Founded by Charles II for old and disabled soldiers and built 1682-1702 to the designs of Sir Christopher Wren. Later additions by Sir John Soane and others. The buildings have sustained some war damage. The former burial ground to north-east contains a number of Renaissance tombs. (R.C.H.M. and Survey of London, Vol XI). Main hospital building of dark brick, with red brick dressings, stone quoins at angles, moulded cornices, and slate roofs with dormers. Blocks disposed to form 3 courtyards open to south-east, south-west and north-east respectively. Centre block with stone Roman Doric pedimented portico front and back to vestibule between hall and chapel, surmounted by cupola and one storey colonnade either side of portico on side facing courtyard. North-east and south-west blocks also with stone pedimented central features. Pavilion blocks with pedimented centres.	Listing Number 1226301

E.2 Site location, topography and geology

Site location

E.2.1 The site comprises one irregularly-shaped continuous area c 300m long in total from east to west over the Chelsea Embankment foreshore and Embankment Road, beginning c 65m to the west of Chelsea Bridge. The site is < 115m across from north to south at its widest. The eastern part of the site incorporates the southern boundary of the Grade II registered Ranelagh Gardens, including its boundary wall of brick with iron railings. The part of the Chelsea Embankment riverside wall within the site is thought not to be listed although confirmation of this is awaited. The site falls within the historic parish of St Luke, Chelsea, formerly within the county of Middlesex.

Topography

E.2.2 In general, the topography of this area of the north bank of the River Thames is flat, with a very gentle and imperceptible slope down to the south to the river. The street level of Chelsea Embankment in the north of the main site is flat at *c.* 104.9 ATD (above Tunnel Datum; the equivalent

of 4.9m Ordnance Datum). To the east of this the ground rises up fairly steeply (artificially) towards the northern approach to the Chelsea Bridge, from 105.1m ATD in the west of the eastern site to *c.* 107.5m ATD in the east. Ground levels continue to rise up to Chelsea Bridge, at 109.5m ATD. Within Ranelagh Gardens in the northern part of the site, the ground level in unaffected by landscaping for the bridge approach road, and beyond the garden boundary vegetation is flat, at 104.0m ATD.

E.2.3 The foreshore within the main site comprises shingle with occasional peat and organic clay outcrops. It lies at around 100.3m ATD at the foot of the river wall and drops down to 98.3m ATD at the edge of the foreshore as exposed at low tide. Below low tide level, the permanently submerged riverbed dips to 97.0m ATD along the southern boundary of the site. Evidence of attempts to consolidate the foreshore with concrete was noted during the site visit. Despite this, the foreshore along this stretch of the river appears to be relatively stable in terms of fluvial deposition and erosion, with features noted during the Thames Archaeological Survey (TAS) in the 1990s still being present. The main site is divided by the Bazalgette brick outfall apron, the base of which slopes down from 99.1m ATD to 99.0m ATD.

Geology

E.2.4 The site is situated in an area of alluvial silts and clays overlying sand and gravel deposits associated with the River Thames (British Geological Survey digital data)[1]. It lies at the mouth of the River Westbourne, one of London's 'lost' rivers, which enters the Thames floodplain at the western edge of a large ancient delta associated with the Tyburn and Tachbrook rivers, at their confluence with the Thames.

E.2.5 The Kempton Park river terrace through which these Thames tributaries cut abuts the site on its western extremity, and survives as a remnant 'island' of gravel terrace 400m to the east (the 'Lupus Street Eyot') at the northeastern corner of Chelsea Bridge.

E.2.6 The site's location in respect to the juxtaposition of the high ground of the river terrace and the lower lying floodplain is particularly significant as, upstream of Chelsea Bridge, the floodplain of the Thames narrows to around 400m across, but downstream of the bridge in Westminster, Lambeth and Southwark, it is variably 1km to 2km wide. This will have had a bearing on the character and distribution of alluvial deposits and on the nature of the past environment surrounding the site.

E.2.7 Although the site was likely to have been dry ground in the Early Holocene (around 10,000 years ago), by the late prehistoric and into the historic period the area of confluence would have become increasingly marshy although occasionally subject to flooding (Barton, 1992) [2].

E.2.8 No geotechnical borehole records exist for the site itself, except for three vibro cores on the foreshore. However, there are several modern and detailed British Geological Survey borehole logs in the vicinity of the site. Borehole data close to the foreshore, *c.* 100m to the west of the site[3] indicates sands and gravels lie at around 98.2m ATD, overlain by alluvial clays to *c.* 101.6m ATD, which is overlain by made ground to 103.6m ATD.

Borehole data close to the river *c.* 300m to the east of the site (British Geological Survey borehole no. SR1087)[4] indicates sands and gravels lie at around 97.9m ATD overlain by sand to 98.7m ATD then alluvial clay to *c.* 101.6m ATD, overlain by made ground to 105.9m ATD. It is likely that similar levels of underlying natural gravels and alluvium are present within the site.

E.2.9 The geotechnical borehole *c.* 100m to the west of the site (British Geological Survey borehole no. SR1089)[5], described the alluvial clay that had accumulated over the sand as 'organic with evidence of possible reed beds'. Such alluvium is likely to have potential for the preservation of environmental remains, suitable for reconstructing past landscape characteristics. In addition, silty peats sampled from the foreshore area between 97.2m and 98.2m ATD were dated to the Neolithic (**HEA 1A**), suggesting that in the vicinity of the site there could be a prehistoric landsurface at these levels.

E.2.10 The foreshore and river bed on the site slopes from c. 100.3m ATD close to the land to c. 97.0m ATD into the river. The previous borehole data from the surrounding area suggests that the surface of Pleistocene gravel could lie at around 97.0m ATD, overlain by 4.0-5.0m of alluvium. Thus, at the southern boundary of the site it is unlikely that any deposits of archaeological interest survive below the riverbed, which is likely to lie directly on Pleistocene gravel. Two vibro cores on the foreshore within the site (VC6002 and VC6003) record London Clay at 96.5m ATD to the west and 97.6m ATD to the east, with 0.25m to 0.6m of foreshore gravels with occasional anthropogenic inclusions. Further north, up the foreshore (and beneath the existing river embankment), a thicker sequence of alluvium might exist, and at the base of this sequence (perhaps between about 97.0m and 98.0m ATD), evidence for a prehistoric land surface, that became waterlogged as river levels rose in later prehistory, is likely to survive (as sampled at **HEA 1A**).

E.2.11 It is possible that remains of riverside structures, such as revetments, jetties and platforms of all periods, as well as palaeoenvironmental evidence, could also be sealed within the alluvium.

E.3 Past archaeological investigations within the assessment area

E.3.1 The foreshore within and beyond the site was surveyed in the 1990s as part of the 'Alpha Survey' of the Thames Archaeological Survey (TAS). This noted, within the main site, the existing late 19th century outfall and apron of the Ranelagh Sewer (**HEA 1C**), a possible post-medieval drain comprising a line of timber posts at right angles to the river (**HEA 1B**), a deposit of peat/organic clay, which was sampled and found to be of Neolithic date (**HEA 1A**), and a post-medieval mooring timber (**HEA 1E**). Other than the mooring timber, the MOLA site visit carried out in Spring 2011 noted that these features were still present.

E.3.2 In addition to the foreshore survey, three small scale archaeological investigations have been carried out within the assessment area, all

around 150m to the northeast of the site. These comprise a watching brief (**HEA 2**) and an evaluation (**HEA 3**), and geoarchaeological monitoring at the former Chelsea Barracks site (**HEA 47**). These recorded 20th century remains as well as elements of the alluvial sequence and historic subsurface in the area. As a result of the limited number archaeological investigations, current understanding of human activity is limited, in particular for the prehistoric and Roman periods, for which there is no historical information.

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 Volume 3: Project wide effects, which sets the overall Thames Tideway Tunnel project, and the individual site-specific assessments, within a broader historic environment context (i.e. past landscapes and human activity within such landscapes). It identifies the main route-wide heritage themes, of which the built and buried heritage assets identified within this assessment form a part.

Prehistoric period (700,000 BC–AD 43)

E.4.2 The site is located at a point where the floodplain of the Thames widens from around 400m upstream (of Chelsea Bridge) to 1-2km downstream. The high ground of the river terrace just beyond the northwest corner of the main site, overlooked a mosaic of islands within a network of streams, pools and marshes, which existed across the floodplain, providing a wide range of natural resources. A number of tributaries draining the river terrace entered the floodplain in this area, providing access to the high ground of what is now Hampstead, and the West End north of the Thames, as well as Brixton to the south. In contrast, the northwest of the site was predominantly high dry ground of the river terrace. The location of the site at the interface of these two very different stretches of the river was likely to have been significant to prehistoric and later people. The natural channels would have served as access routes through the forested environment. The broad delta on which the site was located would have provided rich natural resources whilst the higher terrace at the northwestern edge of the site could have provided a focal point for settlement/occupation.

E.4.3 The level of the highest tide is generally higher today than it was in the prehistoric period and prehistoric land surfaces may be exposed at low tide. Plant roots seen in nearby borehole records suggest that vegetation grew across a dry land surface, prior to rising water levels and inundation in later prehistory. The peats identified on the foreshore within the site (**HEA 1A**) are likely to represent the initial waterlogging of a previously dry early prehistoric land surface. Areas of high ground (whether the river terrace or gravel islands in the network of channels in the Thames or its tributaries) could have provided a focus for settlement/occupation within the expanding wetland.

E.4.4 Evidence of this period from the assessment area is limited to residual chance finds only, recovered from the Thames (possibly during dredging), which may reflect the limited amount of past archaeological investigation. For the early prehistoric period these comprise flint and stone tools, such as a Palaeolithic and a Neolithic axe (**HEA 6**), as well as a Mesolithic and a Neolithic lithic (stone) implement (**HEA 9**) found in the area of Chelsea Bridge, 85m to the east of the site. Finds dating to the later prehistoric period comprise a range of metal objects, such as a Bronze Age spear, dagger and vessel and a sword dating to the late Bronze Age or Early Iron Age, as well as Iron Age human remains (**HEA 9**), all recovered from the Thames in the area of Chelsea Bridge. The GLHER notes the possible site of an early Iron Age/Roman ford and battle at this location (**HEA 6**), although this has no supporting information and appears to be speculative based on the aforementioned finds. It is likely that some of the river finds were deliberately deposited in the Thames as votive offerings, possibly during funerary rites, as seen elsewhere along the river.

Roman period (AD 43–410)

E.4.5 During the Roman period, the site lay within low-lying intertidal marshland which was probably frequently flooded. Toward the higher ground at the northwestern edge of the main site, a more transitional zone probably existed between tidal mudflat and seasonally flooded meadow land.

E.4.6 The site lay some distance from known settlements, *c.* 4.6km to the southwest of the Roman city of *Londinium*, which was founded in the mid 1st century AD. A network of roads spread out from the city, and it is thought that one such road followed the line of the Kings Road (Mills and Whipp, 1980)[6], *c.* 750m to the north of the site, possibly to a river crossing in the area of Fulham, *c.* 4.3km to the southwest. The gravel terrace north of the site would have been a rural landscape, possibly used for farming, with a scatter of farmsteads. The riverfront, including the area of the site, may have been exploited for a range of resources in this period, which may have left evidence in the archaeological record (e.g., timber riverfront structures).

E.4.7 Finds from the assessment area comprise residual chance finds from the Thames. The GLHER records two Roman spearheads, a shoe, anchor, sheath and pottery, as well as human remains recovered near Chelsea Bridge (**HEA 9**). The Portable Antiquities Scheme (PAS) database records the finding of two Roman coins (**HEA 42**) from the south bank foreshore c.250m south of the site.

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

E.4.8 The Roman administration of Britain collapsed in the early 5th century AD, and *Londinium* was largely abandoned. The trading port of *Lundenwic* subsequently developed in the area now occupied by Aldwych, the Strand and Covent Garden (Cowie and Blackmore, 2008)[7]. With the Danish invasions of the late 9th century, the old walled Roman city subsequently reoccupied.

E.4.9 The site lay within the manor (estate) of Chelsea [*Chelcehithe, Cealchythe*], first mentioned in the Anglo-Saxon Chronicle, which records

that a church synod was held there in AD 785; more were held there throughout the 8th and 9th centuries. King Alfred may also have held a council at Chelsea in AD 899 (Victoria County History, 2004)[8]. Chelsea may have been a significant Royal estate, conveniently located for river access to the trading centre of London, and was close to the old Roman roads to west and southwest England. At the end of this period it was held by a woman called Wulfwynn; it included arable land, woodland and pasture[9]. The original name seems to derive from the Old English for a landing place, possibly for chalk, stone or lime (Victoria County History, 2004)[10]. The main Chelsea settlement was located in the vicinity of Chelsea Old Church lime (Victoria County History, 2004)[11], (Farid, 2000)[12], *c.* 1km to the southwest of the site, where archaeological evidence of mid and late Saxon occupation has been uncovered.

E.4.10 There is no evidence for any Saxon settlement or activity close to the site, which would have been intertidal foreshore and it was some distance from the main settlement. The adjacent gravel terrace was possibly cultivated or used for pasture. The foreshore of the site may have been used for fishing, and a number of fish traps of this period have been found at several other locations along the Thames in the central London area, although no evidence for such was found on the site walkover survey conducted as part of the present study.

Later medieval period (AD 1066–1485)

E.4.11 The community at Chelsea village was well established during this period. After the Conquest (AD 1066) the manor (estate) was granted to Edward of Salisbury, and it is described in Domesday Book (1086) as including arable land to support five plough teams and nine tenants (Victoria County History, 2004)[13]. In the early 12th century the manor passed to Westminster Abbey, and was subsequently granted by the Abbey to a succession of tenants (Victoria County History, 2004)[14]. The church, close to the Thames on modern Cheyne Walk, *c.* 1km to the southwest of the site, is recorded in documents from 1157, and named as All Saints Church from 1290. Old Church Street, then known as Church Lane, divided two large arable fields, Eastfield and Westfield (Victoria County History, 2004)[15].

E.4.12 As a country location, yet close to Westminster, Chelsea attracted noble or possibly royal residents; in the years around AD1300, a number of royal letters and orders were dated at Chelsea. During the 14th and 15th centuries an increasing number of residents and landowners had occupations in the City or Westminster (Victoria County History, 2004)[16].

E.4.13 Throughout this period the area of the site would have been located on the river foreshore, where there may have been a number of activities such as fishing taking place. A river wall would have been constructed to the north of the site in this period, and intertidal marshes drained and reclaimed and brought under cultivation. The only known site or find of later medieval date within the assessment area, is the findspot of a horse mount (**HEA 21**) found by chance c. 300m to the south of the site.

Post-medieval period (AD 1485–present)

E.4.14 During the Tudor period, riverside settlements were popular as rural retreats for wealthier members of society and, in common with other Thames side villages a number of large riverside mansions were constructed and Chelsea became known as the 'Village of Palaces'. By the Georgian period, Chelsea had grown into a 'garden suburb', and by the middle of the 18th century, there were around 3,000 inhabitants. The main occupations of the area were connected with market gardening and river trade. From the 17th century, the area of the site began to develop, with the construction of the Royal Hospital Chelsea, its gardens, and the Chelsea Embankment. These are discussed separately below and this is followed by a summary map regression of the site.

The Royal Hospital Chelsea

E.4.15 The site lies within the southern edge of the extensive Royal Hospital Chelsea, founded by King Charles II for old, sick or injured soldiers. It was designed by Sir Christopher Wren and was his first grand scale secular commission. The main construction was built in 1682–1691, with continued development until 1702 (Cherry and Pevsner, 1991)[17]. At the time the land was described as 'Next the old College where the Stable Yard is' (Faulkner, 1892)[18]. This was an unsuccessful college of theology established in 1618 by Dr Sutcliffe, Dean of Exeter (Weinreb and Hibbert, 2008)[19].

E.4.16 The main hospital buildings comprised seven three-storey connected blocks (listed Grade I) situated around a central block with two side courts, creating a symmetrical layout either side of the central block. The hospital construction was completed under the Paymaster Richard Jones, 1st Earl of Ranelagh, who embezzled funds for the building of a large house (Ranelagh House to the north of the site) with associated gardens within the hospital grounds (Denny, 1996)[20]. The hospital building remained unchanged except for minor alterations made by Robert Adam in 1765–82, and the stables which were added to the west by Sir John Soane in 1814 (Weinreb and Hibbert, 2008)[21].

E.4.17 The northern part of the site includes the principle entrance to the hospital from the south, originally accessed from river stairs along a tree-lined avenue. In 1850, the existing Grade II listed entrance gates on Royal Hospital Road (**HEA 12**) were added immediately outside of the site, along with a central island within it. A Grade II listed memorial obelisk (**HEA 15**) on the principle hospital approach road beyond the gates, lies c. 75m to the north of the site.

The Chelsea and Ranelagh Gardens

E.4.18 The northern part of the Thames Tideway Tunnel project site extends across the southern boundary of the Chelsea and Ranelagh Gardens (**HEA 1F**), which are Grade II registered. The gardens were designed in c. 1860 by John Gibson as a naturalistic landscape with undulations, mounds and shrubberies, enclosed and separated from the rest of the gardens by iron railings (Cherry and Pevsner, 1991)[22]. This followed extensive changes to the original 17th century landscaped gardens due to

the construction in the mid and late 19th century of the existing Chelsea Embankment to the south, which introduced a separation (a road, low level sewer and a boundary railings/wall) between the gardens and the Thames. On the recommendation of the Director of the Board of Works, the gardens were remodelled and opened to the public in 1849, prior to subsequent landscaping by Gibson.

Chelsea Embankment and Bazalgette's scheme

E.4.19 In the mid and late 19th century two major public works changed the character of the riverfront as it exists today; the construction of the first Chelsea suspension bridge to the east of the site, and the Metropolitan Board of Works' grand scheme to provide London with a modern sewage system.

E.4.20 Construction of the first Chelsea suspension bridge in the 1850s required alterations to both banks of the River Thames. The construction of the riverfront was not timely and delayed the opening of the bridge until 1857 (Victoria County History Old and New London, 1878)[23], (Victoria County History, 2004)[24].

E.4.21 Between 1871 and 1874, the more extensive Chelsea Embankment scheme was built, to a design by Sir Joseph Bazalgette under the Metropolitan Board of Works. The embankment was designed not only to contain the low level intercepting sewer but also to create a grand thoroughfare, three-quarters of a mile in length, to ease the congestion which was an ever increasing feature of expanding Victorian London. The embankment spanning either side of Albert Bridge is statutorily designated Grade II (**HEA 46**), however this designation stops short of (95m west of) the site. The list entry clarifies the extent of the designation: 'The embankment from Battersea Bridge to a point opposite the southwestern corner of the Royal Hospital Grounds, Chelsea Embankment…circa 1874. Esplanade retaining wall built of granite with cast iron lamp posts numbered up to 64 standing on the parapet having decorative feet and shafts and starting at Battersea Bridge and continuing to a spot opposite Chelsea Royal Hospital garden (i.e. on both sides of the Albert Bridge)'.The retaining wall is constructed in a single phase, with only minor repairs.

E.4.22 The unlisted section of the embankment within the Thames Tideway Tunnel project site (**HEA 1I**) is formed of brick topped with a granite parapet and boundary wall with lamp standards located at regular intervals. Further to the east the foreshore retaining wall is capped with a row of granite stones with a wall of blue engineering brick, 14 courses, in English bond, with railings behind. At the Chelsea Bridge approach to the east of the site, the road and pavement angle away from the riverside, and at this point the wall is capped with a row of granite stones.

E.4.23 The funds for the Chelsea embankment were considerably restricted and therefore the ornamentation and detail that is visible to the west, was not continued onto the Chelsea Bridge. The use of Portland cement was instrumental in helping to reduce the cost of construction of the embankment and it is probable that behind the brick façade of the revetment wall, there is a core of Portland cement.

E.4.24 Joseph Bazalgette's son, Edward, described the works (Bazalgette, 1878)[25] and also provides an explanation as to why these did not extend as far east as the Chelsea Bridge: "The balance…was only sufficient to form the embankment and roadway as far as the western end of the Chelsea Hospital gardens and the remainder of the work was abandoned.... The work was commenced in July, 1871, and was finished in May, 1874. It extends from Chelsea Hospital to Battersea Bridge on the northern bank of the river, and is upwards of ¾ mile in length. With the exception of a short length of river not embanked, between Millbank and 360 feet west of the Houses of Parliament, it completes one continuous river embankment extending from Battersea to Blackfriars Bridge, a distance of 4 ½ miles. The works comprised the construction of 4130 lineal feet of river wall formed with granite facing backed with Portland cement concrete. The granite facing, instead of being dressed to a smooth surface as in the other embankments, was hammer-dressed, and the parapet was made of a bolder and less refined contour. It is dressed on the river side to correspond with the general appearance of the wall. The result has been effective at a reduced expense. The total cost of the structural work, including the low level sewer, was £134,000, or about the cost of the whole-tide cofferdam for the Victoria Embankment. The introduction of concrete, in lieu of brickwork, effected a saving in this embankment of £21,000".

E.4.25 The embankment includes a low-level intercepting sewer from Battersea Bridge to Chelsea Hospital (Halliday, 2009)[26] and also an outfall and apron (**HEA 1C**) is located in the centre of the main site. This was originally the outfall of the pre-Bazalgette Ranelagh Sewer, but was expanded and partially rebuilt in 1883 as part of the King's Scholars' Pond Storm Relief sewer. A Grade II listed Bazalgette sewer vent is located at the western end of Chelsea Bridge (**HEA 14**), c. 45m to the southeast of the eastern Thames Tideway Tunnel project site.

Other development within the site from the mid 18th century

E.4.26 In 1723, the Chelsea Waterworks Company founded a pumping station (**HEA 19**) beside the later Chelsea Bridge head, *c.* 100m to the east of the site. It supplied water from the tidal Thames during the 18th and 19th centuries, and fed the reservoirs in Hyde Park and Green Park. In 1902, the Metropolitan Water Board took over the functions of the company (Weinreb and Hibbert, 2008)[27]. The extent of the Chelsea Waterworks during the 18th century is shown on Rocque's map of 1746 (Vol 13 Plate E.1) and Horwood's map of 1799 (Vol 13 Plate E.2).

E.4.27 Rocque's map of 1746 (Vol 13 Plate E.1) shows the site located within the River Thames, prior to the Chelsea Embankment works described above, probably on what was then the foreshore. A number of linear features are shown to the northeast (outside) the site, later annotated 'osier beds' (Osiers (willows) were grown for basket-making). To the north of the site lie the extensive grounds of the Royal Hospital Chelsea, and also Ranelagh Gardens, which were at the time pleasure gardens. The map shows an open watercourse, the Ranelagh Sewer, extending towards the

main site. This was subsequently incorporated into the Bazalgette system and currently outfalls via a drain within the site.

E.4.28 Horwood's map of 1799 (Vol 13 Plate E.2) shows the site located in the River Thames, with the extensive osier beds to the northeast. As on Rocque, the map shows the riverfront set back further north of the site than it is today, with the gardens and grounds of the Royal Hospital and the Ranelagh Gardens beyond.

E.4.29 The Ordnance Survey 1st edition 25" map of 1868–82 (Vol 13 Plate E.3) shows the site much as it is today, with the southwards extension of the riverfront to its present position with the construction of the Chelsea Embankment, and the existing Ranelagh Gardens boundary.

E.4.30 The Ordnance Survey 2nd edition 25" map of 1896–99 (Vol 13 Plate E.4) shows a jetty in the main site, named Victoria Pier. The foreshore within the site is labelled as 'sand' and the low tide watermark is shown to the south. The map shows the outfall on the foreshore within the site (**HEA 1C**).

E.4.31 The Ordnance Survey 3rd edition 25" map of 1909 (Vol 13 Plate E.5) no longer shows Victoria pier within the site. The site is mostly located on the foreshore with the river wall in its northern part. Subsequent OS maps up to the present day show no change within the site.

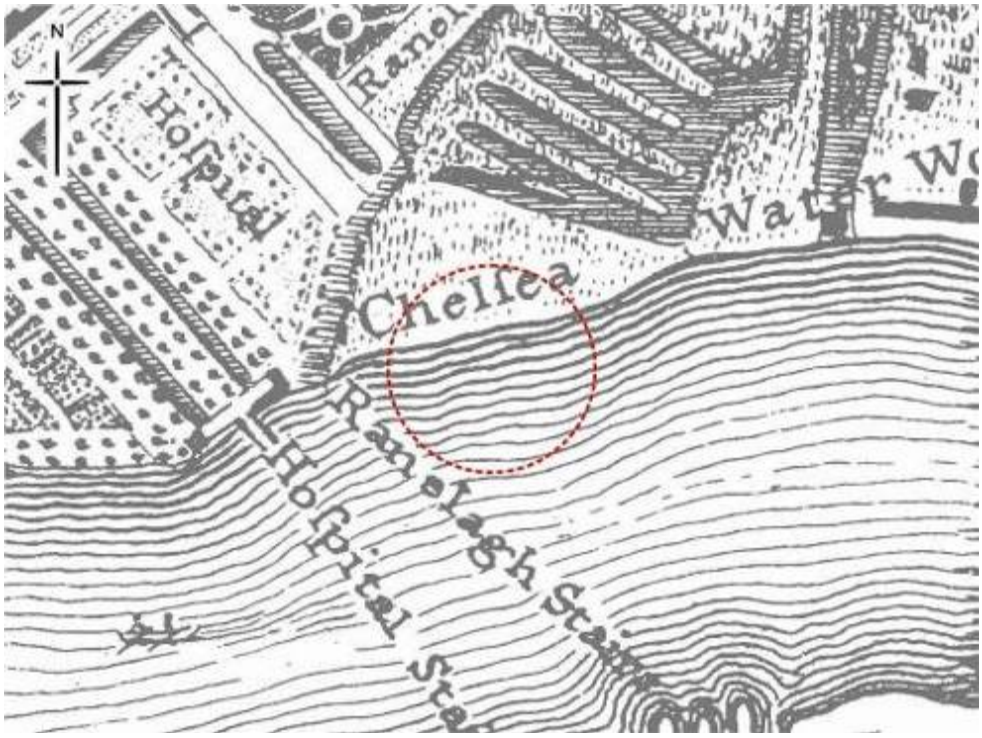
E.4.32 In 1934–37, the existing Grade II Chelsea Bridge (**HEA 18**) was built, c. 60m to the east of the site. This self–stabilising suspension bridge replaced the earlier 1850s bridge. It was designed by London County Council Engineers under the leadership of Sir T Peirson Frank. Similar in form to the earlier structure, it is of unusual design and marked a major British breakthrough in the design of bridges and use of high tensile steel, building from work undertaken by Continental and American engineers.

The current site

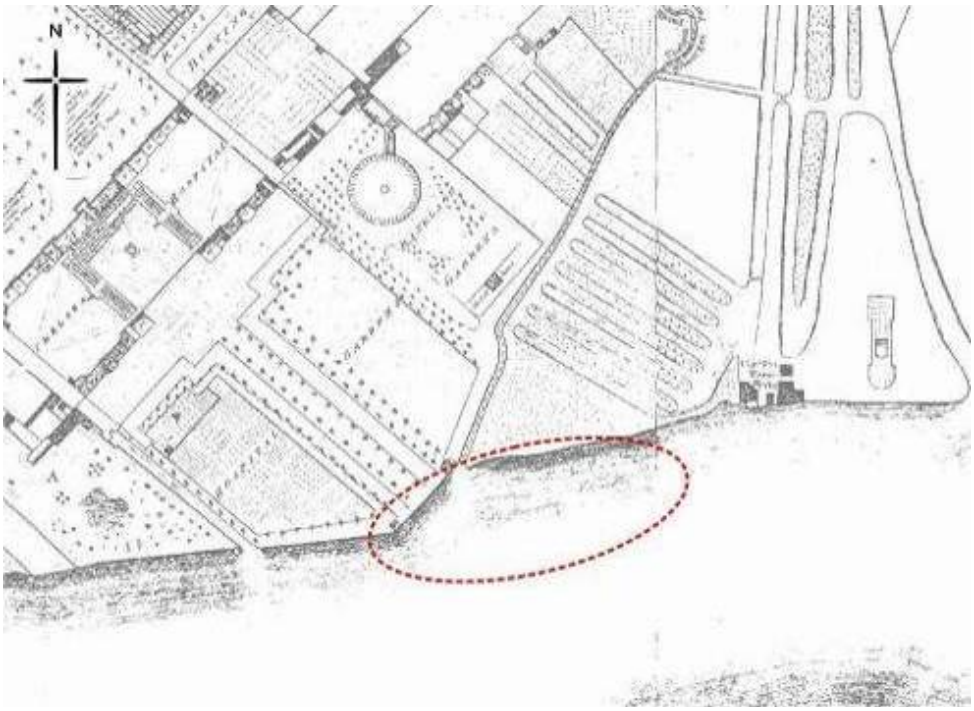
E.4.33 At low tide a large proportion of the site is a foreshore area of shingle. A number of attempts to consolidate the foreshore with concrete were noted on the site walkover survey. Unclassified timber post structures (possibly jetty, causeway or drain remains) were also identified (Vol 13 Plate E.10), along with some small areas of peat or organic clay (Vol 13 Plate E.9). The site also includes an unlisted section of the Chelsea embankment (Vol 13 Plate E.8) and riverside wall. The eastern part of the site includes an area of trees immediately to the north of the Chelsea Embankment road, and includes part of the southern boundary of the Ranelagh Gardens, including a 30m wide section of its brick-built boundary wall (Vol 13 Plate E.12).

E.5 Plates

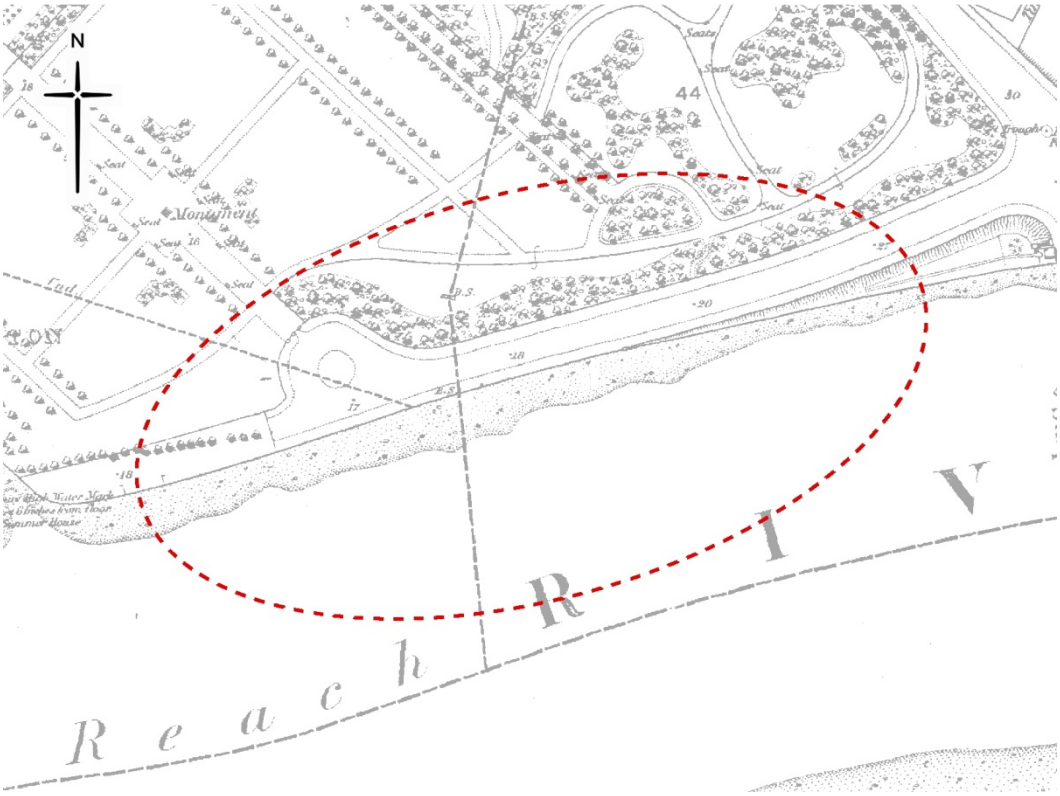
Vol 13 Plate E.1 Historic environment – Rocque's map of 1746



Vol 13 Plate E.2 Historic environment – Horwood's map of 1799

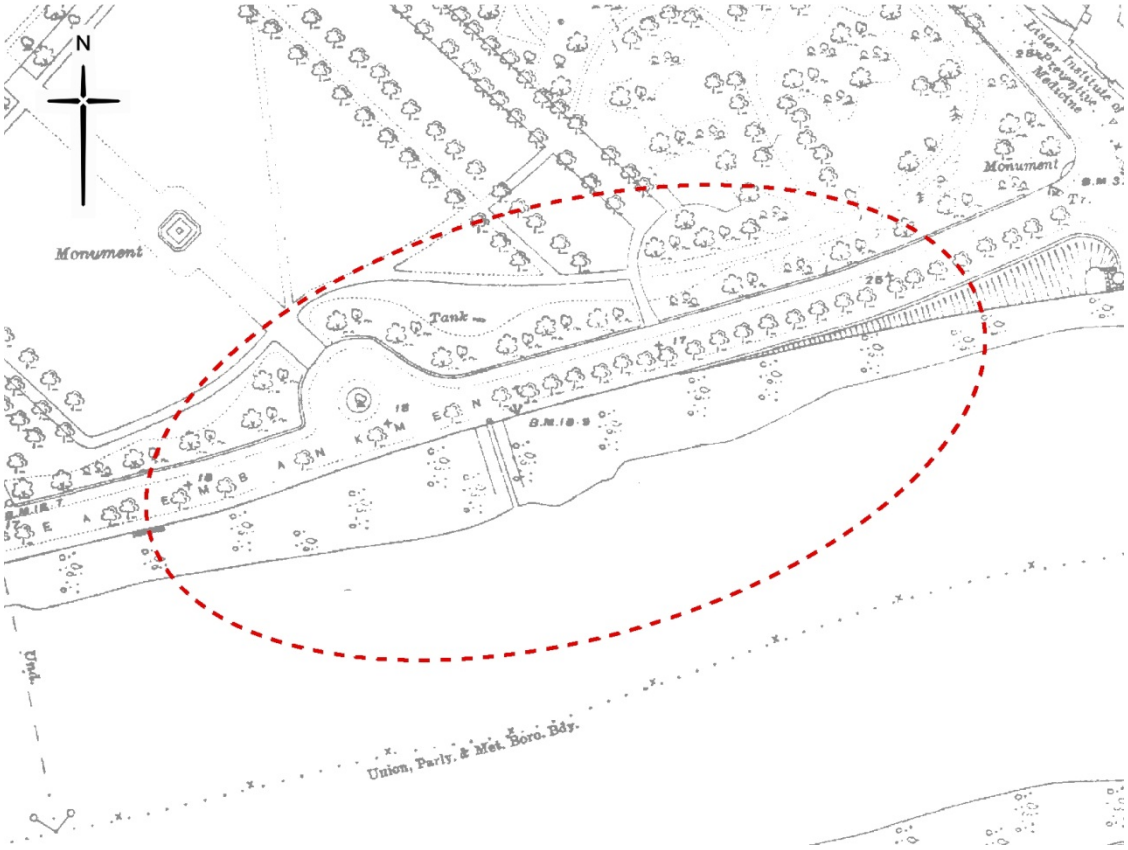


Vol 13 Plate E.3 Historic environment – OS 1st edition 25” scale map of 1868–82 (not to scale)



Vol 13 Plate E.4 Historic environment – OS 2nd edition 25” scale map of 1896–9 (not to scale)

Vol 13 Plate E.5 Historic environment – OS 3rd edition 25" scale map of 1909 (not to scale)



Vol 13 Plate E.6 Historic environment – View of the Chelsea Embankment towards the Chelsea Bridge looking east; standard lens

Vol 13 Plate E.7 Historic environment – View of the Grade II listed embankment (HEA 46) to the west of the site, from the foreshore within the site, looking west; standard lens

Vol 13 Plate E.8 Historic environment – View of the unlisted embankment wall with the Chelsea Bridge in the background; from the foreshore, looking northeast; standard lens

Vol 13 Plate E.9 Historic environment – Deposit of peat/organic clay (HEA 1A) in the main site. First noted by the TAS in the 1990s; standard lens

Vol 13 Plate E.10 Historic environment – Unclassified structure comprising a line of timber posts at right angles to river, possibly representing a drain of post-medieval date (HEA 1B). First recorded by the TAS in the 1990s; view northwest; standard lens

Vol 13 Plate E.11 Historic environment – View of the storm outfall tunnel and apron (HEA 1C) in the retaining wall from the foreshore looking north; standard lens

Vol 13 Plate E.12 Historic environment – Southern boundary of the Grade II registered Royal Hospital and Ranelagh Gardens looking northwest; standard lens

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea Embankment Foreshore appendices

Appendix F: Land quality

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

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Thames Tideway Tunnel

Environmental Statement

Volume 13 Chelsea 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, including historic maps and environmental records

c. stakeholder consultation

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

Site walkover

F.1.2 A site walkover was undertaken on 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 The construction site comprises an area of foreshore, the adjoining river wall and part of the highway as well as the soft landscaped area just to the north of the highway.

F.1.5 No potential contaminative sources were identified during the survey and no tidal outflows were visible within the river wall at the time of the survey.

F.1.6 Detailed site walkover notes are provided in Vol 13 Table F.1 below.

Vol 13 Table F.1 Land quality – site walkover report

Item (Site ref: C14XJ, Chelsea Embankment Foreshore)		Details
Date of walkover	4th November 2010	
Site location and access	On the foreshore of the River Thames to the west of the junction of Chelsea Embankment (A3212) and Chelsea Bridge Road (A3216). Access across the entirety of the site.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	The foreshore area is relatively wide and at low tide sand and gravel deposits are visible. Area to the north of the highway comprises soft landscape (entrance to Ranelagh Gardens).
Neighbouring site use (in particular note any potentially	North	The surrounding area is largely suburban residential. The closest properties are

Item (Site ref: C14XJ, Chelsea Embankment Foreshore)		Details
contaminative activities or sensitive receptors)		The Lister Hospital and grounds and residential properties located on Chelsea Bridge Road and Ranelagh Gardens/Royal Hospital Chelsea Grounds.
	South	Bordered by the River Thames.
	East	Chelsea Bridge is located east of the proposed worksite. River Thames located east
	West	Suburban residential area and the River Thames.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	None
Surfacing	Record type and condition	Sand and gravel in main construction area. Planting in northern area.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	The embankment area above the river wall is heavily vegetated. (NB: It is understood Japanese Knotweed has been identified directly adjacent to the site)
Services	Evidence of buried services?	None observed
Fuels or chemicals on-site	Types/ quantities?	None observed
	Tanks (above ground or below ground)	None observed
	Containment systems (eg, bund, drainage interceptors). Record condition and standing 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

Item (Site ref: C14XJ, Chelsea Embankment Foreshore)		Details
Waste generated/stored onsite	Adequate storage and security? Fly tipping?	None observed
Surface water	Record on-site or nearby standing water	River Thames
Site drainage	Is the site drained, if so to where? Evidence of flooding?	No tidal outflows were 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		No potential contaminative sources were identified during the survey.
Any other comments	Eg, access restrictions/ limitations	No

Review of historical contamination sources

F.1.7 Historical mapping (dated between 1874 and 1975) has been reviewed in order to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.8 Vol 13 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.1.9 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.1.10 Items listed in the table below are also shown on Vol 13 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 13 Appendix E.

Vol 13 Table F.2 Land quality – potentially contaminating land-uses

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
On-site			
None			
Off-site			
1	Timber yard (165m northeast)	c1874-c1896	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, polyaromatic hydrocarbons (PAHs), cresols
2	Timber yard (110m northeast)	c1875-c1896	
3	Dock (115m northeast)	c1896-c1975	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, polychlorinated biphenyls (PCBs), sulphides, sulphates, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
4	Battersea Wharf (215m southeast)	c1896-c1975	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
5	Disinfection station (140m northeast)	c1916-c1973	Pathogens, medical wastes, glycol, alcohols
6	Lister Hospital (90m northeast)	c1896 - present	Potential for PAHs, heavy metals, oils associated with boilers/ incinerators. Also radioactive substances associated with x-ray facilities
7	(a) Saw mill and iron works (155m northeast)	c1916	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs, cresols
	(b) Corporation Depot (155m northeast)	c1950-c1975	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
8	Depot (120m northeast)	c1973	
9	Electrical substation (220m	c1973	Oils, PCBs

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
	southeast)		
10	Western Pumping Station and Engine House (160m northeast)	c1916-c1972	Heavy metals, arsenic, free cyanide, nitrates, sulphates, sulphides, asbestos, oil/fuel hydrocarbons, chlorinated aliphatic hydrocarbons, chlorinated aromatic hydrocarbons, PCBs, pathogens
11	Rail bridge (240m east)	c1880	PAHs, heavy metals, phenols, sulphates, fuel/oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons

On-site

F.1.11 The historical mapping has identified no significant contaminative on-site uses.

Off-site

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

F.1.13 The nearest current potential contamination source relates to the Lister Hospital located approximately 90m northeast from the site, this is not considered to be a significant ongoing pollution source that may affect the site.

Geology

F.1.14 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 13 Table F.3 below.

Vol 13 Table F.3 Land quality – anticipated site geology

Geological Unit/ Strata	Description	Approximate depth below river bed level (m)
Alluvium	Soft and firm sandy slightly gravelly clay with occasional shell fragments	0.00-1.40
River Terrace Deposits	Medium dense to dense to dense sand and gravel (predominantly quartz sand and flint gravel).	1.40-4.25
London Clay	Silty clay with pockets of selenite crystals and partings of fine sand/silt.	4.25-41.6
Harwich Formation	Sand and shelly sandstone	41.6-41.7

Geological Unit/ Strata	Description	Approximate depth below river bed level (m)
Lambeth Group (Upper Shelly Beds)	The Lower and Upper Mottled Beds are mottled or multicoloured, stiff or very stiff fissured clay, compact silt, and dense or very dense sand. The Upper Shelly Clay is mainly a grey shelly clay, and occasionally a 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 Clay 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 Upnor Formation comprises silty glauconitic sand.	41.7-44.1
Lambeth Group (Upper Mottled Beds)		44.1-49.8
Lambeth Group (Laminated Beds/ Lower Shelly Beds)		49.8-51.3
Lambeth Group (Lower Mottled Beds)		51.3-55.8
Lambeth Group (Lower Mottled Beds - Gravel)		55.8-58.2
Lambeth Group (Upnor Formation)		58.2+

Unexploded ordnance

F.1.15 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.1.16 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited at the Chelsea Embankment Foreshore site (see Vol 13 Appendix F.3). The assessment covered two areas within the Chelsea Embankment Foreshore site (Area A – land aspect of work area and Area B – foreshore and river of work area. The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.17 The report advises that no high explosive bomb strikes occurred within the proposed construction areas, however one bomb strike occurred within the buffered site boundary and a further five within 100m of the buffered site boundary.

F.1.18 Taking into account the findings of this study and the known extent of the proposed works at the Chelsea Embankment Foreshore site, it was considered that within Area A there is an overall low/medium threat from UXO and within Area B there is a high threat from UXO.

Thames Tideway Tunnel ground investigation data

F.1.19 This section summarises the ground investigation undertaken by the Thames Tideway Tunnel project.

F.1.20 Vol 13 Figure F.1.2 (see separate volume of figures) identifies boreholes excavated in the 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 No contamination testing was undertaken within the terrestrial limits of the site. Refer to F.1.25 for sediment quality within the foreshore environment.

Soil gas testing

F.1.22 No soil gas testing was undertaken within the site.

Groundwater contamination data

F.1.23 No notably elevated levels of contamination were recorded in the shallow River Terrace Deposits aquifer in the vicinity of the site.

F.1.24 Refer to Section 13 Water resources – groundwater of this volume for further information.

Sediment quality testing

F.1.25 An investigation into the sediment quality at the Chelsea Embankment Foreshore site was undertaken by the Port of London Authority (PLA) hydrographic department in December 2011 (Port of London Authority, 2011)[3]. A report on the findings is presented in Mott MacDonald Limited *Thames Tunnel Foreshore Sediment Quality Interpretative Report (*Mott MacDonald Limited, 2012)[4].

F.1.26 Three samples of sediment taken from the foreshore of the River Thames at the Chelsea Embankment Station were sent for laboratory analysis.

F.1.27 The testing showed relatively low levels of PAHs and metals within the foreshore sediments which are typical of the sediments along the tidal River Thames. These contaminants reflect the former industrial nature of the river and are present as they tend to bind with soils.

F.1.28 None of the samples exceeded the residential screening criteria for metals, semi-metals or petroleum hydrocarbons, however seven PAH compounds were found to exceed the residential soil screening values in either one or two samples. No samples recorded any contaminants above the light industrial/commercial soil screening criteria.

F.1.29 These results are not elevated in terms of risk to human health but slightly elevated over PLA approved sediment quality guideline.

F.1.30 Refer to Volume 2 Environmental assessment methodology for full guidance on the benchmarks used.

Third party ground investigation data

F.1.31 No third party ground investigation data was available for review for the Chelsea Embankment Foreshore site

Other environmental records

F.1.32 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 13 Table F.4. Pertinent records are discussed in further detail below.

F.1.33 The location of these records is shown on Vol 13 Figure F.1.3 (see separate volume of figures).

Vol 13 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	0
Licensed waste management facility	0	0
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	0	There are a number of areas classified as past potential contaminated industrial uses within 250m of the site.
Pollution incident to controlled water*	0	8
Registered waste transfer site	0	1
Registered waste treatment or disposal site	0	0

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

F.1.34 Inspection of the data has identified no on-site hazard and waste sites at Chelsea Embankment Foreshore site.

F.1.35 Within 250m of the Chelsea Embankment Foreshore site, inspection of the data has identified areas of past potential contaminated industrial use.

F.1.36 The majority of these past potential contaminated industrial uses are located northeast of the site, with a further much smaller area to the southeast. It can be inferred from historical mapping that these relate to the Lister Hospital and the Grosvenor Canal, adjacent to the Grosvenor Waterside building. This was the site of former wharves and areas of industrial activity, as shown on Vol 13 Figure F.1.1 (see separate volume of figures). Contaminants associated with these types of previous land-use are identified in Vol 13 Table F.2.

F.1.37 There are also eight pollution incidents to controlled waters within 250m of the site, five of which are located at various points along the River Thames with a further three in and around Ranelagh Gardens. These relate to pollution with oils and sewage but do not include the regular CSO discharges at the site.

F.1.38 Other than CSO spills, information provided by the Royal Borough of Kensington and Chelsea (RBKC) identifies several sewage overflow incidents in the last ten years within the vicinity of Chelsea Embankment Foreshore site. Only two of these have been classified as major or significant. The Council has also identified one minor inorganic chemical pollution incident at the location of Grosvenor Docks in 2009.

F.1.39 One registered waste transfer site is recorded within the assessment area.

Land quality data from local authority

F.1.40 The RBKC was consulted in relation to data on land quality that the Council holds in respect of the site and search area.

F.1.41 The Council provided no additional data beyond that already reviewed and commented on as part of the baseline study. The response from the Council is provided in Section F.2.

Summary of contamination sources

F.1.42 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. historic contamination of foreshore sediments – minor metals and PAH contamination of soils/sediments in comparison with PLA guidance for protection of aquatic organisms

b. potentially elevated levels of lead and PAH can be associated with near surface soils adjacent to highways which are associated with atmospheric deposition from vehicle emissions

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

d. potential UXO

e. Japanese Knotweed present directly adjacent to the site.

F.1.43 There were no other viable off-site contamination sources identified.

F.2 Local authority consultation

Housing Health and Adult Social Care
Council Offices, 37 Pembroke Road, Kensington, LONDON, W8 6PW

Executive Director Housing Health and Adult Social Care
Ms Jean Daintith

Director of Environmental Health
Mr Paul Morse

Mott MacDonald House
8-10 Sydenham Road
Croydon
CR0 2EE

28th January 2011
My reference: 11/095812
Your reference:
Please ask for:Davene chatter- Singh or Ashley Smith

Dear Ms C Peretti – (fao Mr D. Giordanelli)

Chelsea Embankment Foreshore - Environmental Information

Thank you for your enquiry and cheque for **£ 96.85**. A search of our records has highlighted a past industrial use within 250m of the proposed development area.

Our records show adjacent land within 250m of the proposed development area to have had a potentially contaminative land use since the mid 1800's. Records show that an area to the N of the proposed development area is a hospital with associated grounds, parks and garden spaces. The hospital site is still in current use. Land to the N of the proposed development area is classified as Grade II recreational parks and gardens- The Royal Hospital and Ranelagh Gardens .

Potentially contaminative land uses
The following table has been produced from information extracted from our digitised historical maps (up until 1996, plus 2002 Landline map) and tanks database. **Table 1** below and attached maps show that there is one recorded former industrial use within **250m** of the property.

Table 1

No	Industry	Date	Address	Distance and direction from property
1	Hospital	1843-present	Royal Hospital, Royal Hospital Road	247 m NNW

Entries from Kelly's directories
Our records indicate that there are no registered industries in the Kelly's Kensington and Chelsea Trade Directories (from 1890, 1935, 1953).

Planning Records
A search of the Borough's planning records indicate that no planning permissions exist from 1948 to the present day (no planning records are available prior to 1948).

Part 2A of the Environmental Protection Act
The Chelsea Embankment Foreshore development area has **not** been designated as Contaminated Land under Part 2A of the Environmental Protection Act 1990 (EPA). The Royal Borough of

Kensington and Chelsea have not designated any sites as Contaminated Land under the regulations and have not served any remediation notices to date.

Under Part 2A of the EPA (1990), the council has a duty to investigate all sites in the Borough with a former industrial use. This site is not currently on our priority list of sites to investigate.

Part of the proposed development area is due to be redeveloped. The Environmental Health department has been involved with initial plans for the site and will ensure that any contamination found is remediated to the necessary standard. It is likely that when the redevelopment occurs the process will be regulated through planning conditions.

Radioactive substances
There are no entries on our Radioactive Substances Register at the site or within 250 metres of the proposed evelopment area.

Part B Processes
There are no Part B Process authorisations licensed to the site or within 250m of the proposed development area.

Waste Sites:
Our records indicate that there are no waste sites present at the site or within 250m of the proposed development area:

Landfill sites
We hold no records of any active or historical landfill sites in the Royal Borough of Kensington and Chelsea.

Licence abstractions
Our records show the following licensed abstractions at the site and within 250m of the proposed development area:

Licence Number 28/39/39/0225. Original_Effective_Date 21/12/2006. Expiry Date 31/03/2013. Start date 01/04/2008. License holder Royal Horticultural Society, 80 Vincent Square, London, SW1P 2PE. Agriculture. Horticulture and nurseries. Spray irrigation – direct. Ranelagh Gardens, Royal Chelsea Hospital Gardens, Chelsea Embankment. Thames groundwater. Ranelagh Gardens- borehole. abstraction start 01/10. abstraction end 30/09. ngr tq28487794

Licence Number 28/39/39/0227. EA LEAP THAMES TIDEWAY AND ESTUARY LEAP. Original Effective Date 07/12/2006.Expiry Date 31/03/2016. Start date 07/12/2006. Licence holder St James Homes (Grosvenor Dock)Ltd. Berkeley House, 19 Portsmouth Road, Cobham, Surrey, KT11 1JG. Industrial, Commercial And Public Services. Subpurpose Navigation. Make-Up Or Top Up Water. Grosvenor Waterside, Gatliffe Road, London. Thames Surface Water – tidal. River Thames at Grosvenor Waterside, Gatliffe Road, London. Abstraction Start 01/01. Abstraction End 31/12. NGR TQ28607798.

Discharge consents
Our records show the following discharge consents at the site and within 250m of the proposed development area:

DEPOT AT GATLIFF ROAD, LONDON, SW1. REVOKED 01/02/2005. Undefined discharge or Other. NGR TQ2850078000

WESTERN PS LOW LEVEL SEWER, LONDON. Revoked n/a.Sewerage Network - Pumping Station - water company. NGR TQ2868077940

SLOANE STREET, RANELAGH GDNS, LONDON. Revoked n/a. Sewerage Network - Sewers - water company. NGR TQ2829077850

Smith Street, Chelsea Embankment. Revoked n/a. Sewerage Network - Sewers - water company. NGR TQ2811077790

SMITH STREET, LONDON. Revoked n/a. Sewerage Network - Sewers - water company. NGR TQ2811077891

Pollution Incidents
Our records indicate that the following pollution incidents have occurred at the site and within 250m of the proposed development area:

07/10/2001. Chelsea Bridge. Category 3 (Minor). Other Cause. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

26/04/2002. Chelsea Pumping Station, 124 Grosvenor Road, London. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

10/06/2002. Chelsea Bridge. Category 3 (Minor). Natural Causes. Other Extreme Weather Conditions. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

09/07/2002. Western Pumping Station, Grosvenor Road, London. Category 3 (Minor). Natural Causes. Flooding. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

21/08/2002. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

02/11/2002. Chelsea Bridge. Category 3 (Minor). Natural Causes. Flooding. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

31/10/2003. Tidal Thames (Battersea Reach). Category 3 (Minor). Natural Causes. Other Extreme Weather Conditions. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

21/11/2003. Initially Western Pumping Station. Category 1 (Major). Authorised Activity. Consented Works on Land. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

03/05/2004. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

21/10/2005. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Sewage Treatment Works. Sewage Materials. Storm Sewage

24/10/2005. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

08/03/2006. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

30/03/2006. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

02/04/2006. Chelsea Bridge. Category 4 (No Impact). Authorised Activity. Other Authorised Activity. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

01/05/2006. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

24/08/2006. Chelsea Bridge. Category 3 (Minor). Authorised Activity. Other Authorised Activity. Water Industry. Combined Sewer Overflow. Sewage Materials. Storm Sewage

13/09/2007. Royal Hospital. Category 4 (No Impact). Fires. Other Fire. Atmospheric Pollutants and Effects. Smoke

15/01/2008. Chelsea Bridge. Category 3 (Minor). Natural Causes. Flooding. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

27/06/2009. Chelsea Bridge. Category 2 (Significant). Authorised Activity. Other Authorised Activity. Water Industry. Pumping Station. Sewage Materials. Storm Sewage

30/09/2009. Grosvenor Dock. Category 3 (Minor). Cause Not Identified. Not Identified. Inorganic Chemicals/Products. Other Inorganic Chemical or Product

For further information relating to pollution incidents please contact the Environment Agency on their general enquiries number 08708 506 506.

Summary
Please note that Kensington and Chelsea Council has provided the above reply based upon data currently available to the Council and only within the Royal Borough of Kensington and Chelsea boundary limits. This data set is not yet complete and is continually being updated and reviewed. Therefore, the above information may be changed upon the receipt of additional data and no warranty can be given as to the accuracy or completeness of the information provided. Any previous developer of the site would have had responsibility for land contamination issues and may have further information.

Our Contaminated Land Inspection and Remediation Strategy is available for viewing and downloading on our website at http://www.rbkc.gov.uk/environmentandtransport/landquality.aspx. If you have any further questions do not hesitate to contact me on the number below.

Yours sincerely,

Miss Davene chatter-Singh
Assistant Environmental Pollution Officer

Environmental Quality and Public Health Team

F.3 Detailed Unexploded Ordnance (UXO) risk assessment

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PKC4X – Chelsea Embankment Foreshore
Document Number: 336-RG-TPI-PKC4X-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R7_V1.0
Date: 18th May 2012

Originator: Max Chainey (18th May 2012)
Quality Review: Lisa Askham (22nd May)
Released by: Lee Gooderham (23rd May)

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Figures

EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as Work Area PKC4X, located at National Grid Reference "528307, 177834". For the purposes of this report, the Site has been divided into **AREA A** (Land aspect of Work Area) and **AREA B** (Foreshore and river of Work Area).	
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • **AREA A** is situated on what was a public highway during World War Two (WWII). **AREA B** overlaps the foreshore of the *River Thames*. • Whilst no WWII bombing targets have been identified within **AREA A or B**, the "*Battersea Power Station* located 470m to the southeast of the Site was a primary bombing target. • *Chelsea Metropolitan Borough*, where the Site is located, experienced a bombing density of 343 High Explosive (HE) bombs per 1,000 acres. This is a relatively high bombing density for *London*. • No HE bomb strikes occurred within the Work Area, however one bomb strike occurred within the buffered Site boundary and a further five HE bomb strikes were recorded within 100m of the buffered Site boundary. • Bomb damage was not recorded within the Work Area or buffered Site boundary, however this can be explained by the lack of structural developments within the area. • The Site has not been developed since WWII and thus is unlikely to have removed buried UXO items. Additionally, UXB entry holes within **AREA B** are unlikely to have been witnessed and recorded. 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	**AREA A** **LOW/MEDIUM**	**AREA B** **HIGH**
Recommended Risk Mitigation	**The following actions are recommended before undertaking any activity on the Study Site:** **ALL AREAS** **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. **AREA B** **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 PKC4X. The Site is located at National Grid Reference 528307, 177834. For the purposes of this study, a 50m assessment radius will be applied to the work area to provide flexibility should it need to be relocated. Additionally, the Site has been divided into **AREA A and B** for the purpose of this report. See *Figures 1* and *2* for the Site location and area divisions.
Location Description ***(Figure 3)***	The Work Area is situated to the southwest of the *City of London* within the *Chelsea Metropolitan Borough*. Current aerial photography has identified the following within each area: **AREA A:** A public highway. **AREA B:** The *River Thames* and foreshore.
Proposed Engineering Works	*Thames Water* have specified a summary of the proposed engineering works, including working draft plans with drawing no. 100-DA-CNS-PKC4X-254105_AF; 100-DA-CNS-PKC4X-254106_AF; 100-DA-CNS-PKC4X-254107_AF; 100-DA-CVL-PKC4X-354020_AF; and 100-DA-CVL-PKC4X-354021_AE. These works have been divided between **AREAS A and B**, however where not explicitly stated, 6 Alpha has made an assumption of which area the work will be carried out. **Area A** • Underground chambers and ventilation ducts. **Area B** • A 12m internal diameter combined sewer overflow (CSO) drop shaft, approximately 50m deep. • A 4m diameter (reducing to 3m) 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	1.40
River Terrace Deposits	1.40	2.85
London Clay	4.25	37.35
Harwich Formation	41.60	0.10
Lambeth Group	41.70	17.60

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 – AREA A** is located on land developed as a public highway only. **AREA B** contains no structures, and has a prominent foreshore. **1949 OS mapping –** There are no significant or noticeable changes to the areas.
1945 Aerial Photography ***(Figure 4)***	**ALL AREAS:** The 1945 aerial photography confirms the Site remained unchanged pre- and post-WWII.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	**ALL AREAS**: Primary targets have been identified as *Battersea Power Station* located approximately 470m to the southeast of the buffered Site boundary, "gas holders" located 625m to the southeast and "gas works" located 1km to the southeast. "Opportunistic" targets include railway stations and railway infrastructure, "depots", "goods sheds", "docks" and "wharves" all located within 2km of the Site. Additionally, *Chelsea Barracks* is located 115m to the north of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate the following: **AREA A:** No bomb strikes. **AREA B:** No bomb strikes. One bomb strike occurred within the buffered Site boundary and five strikes occurred within 100m of the buffered Site boundary.
WWII Bomb Damage ***(Figure 7)***	*London County Council* (LCC) bomb damage maps indicate the following: **AREA A**: No bomb damage. **AREA B:** No bomb damage. No bomb damage was recorded within the buffered Site boundary. Bomb damage was typically only recorded for building structures and not for damage sustained by land features. This may explain the lack of damage recorded within and around the Site, as no building structures are present.
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located within the *Chelsea Metropolitan Borough,* which recorded 343 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 within 1,000m of the Site.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	**AREA A:** No; the ground was developed as a public highway. **AREA B:** Yes; this area overlaps the *River Thames* and was undeveloped.
Is there a reason to suspect that the immediate area was a bombing target during WWII?	**ALL AREAS:** Yes; this Site is surrounded by numerous primary *Luftwaffe* bombing targets and sits 115m to the south of *Chelsea Barracks*.
Is there firm evidence that ordnance landed on Site?	**AREA A:** No. **AREA B:** No; but unlikely to have been recorded given the environment. However, there is evidence of one bomb strike within the buffered Site boundary.
Is there evidence of damage sustained on Site?	**AREA A:** No. **AREA B:** No. However, photographic evidence suggests bomb damage to the underside of *Chelsea Bridge* located approximately 100m to the east of the Site.
Is there any reason to suspect that military training may have occurred at this location?	**ALL AREAS:** Whilst the active WWII *Chelsea Barracks* are located only 115m to the north of the Site, there is no reason to suspect that they used the *Chelsea Embankment* and foreshore for military training.
Would an UXB entry hole have been observed and reported during WWII?	**AREA A:** Yes; the land was used for a public highway during WWII, and no bomb damage was recorded within this area that may have created debris. Therefore an UXB entry hole is likely to have been witnessed and recorded. **AREA B:** 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?	**ALL AREAS:** The most likely source of UXO contamination is from *German* aerial delivered ordnance, which ranges from small incendiary bombs through to large HE bombs (of which the latter forms the principal threat).
Would previous earthworks have removed the potential for UXO to be present?	**AREA A:** No; no significant earthworks have occurred. **AREA B:** No; no significant earthworks have occurred.

STAGE FOUR – RISK ASSESSMENT		
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	Considering the general ground conditions (highlighted in Stage 1) including the potential depth of made ground and the hard surface geology within **AREA A**, the most likely Bomb Penetration Depth (BPD) for a 250kg bomb is assessed to be a maximum of 4m bgl, dependant on the depth of rock. As the boundary of **AREA B** 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. Therefore, the most likely BPD for a 250kg bomb is assessed to be a maximum of 7m bgl, dependant on the depth of rock. 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, therefore 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	AREA A		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	2x1=2	3x2=6	2x6=12

Activity	AREA B		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	2x1=2	3x2=6	2x6=12
Tunnelling	1x2=2	1x2=2	2x2=4
Shaft Installation	2x2=4	1x2=2	4x2=8
Open Excavations	2x2=4	2x2=4	4x4=16
Cofferdam (Sheet Piles)	2x3=6	2x2=4	6x4=24
Dredging	2x3=6	3x2=6	6x6=36

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, 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 AREAS	**The following actions are recommended before undertaking any activity on the Study Site:** **1. Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site to plan for and guide upon the actions to be carried out in the event of a suspected or real UXO discovery. **2. UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a general briefing on the identification of UXB, what actions they should take to keep people and equipment away from the hazard and to alert site management. 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
AREA B	**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 or 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. 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.		

Report Figures

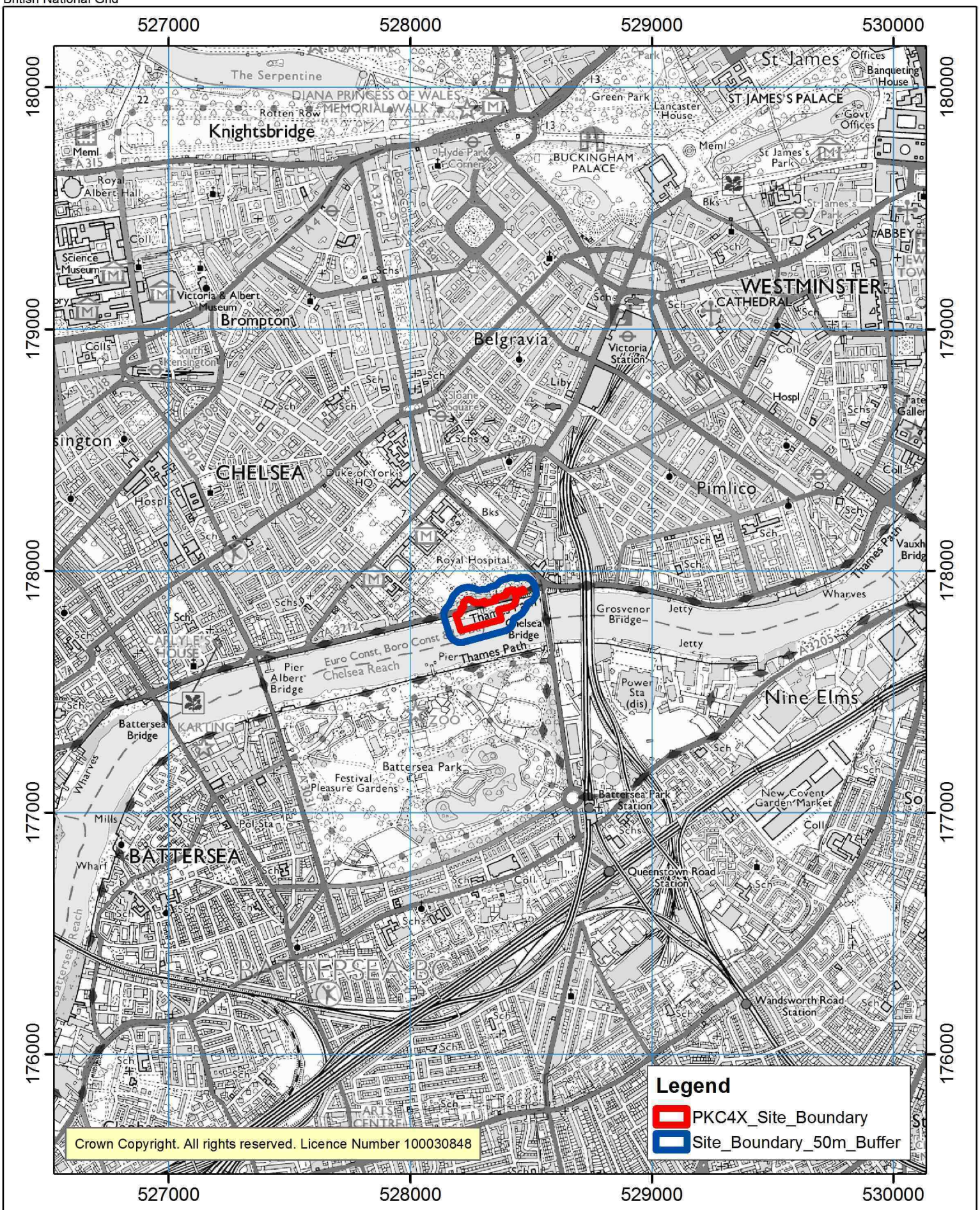
Figure One

Site Location

Thames Tideway Tunnel - Work Area PKC4X
Site Location

Figure 1

British National Grid



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0 100 200 400 600 800 1,000 Meters

N

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Checked by: Lee Gooderham
Date: 10th May 2012

Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PKC4X Site Boundary

Figure 2

British National Grid

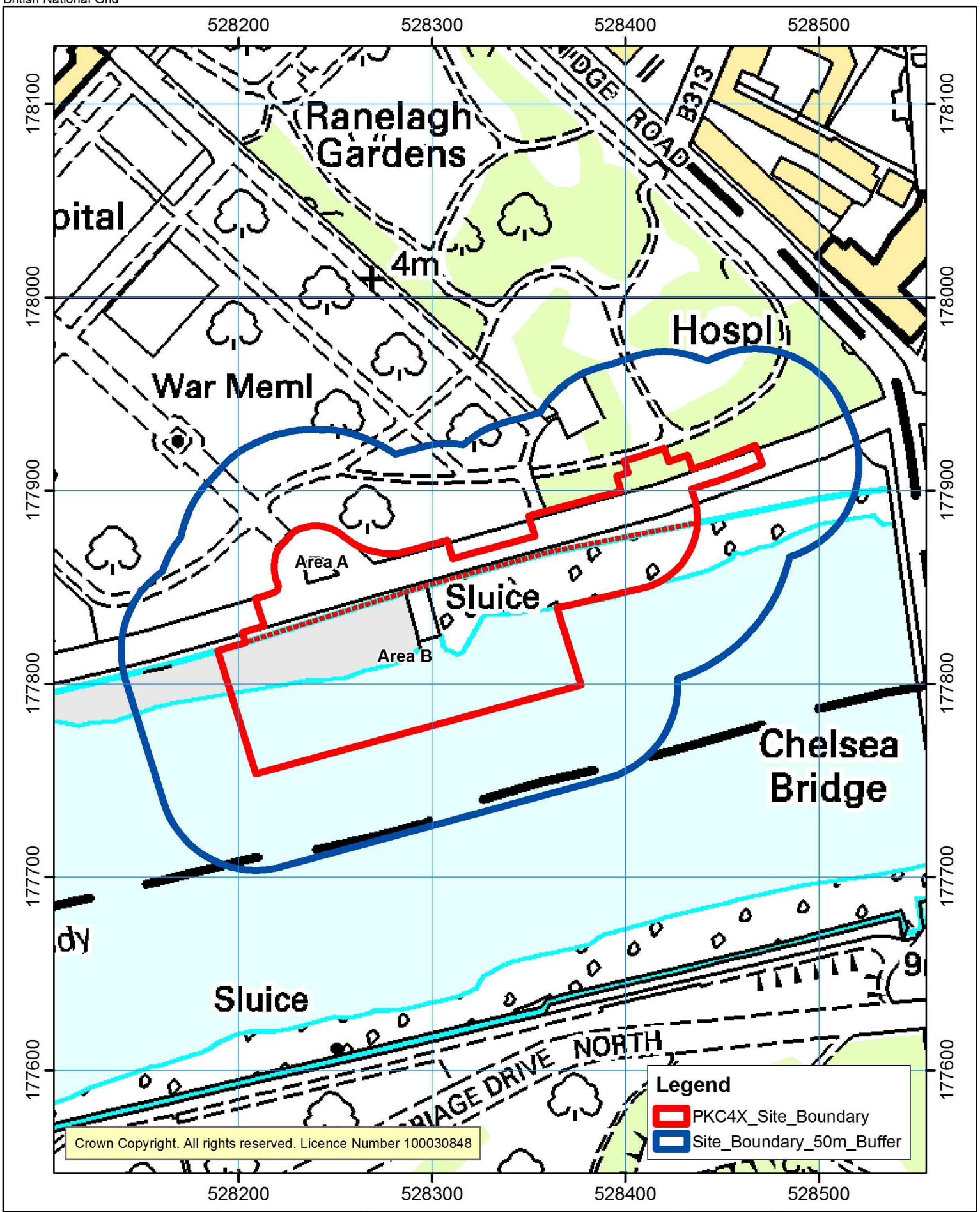

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Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PKC4X
Current Aerial Photography

Figure 3

British National Grid

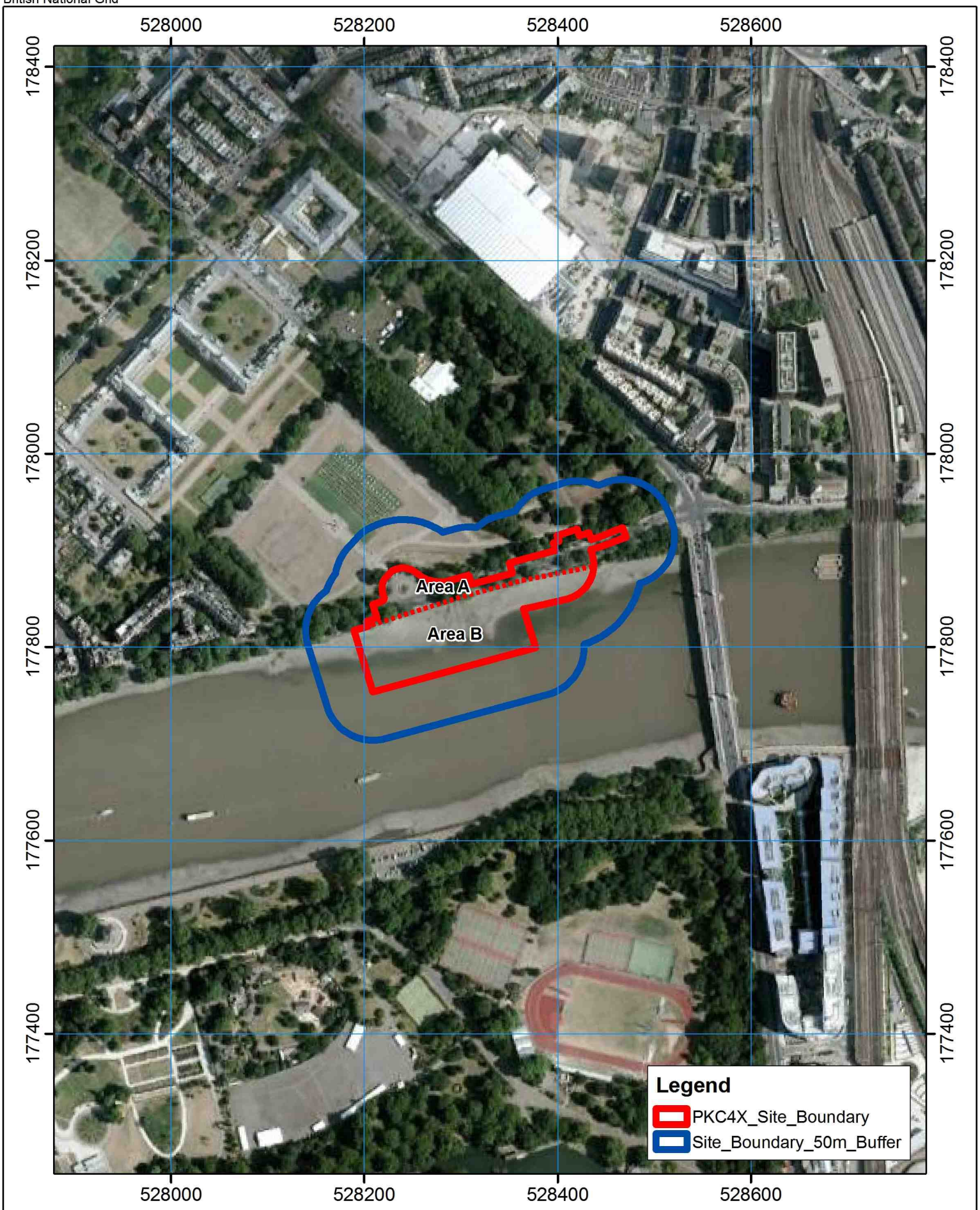

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PKC4X
1945 Aerial Photography

Figure 4

British National Grid

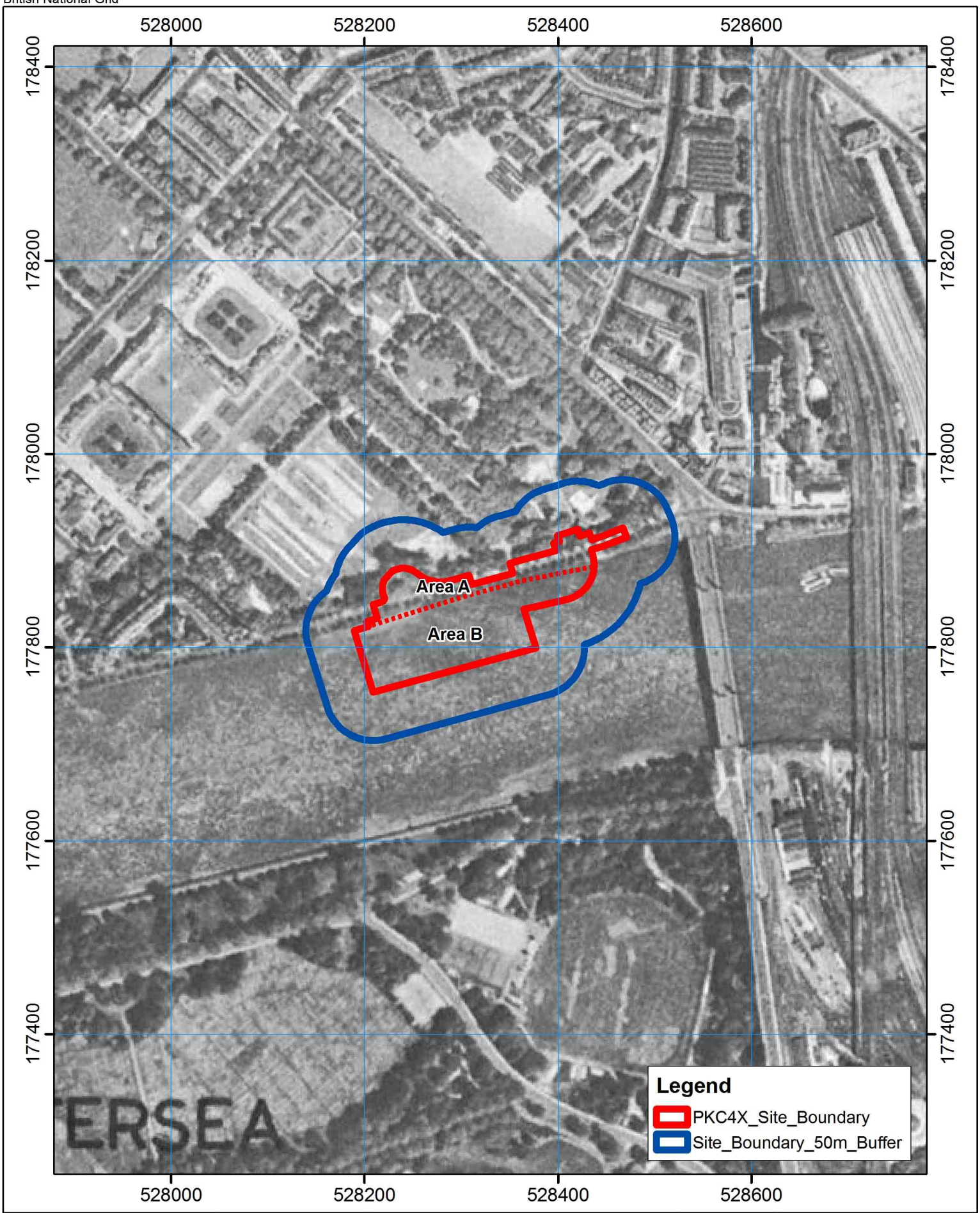

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Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PKC4X
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid

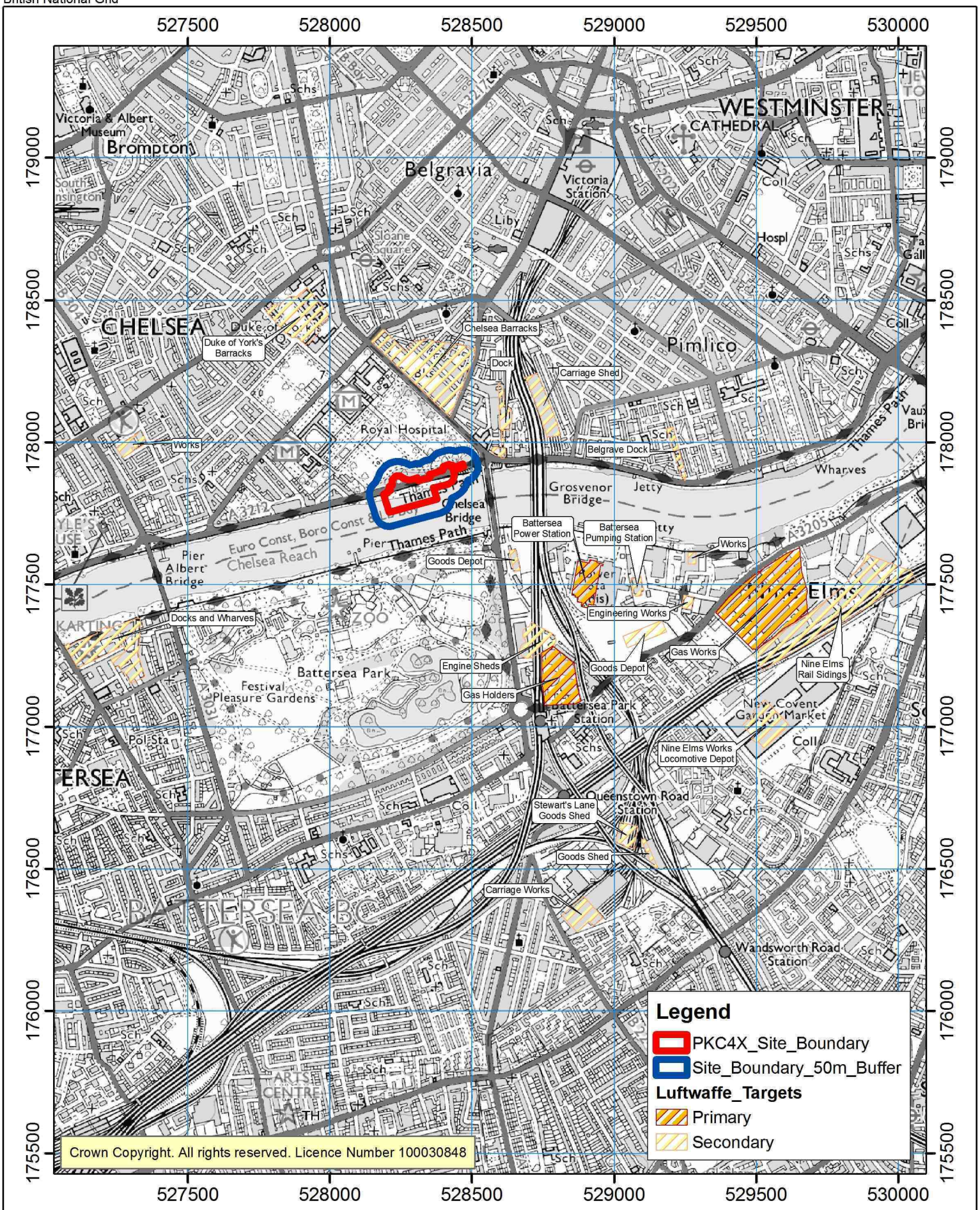

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Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PKC4X
WWII High Explosive Bomb Strikes

Figure 6

British National Grid

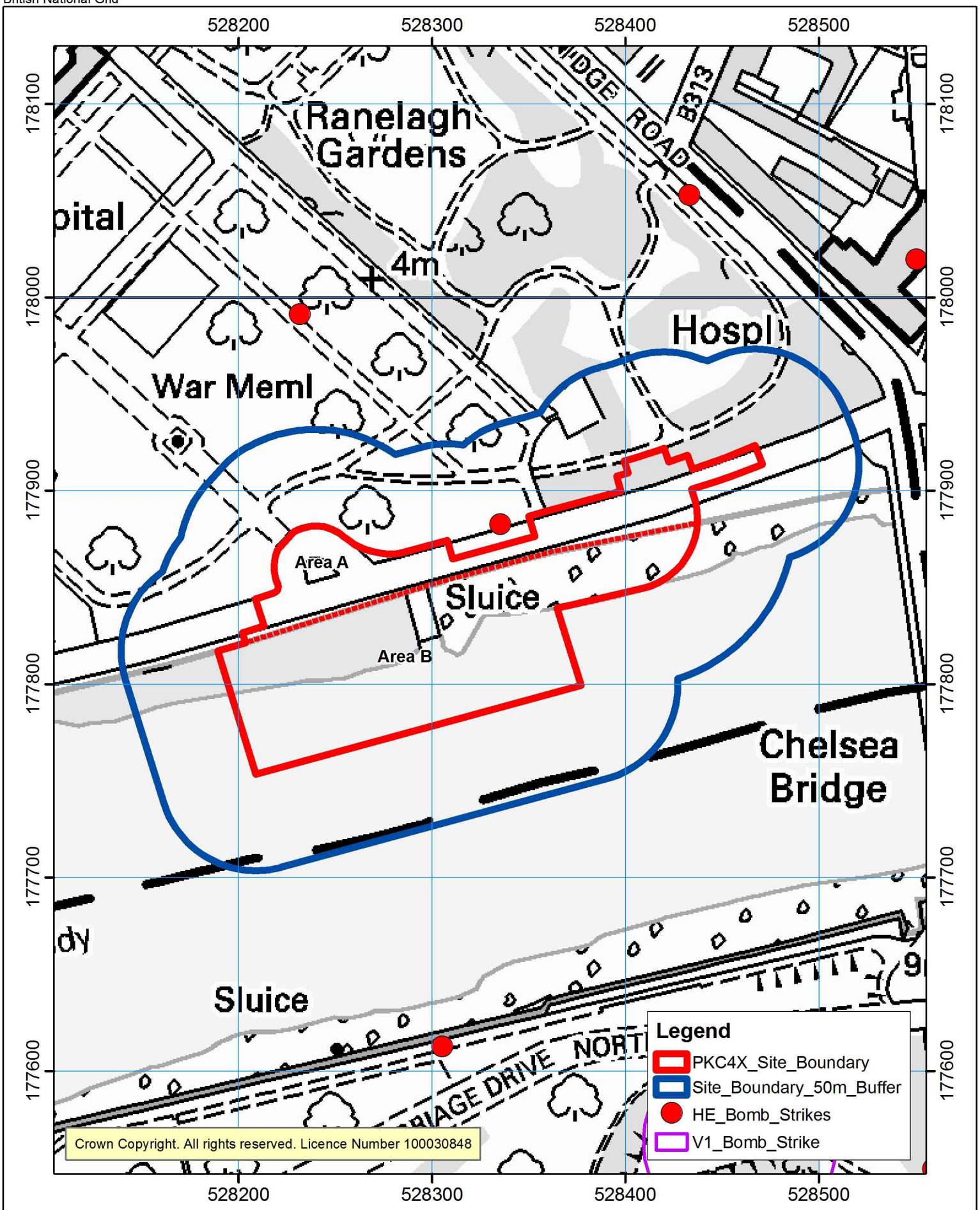

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Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PKC4X
London County Council Bomb Damage Map

Figure 7

British National Grid

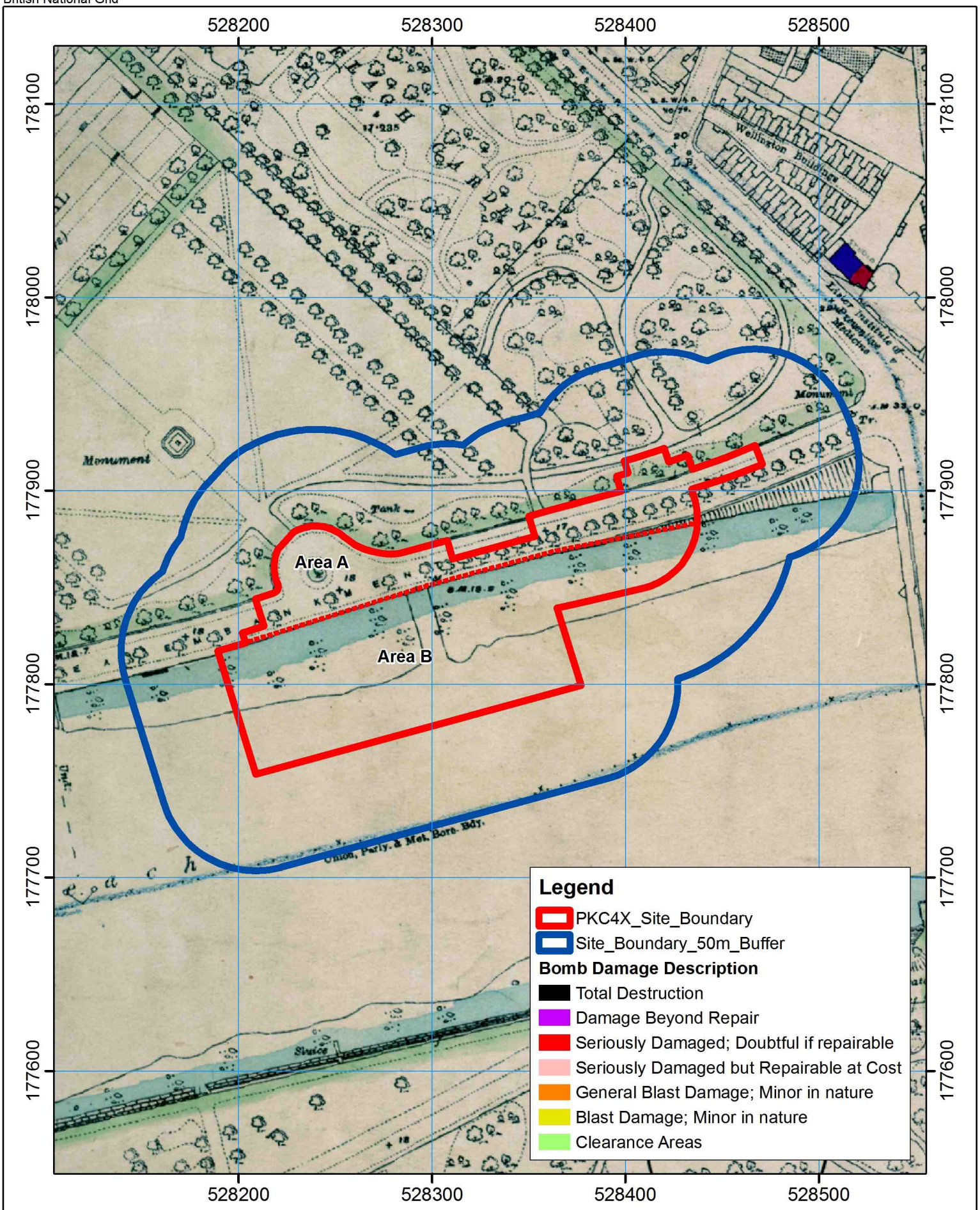

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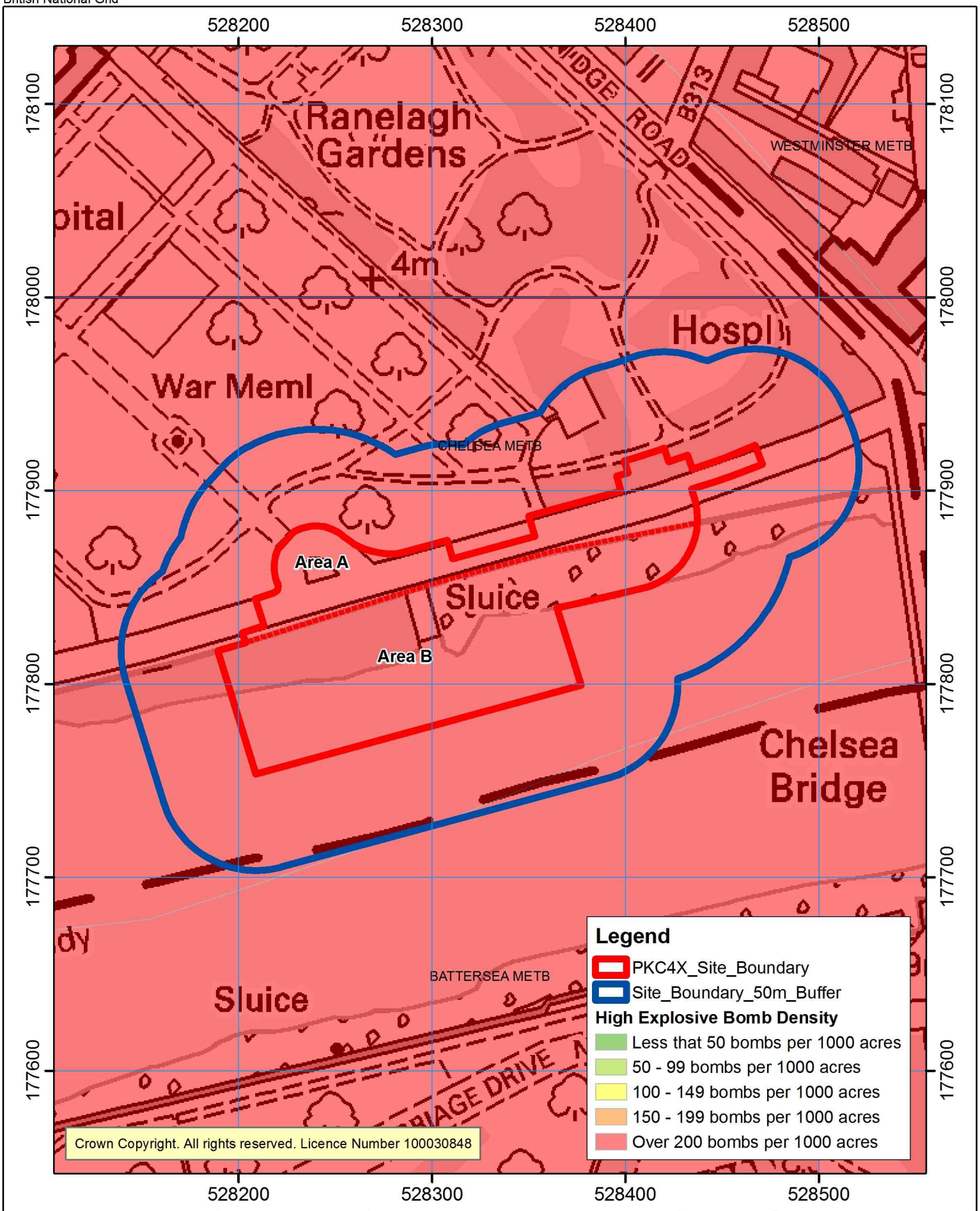
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PKC4X
WWII High Explosive Bomb Density

Figure 8

British National Grid



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Checked by: Lee Gooderham
Date: 10th May 2012

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References

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

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

[3] Port of London Authority. *Thames Tunnel Foreshore Contamination Sampling Report*. PLA Ref Q55/11 (December 2011).

[4] Mott MacDonald Limited. *Thames Tunnel Foreshore Sediment Quality Interpretative Report* (May 2012).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea Embankment Foreshore appendices

Appendix G: Noise and vibration

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 13 Chelsea 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 Chelsea Embankment Foreshore are the dwellings at Chelsea Gardens and Embankment Gardens, Lister Hospital and Ranelagh Gardens, a Grade II listed park and garden.

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 to 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 Royal Borough of Kensington & Chelsea has been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys.

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 three locations (CEF01, CEF02 and CEF04). Measurements were undertaken during the interpeak periods of 14:00-18:00 and 00:00-04:00 on a typical weekend day, and 20:00-22:00 and 00:00-04:00 on a typical weekday. Representative continuous unattended monitoring data was collected at one location (CEF05).

G.1.7 Vol 13 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 13 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date*
Initial Baseline Survey: 7th April, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2626232 2626233	15/02/2010
½ " Microphone(s)	4189	Brüel & Kjær	2621211 2621212	15/02/2010
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2619374 2619375	21/02/2011 12/01/2011
Additional baseline survey: 13th - 15th November, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2626230 2626231	19/01/2010 20/01/2010
½ " Microphone(s)	4189	Brüel & Kjær	2621208 2621209	19/01/2010 20/01/2010
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2619372	13/01/2011

** Hand-held analyser(s) and ½ " microphone(s) valid for two years from the date listed, calibrator(s) 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 For the attended measurements, the sound level meters were tripod-mounted with the microphone approximately 1.3m above ground level. A windshield was fitted over the microphone at all times during the survey period to minimise the effects of any wind induced noise.

G.1.10 For the unattended measurement, the environmental case used for the continuous data logging was locked to avoid any potential tampering. The microphone was tripod-mounted approximately 1.3m above ground level. A windshield with bird spikes was fitted over the microphone at all times during the survey period to minimise the effects of any wind induced noise, and also to prevent birds from perching on the equipment.

G.1.11 The prevailing weather conditions observed for both attended baseline surveys are described in Vol 13 Table G.2.

G.1.12 Contemporary weather data recorded at Heathrow Airport (EGLL) has been summarised in Vol 13 Table G.3. This is deemed to be representative of the prevailing weather conditions for the continuous unattended data collected.

Vol 13 Table G.2 Noise – weather conditions during baseline noise surveys

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Initial Baseline Survey – 7th April, 2011 (daytime, 10:00-12:00; 14:00-16:00)				
Maximum: 1.4-3.8 Average: 0.4-1.5	Westerly	16-25	No	Warm, sunny, dry with occasional light breeze. Turned cloudy towards the end of the afternoon.
Additional baseline survey – 13th November, 2011 (daytime, 14:00-18:00)				
Maximum: 0.8-3.8 Average: 0-1.8	Easterly	13-16	No	Sunny, clear and dry with occasional light breeze.
Additional baseline survey – 14th November, 2011 (night-time, 00:00-04:00)				
Maximum: 0.8-3.4 Average: 0.1-0.7	Easterly	10-12	No	Started misty and damp. Became clear, mild and dry with occasional light breeze.
Additional baseline survey – 14th November, 2011 (evening, 20:00-22:00)				
Maximum: 0.7-4.6 Average: 0-1.6	Easterly	10-11	No	Clear, dry and mild with occasional light breeze
Additional baseline survey – 15th November, 2011 (night-time, 00:00-04:00)				
Maximum: 1.6-3.5 Average: 0.4-0.7	Easterly, ENE	9-10	No	Generally clear, dry and mild with occasional light breeze

Vol 13 Table G.3 Noise – contemporary weather data for Heathrow Airport

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Sunday 18th December, 2011 (00:00 - 00:00)*				
1.0-7.2	Variable (Predominantly W and WNW)	(-)1-6	Yes (between 14:00 and 15:00, 0.6mm total)	Clear and dry for majority of day. Light rain shower and strong gusts early PM.
Monday 19th December, 2011 (00:00 - 00:00)**				
1.0-6.7	Variable (Predominantly W and SSW)	(-)2-7	Yes (between midday and 18:30, 5.0mm total)	Generally overcast and wet for majority of day
Tuesday 20th December, 2011 (00:00 - 17:00)***				
1.0-6.7	Variable (Predominantly W and WNW)	5-8	No	Partly cloudy, dry, mild and breezy

**http://www.wunderground.com/history/airport/EGLL/2011/12/18/DailyHistory.html*
***http://www.wunderground.com/history/airport/EGLL/2011/12/19/DailyHistory.html*
****http://www.wunderground.com/history/airport/EGLL/2011/12/20/DailyHistory.html*

Measurement locations

G.1.13 Vol 13 Table G.4 details the measurement locations which are also presented in Vol 13 Figure G.1 Noise – measurement locations (see separate volume of figures), and shown in Vol 13 Plate G.1 to Vol 13 Plate G.5.

Vol 13 Table G.4 Noise – measurement locations

Measurement location number	Description	Co-ordinates	
		X	Y
CEF01	On public footbath alongside Chelsea Embankment	528389	177896
CEF02	On public footbath within Chelsea Hospital Gardens	528218	177905
CEF03	On public footbath alongside Chelsea Embankment	528087	177811
CEF04	On public footbath alongside Chelsea Bridge Road	528523	177995
CEF05	Within the grounds of Chelsea Royal Hospital	528065	178024

Results

G.1.14 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 13 Table G.5 to Vol 13 Table G.10.

Vol 13 Table G.5 Noise – sampled noise survey results - CEF01

Location Detail: CEF01, on public footbath alongside Chelsea Embankment, in front of Ranelagh Gardens						
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)	103	69	76-79	77	80	80
Evening (20.00-22.00)	86	62	75-76	75	78	80
Night (00.00-04.00)	87	51	71-73	72	75	75
Weekend day (14.00-18.00)	94	68	76	76	79	80
Weekend night (00.00-04.00)	85	50	69-73	71	74	75

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

Vol 13 Table G.6 Noise – sampled noise survey results - CEF02

Location Detail: CEF02, on public footpath within Chelsea Hospital Gardens						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Façade**	**Façade**
Daytime (10.00-12.00, 14.00-16.00)	84	56	59-60	60	63*	65

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

Vol 13 Table G.7 Noise – sampled noise survey results - CEF03

Location Detail: CEF03, on public footbath alongside Chelsea Embankment, in front of a residential dwelling						
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)	101	69	76-78	77	80	80
Evening (20.00-22.00)	89	63	75-76	76	78	80
Night (00.00-04.00)	88	50	69-74	72	75	75
Weekend day (14.00-18.00)	93	69	75-76	76	79	80
Weekend night (00.00-04.00)	87	49	70-72	71	74	75

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

Vol 13 Table G.8 Noise – sampled noise survey results - CEF04

Location Detail: CEF04, Public footpath alongside Chelsea Bridge Road, in front of the Lister Hospital						
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)	96	64	70-75	69	72	70
Evening (20.00-22.00)	97	61	69-72	68	71	70
Night (00.00-04.00)	83	53	62-68	63	66	65
Weekend day (14.00-18.00)	92	62	71	68	71	70
Weekend night (00.00-04.00)	92	53	64-68	63	66	65

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

Vol 13 Table G.9 Noise – continuously logged noise survey results - CEF05

Location Detail: CEF05, Within private grounds of Royal Hospital							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Period noise level (dB(A) façade)**		
		L_{AFmax}	L_{A90}	L_{Aeq}	L_{AFmax}	L_{A90}	L_{Aeq}
Weekday	07.00-08.00	73	53	58	76	56	61
	08.00-18.00	90	51	58	93	54	61
	18.00-19.00	69	51	54	72	54	57
	19.00-22.00	70	49	54	73	52	57
	22.00-07.00	92	50	58	95	53	61
Saturday	22.00-07.00*	74	44	50	77	47	53
Sunday	07.00-21.00	77	49	55	80	52	58
	21.00-07.00	80	42	53	83	45	56

**The data presented in this row is deemed to be representative of the reference period. The continuous monitor started collecting data from 00:00 hours on Sunday morning in order to maximise data collection for the reference periods using the remote battery power of the environmental kit only.*

Vol 13 Table G.10 Noise measurements near embankment (for river-based traffic assessment

Sensitive receptor locations	**Measurement location**	**Measurement period**	**Noise level (dBL_{Aeq}, facade)**
Chelsea Embankment (west)	CEF03	Day/evening (07.00-23.00)	80
Chelsea Embankment (east)	CEF04	Day/evening (07.00-23.00)	72

Plates of noise measurement locations

G.1.15 The following plates (Vol 13 Plate G.1 to Vol 13 Plate G.5) illustrate the noise measurement locations.

Vol 13 Plate G.1 Noise measurement location CEF01

Note: On public footpath adjacent to adjacent to Chelsea Embankment, looking west

Vol 13 Plate G.2 Noise measurement location CEF02

Note: On public footpath within Chelsea Hospital Gardens, looking south

Vol 13 Plate G.3 Noise measurement location CEF03

Note: On public footpath adjacent to Chelsea Embankment, looking west

Vol 13 Plate G.4 Noise measurement location CEF04

Note: On public footpath adjacent to Chelsea Bridge Road, opposite the Lister Hospital, looking northwest (façade measurement)

Vol 13 Plate G.5 Noise measurement location CEF05

Note: Within private grounds of the Royal Hospital, looking southeast towards Chelsea Embankment

G.2 Construction noise prediction results

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

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

G.2.3 Construction plant assumptions used in the assessment are presented in Vol 13 Table G.11.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Vol 13 Plate G.6 to Vol 13 Plate G.13.

Vol 13 Table G.11 Noise and vibration – typical construction plant schedule

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Hoarding General site equipment NOT applicable during this phase	Excavator digging post holes for hoarding	1	105	30	BS5228-1[i]: Table C.2, Item 2	Tracked excavator, 71 t
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Circular saw cutting timber	1	113	5	BS5228-1: Table C.4, Item 71	Circular bench saw (petrol),
	Cutting equipment (diamond saw)	1	108	5	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Nail guns for erection of hoarding	1	101	10	BS5228-1: Table C.4, Item 95	Handheld cordless nail gun, 15 to 50 mm nails
	Compressor 250cfm	1	93	30	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	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 set up and general site	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar
	JCB with hydraulic breaker	1	116	25	BS5228-1: Table C.5,	Backhoe Mounted

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 1	Hydraulic Breaker,
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	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,
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4, Item 15	Fuel tanker lorry,
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Wheel wash	1	110	20	Measured data	Jet wash,
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Water settling/treatment	1	104	100	Measured data	Dirty water plant,
	Well drilling Rig	1	107	50	Manufacturer	BauerBBA Well Drilling Rig,
	Dewatering Pump	1	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
Demolition General site	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
equipment also applicable during this phase	22T Excavator c/w hydraulic hammer	1	119	15	BS5228-1: Table D.2, Item 4	Tracked excavator fitted with breaker, 200 kg·m
	Site dumper	1	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Pneumatic breaker	1	111	15	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 note: piling and backfilling will be concurrent however the two operations will be	400 cfm compressor	2	93	100	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	150t crawler crane	1	103	60	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Barges	1	101	5	Measured data	Barge arriving and slurry loading,
	Generator	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Jack-up barge	1	100	10	Measured	Jack-up barge,
	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, Item 9	Piling, 10 t

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
separated by some distance.	Secant pile rig	1	107	30	BS5228-1: Table C.3, Item 16	Crane mounted auger
	Dewatering pumps - cofferdam	2	96	100	BS5228-1: Table C.4, Item 88	Water pump (diesel), 100 kg
	Vibratory piling rig	1	116	60	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol) ,
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Shaft sinking General site equipment also applicable during this phase	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	40t crawler crane	1	98	50	BS5228-1: Table C.3, Item 29	Tracked mobile crane, 55t
	Shaft jacking system	1	94	20	BS5228-1: Table C.4, Item 78	Diesel generator,
	Bentonite/grout mixing plant	1	96	50	Measured data	Electric Bentonite pump,
	Ventilation fans	1	100	100	Measured	Ventilation fans,
	Long reach excavator	1	106	80	BS5228-1: Table C.7, Item 1	Long reach tracked excavator, 21 m arm / 39

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
						t
	12t excavator with breaker	1	110	15	BS5228-1: Table D.8, Item 13a	Tracked excavator fitted with hydraulic rock breaker
	25t excavator	1	105	30	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
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
Drive connection tunnel construction General site equipment also applicable during this phase	Concrete deliveries (aggitating)	1	99	80	BS5228-1: Table C.4, Item 19	Cement mixer truck (idling),
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	100t crawler crane	1	103	80	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t mobile crane	1	98	20	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Tunnel ventilation fans	1	100	100	Measured	Ventilation fans,
	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	400 cfm compressor	1	93	50	BS5228-1: Table C.5,	Compressor for hand-

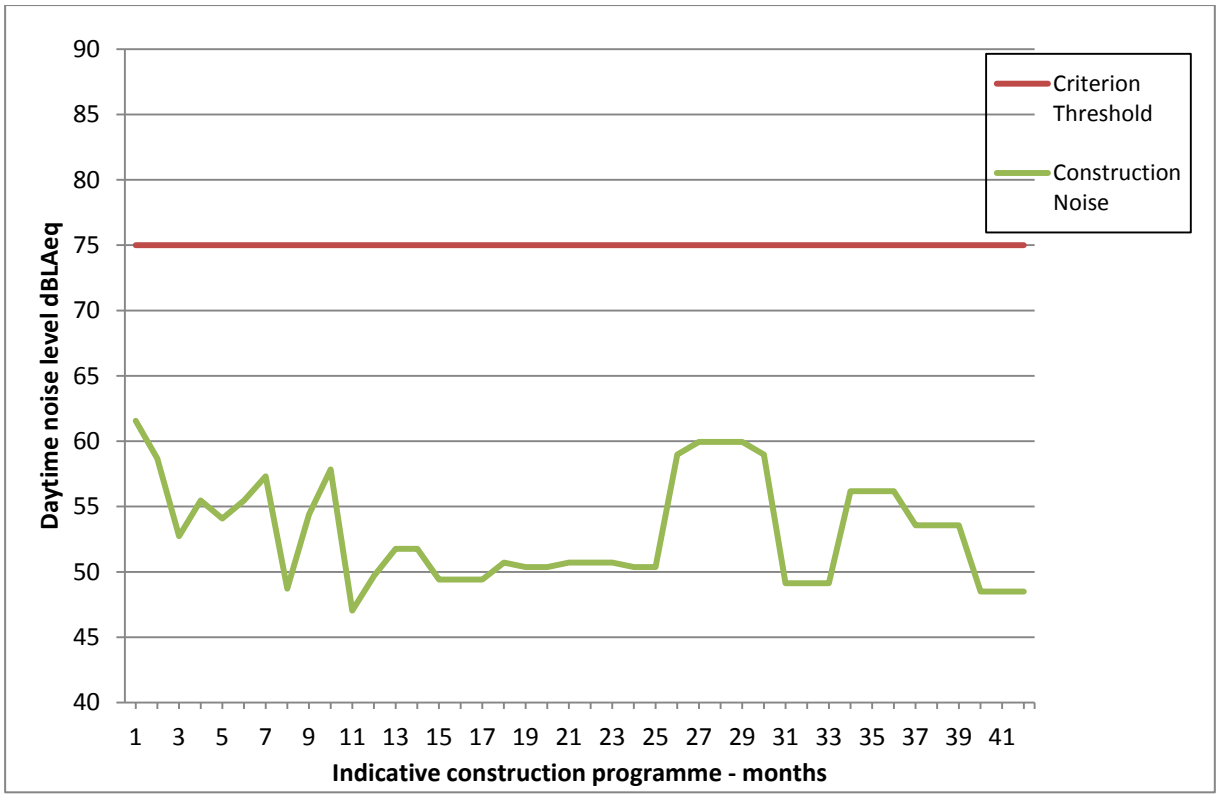
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 5	held pneumatic breaker, 1 t
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
Shaft and connection tunnel secondary lining General site equipment also applicable during this phase	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Service Crane 40T mobile Crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	2	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor,
Culvert and chamber works General site equipment also applicable during this phase	Service crane100T mobile crane	1	99	50	BS5228-1: Table C.4, Item 41	Mobile telescopic crane, 100 t
	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),

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Concrete boom pump	1	108	20	BS5228-1: Table C.4, Item 29	Truck mounted concrete pump + boom arm, 26 t
	Fixed and portable concrete vibrators	4	106	20	BS5228-1: Table C.4, Item 33	Poker vibrator
Landscaping General site equipment NOT applicable during this phase	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 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	93	10	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	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

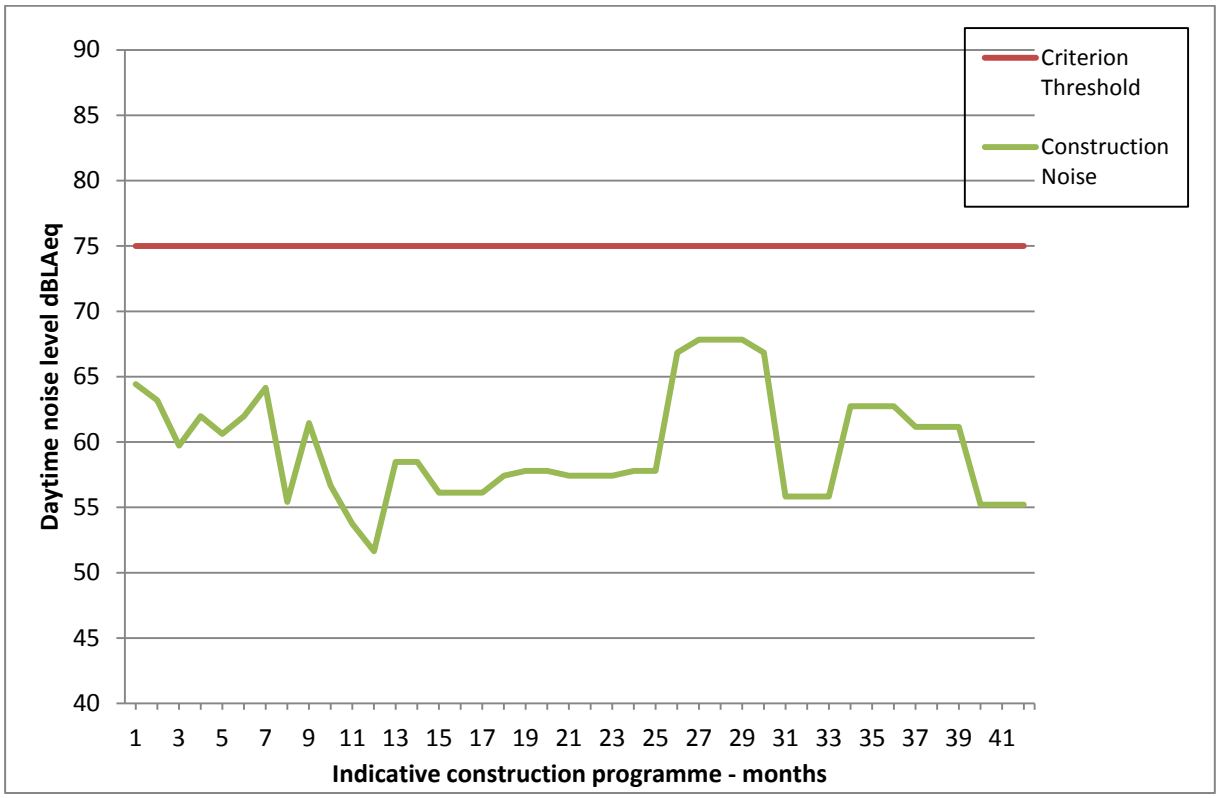
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable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

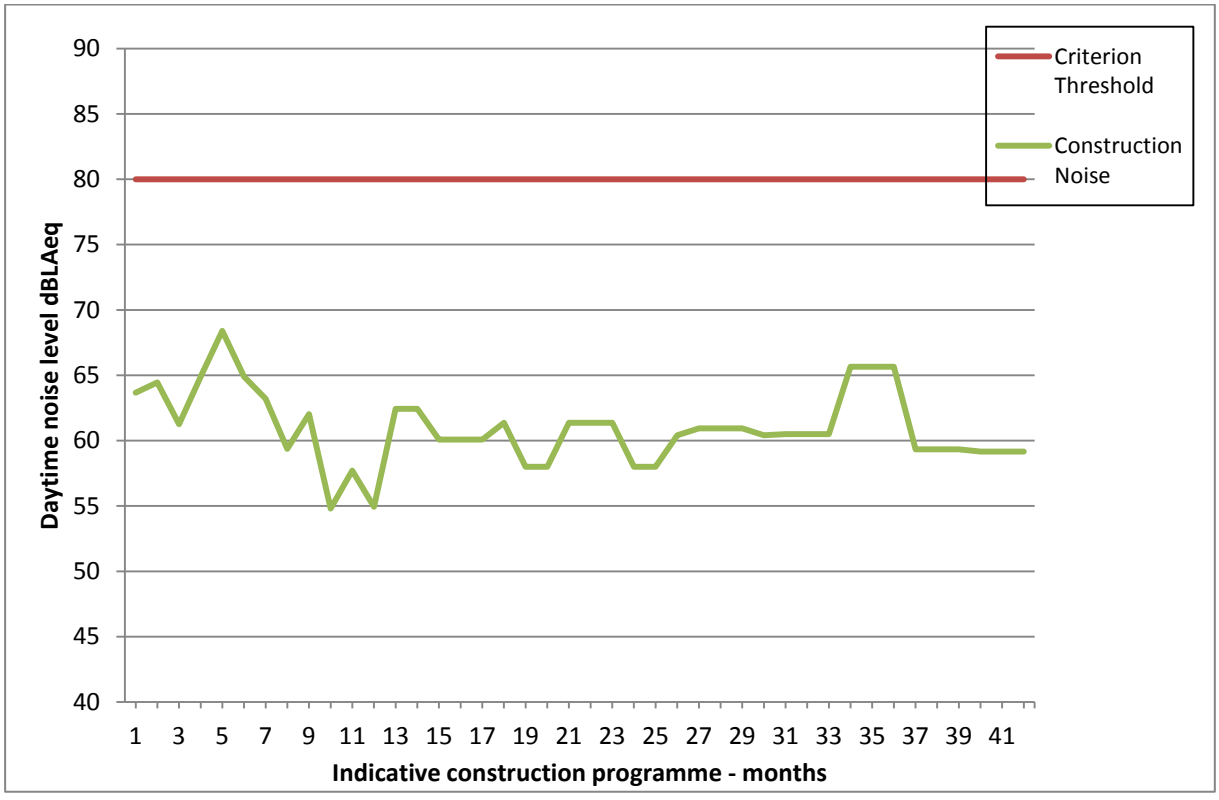
Vol 13 Plate G.6 Average monthly daytime noise level over duration of construction – 1-15 Pavilion Court (CE1)



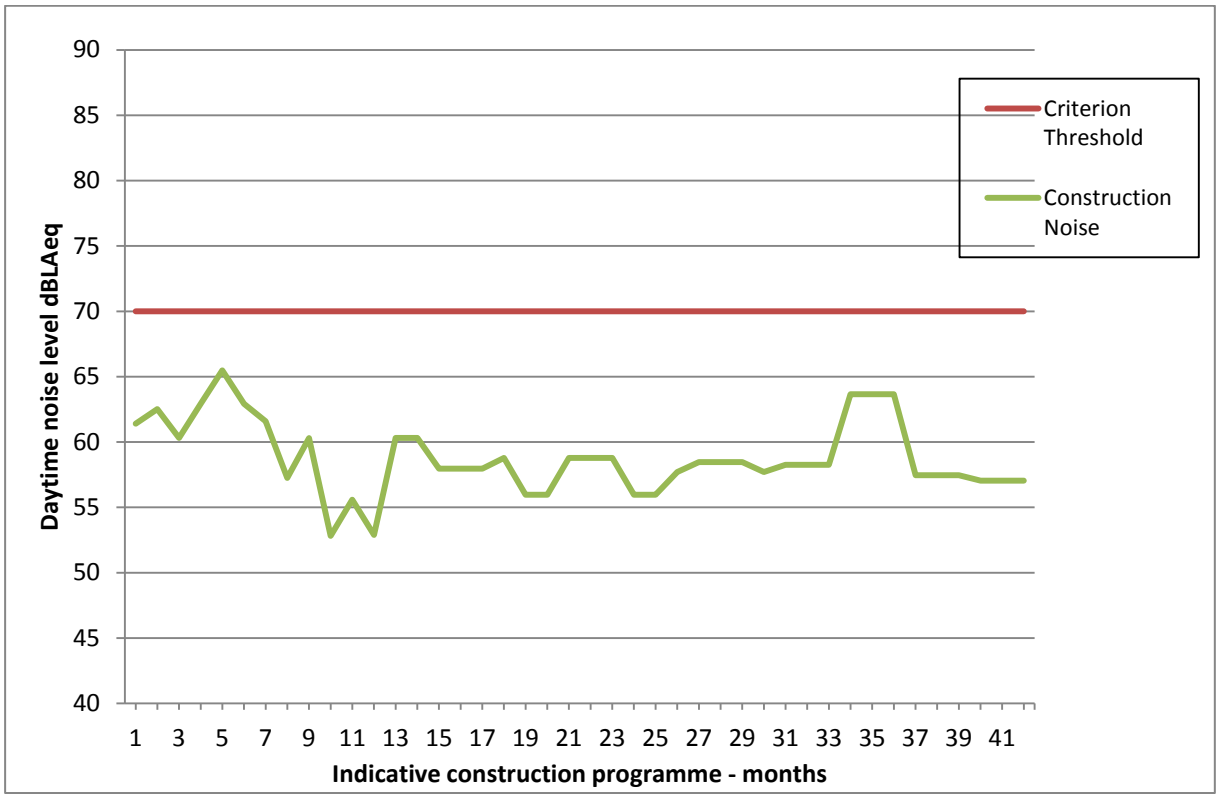
Vol 13 Plate G.7 Average monthly daytime noise level over duration of construction – 1-104 Chelsea Gardens (CE2)



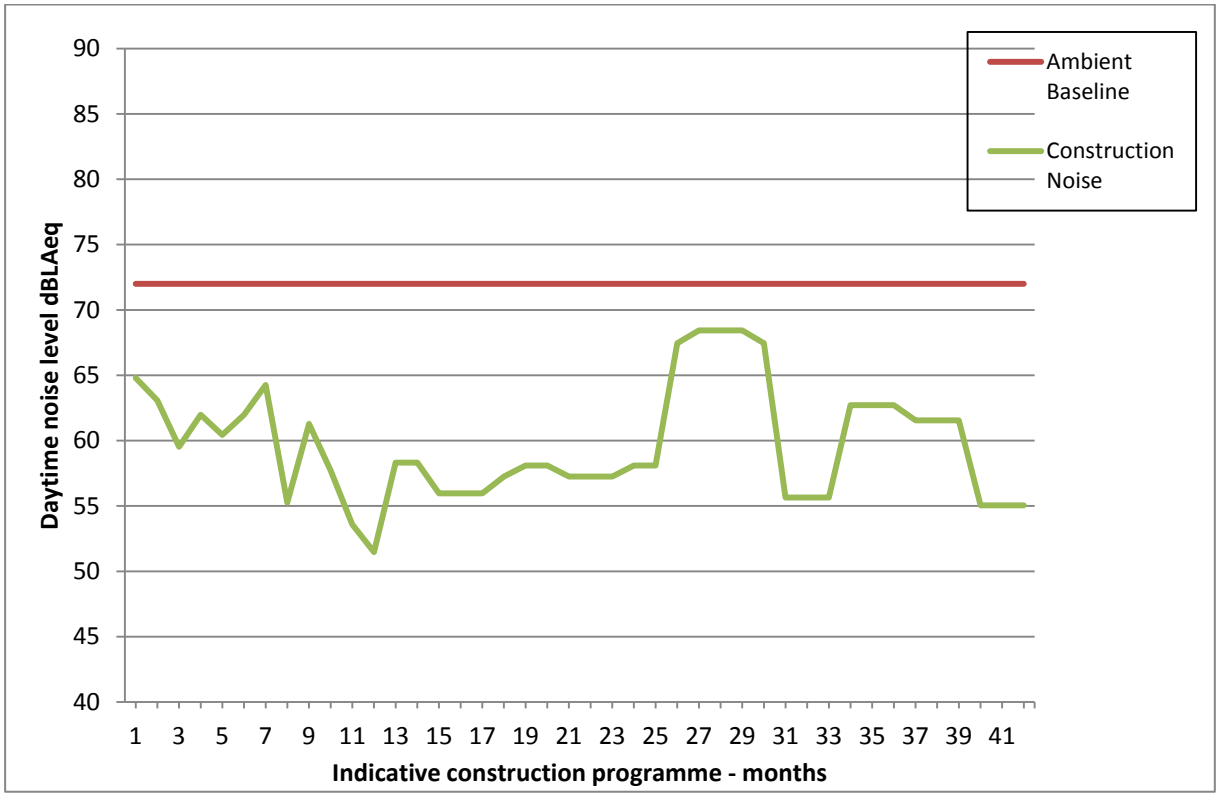
Vol 13 Plate G.8 Average monthly daytime noise level over duration of construction – 21-23 Embankment Gardens (CE3)



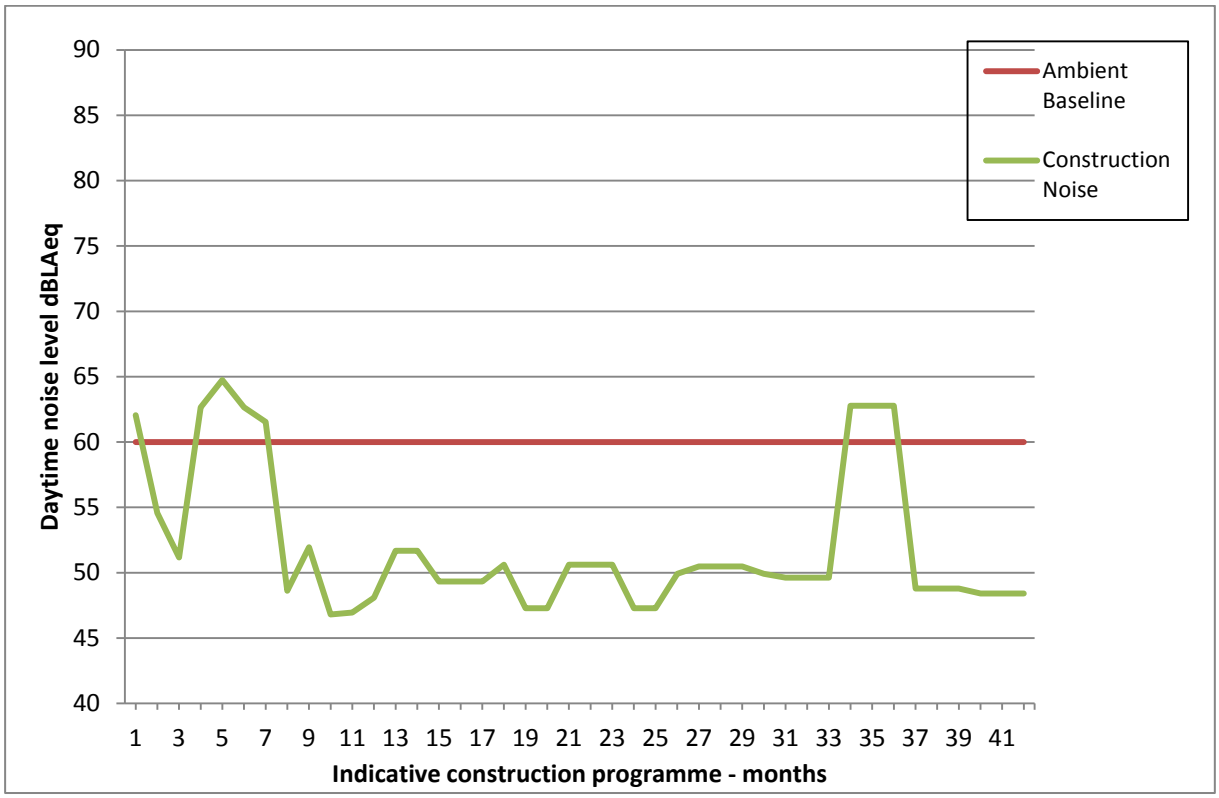
Vol 13 Plate G.9 Average monthly daytime noise level over duration of construction – 13-16 Embankment Gardens (CE4)



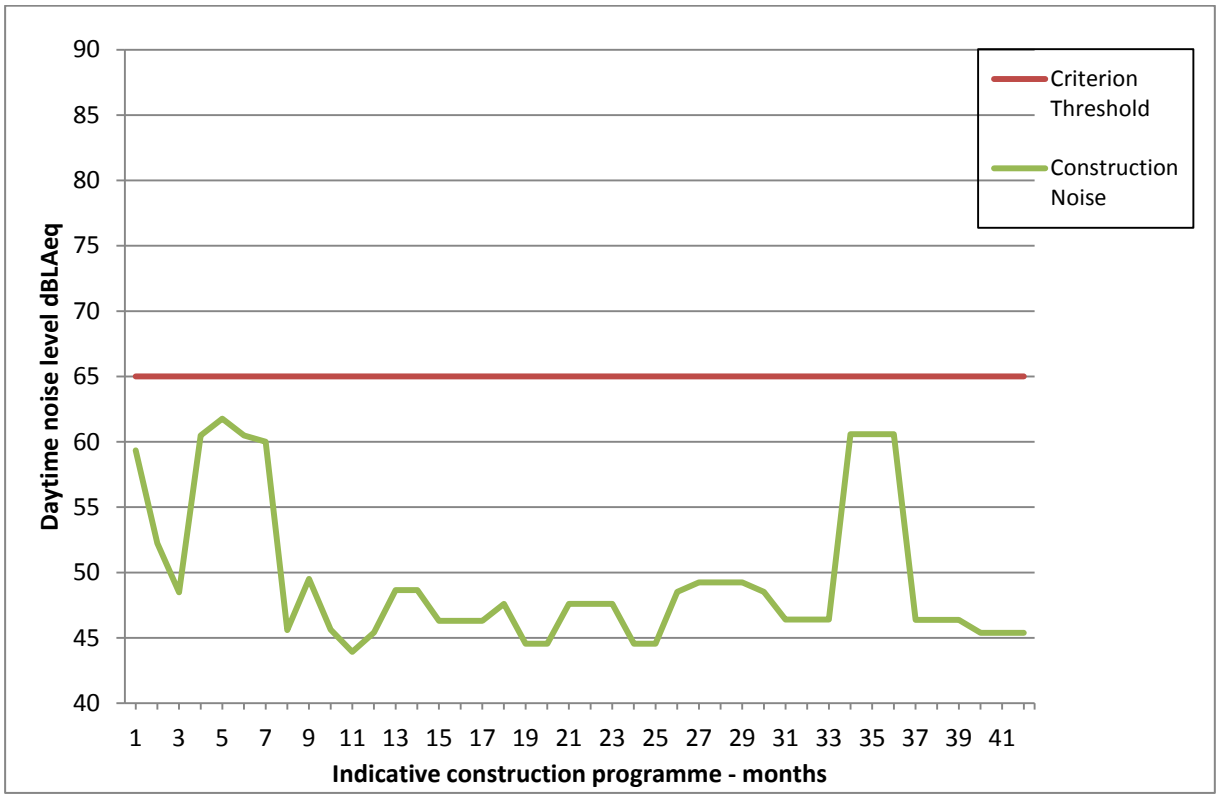
Vol 13 Plate G.10 Average monthly daytime noise level over duration of construction - The Lister Hospital (CE5)



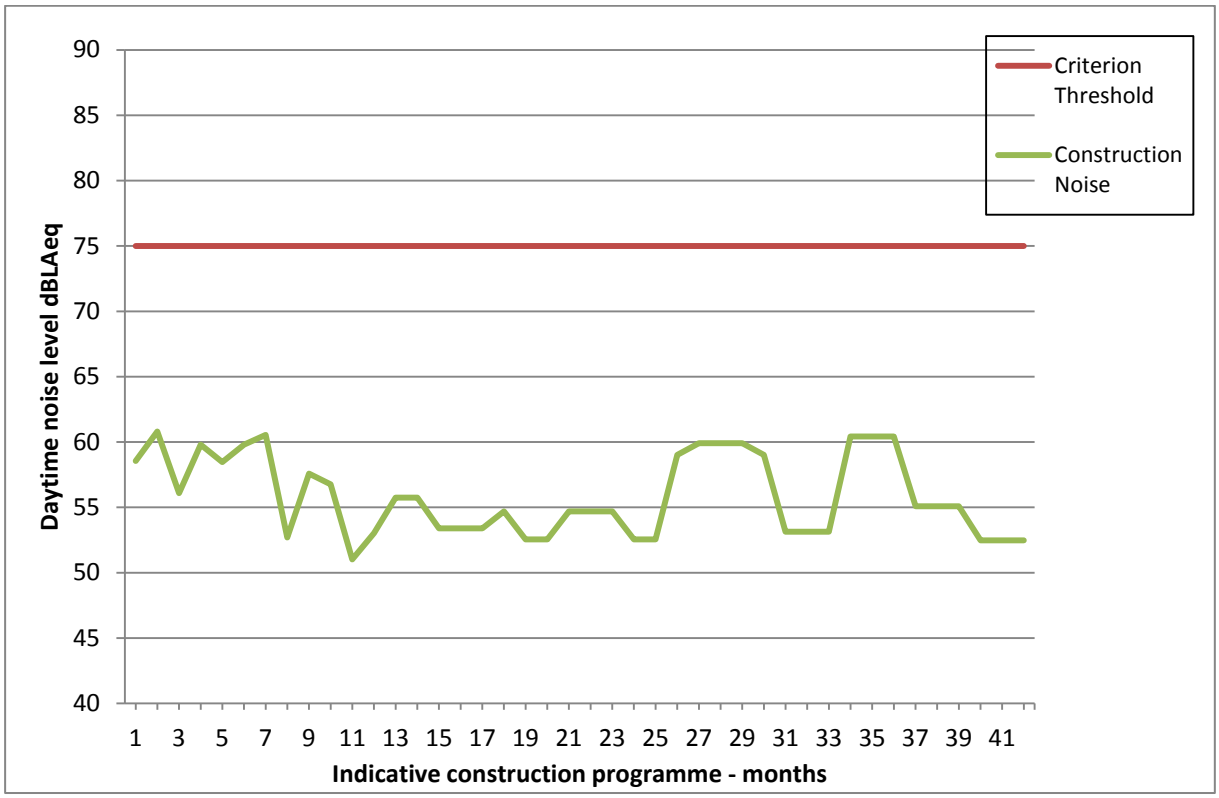
Vol 13 Plate G.11 Average monthly daytime noise level over duration of construction - Ranelagh Gardens (CE6)



Vol 13 Plate G.12 Average monthly daytime noise level over duration of construction - Royal Hospital (CE7)



Vol 13 Plate G.13 Average monthly daytime noise level over duration of construction - Chelsea Bridge Wharf (CE8)



References

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea Embankment Foreshore appendices

Appendix H: Socio-economics

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

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Thames Tideway Tunnel

Environmental Statement

Volume 13 Chelsea Embankment Foreshore appendices

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 'Output Area' (OA) and local authority 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, and supplemented with ONS statistics relating to health and lifestyle indicators. 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 Royal Borough [RB] of Kensington and Chelsea).

H.1.3 The main protected characteristic groups concentrated within the immediate area surrounding the proposed construction site are:

a. persons aged over 65 years old
b. persons suffering from a long term limiting sickness
c. persons suffering from a disability.

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

a. persons aged over 65 years old
b. persons suffering from a long term limiting sickness
c. persons suffering from a disability.

Resident population

H.1.5 The resident population was approximately 900 within 250m of the site and approximately 31,150 within 1km at the time of the last census.

Gender and age

H.1.6 Of the total population within 250m of the site 50.6% of residents are female. The proportion of females within 1km (51.7%) and at a borough wide level (52.2%) is slightly higher.

[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.

H.1.7 Vol 13 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (6.7%) is considerably lower than the proportion of under 16 year olds within 1km (13.3%), the borough wide level (15.6%) and Greater London average (20.2%).

H.1.8 Contrastingly, within 250m the proportion of over 65 year olds (29.3%) is considerably higher than within 1km (15.6%), at a borough wide level (12.2%) and Greater London levels (12.4%).

Vol 13 Table H.1 Socio-economics – age breakdown by assessment area

Age group	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (RB of Kensington and Chelsea)	Greater London
Under 16 years old	6.7%	13.3%	15.6%	20.2%
Over 65 years old	29.3%	15.6%	12.2%	12.4%

Ethnicity

H.1.9 Vol 13 Table H.2 outlines ethnicity by assessment area, showing that within 250m of the site, White residents comprise a high proportion of the population (86.6%), and Black and Minority Ethnic (BME) groups comprise the remaining 13.4% residents. The proportion of White residents within 250m is broadly in line with the proportion within 1km (83.9%) and slightly higher than at a borough wide level (78.6%). The proportion of White residents within Greater London (71.2%) is slightly lower than within the above assessment areas.

H.1.10 Within 1km the proportion of Asian residents (4.9%) is in line with the proportion of Asian residents at a borough wide level (4.9%) and considerably lower than the Greater London average (12.1%). Within 250m however, the proportion of Asian residents (1.9%) is considerably lower than within Greater London. The proportion of Black residents within 250m (4.5%) is in line with the proportion within 1km (4.5%), moderately lower than within the RB of Kensington and Chelsea (7.0%) and considerably lower than the Greater London average (12.1%).

Vol 13 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (RB of Kensington and Chelsea)	Greater London
White	86.6%	83.9%	78.6%	71.2%
BME	13.4%	16.1%	21.4%	28.8%
Asian	1.9%	4.9%	4.9%	12.1%
Black	4.5%	4.5%	7.0%	10.9%
Other	4.2%	3.5%	5.4%	2.7%
Mixed	2.9%	3.2%	4.1%	3.2%

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

Religion and belief

H.1.11 Within 250m and 1km and at a borough wide level, Christians are the predominant religious group at 65.6%, 66.8% and 62.0% respectively. Within 250m, Muslims are the second most predominant religious group (5.1%), somewhat lower than within 1km (6.9%) and considerably lower than the borough wide (8.4%) and Greater London levels (8.5%).

H.1.12 Within 250m, the proportion of residents who do not follow a religion (27.9%) is somewhat higher than within 1km (23.8%) and slightly higher than the borough wide (24.4%) and Greater London average (24.3%).

Health indicators

H.1.13 Vol 13 Table H.3 outlines health indicators by assessment area, noting that the proportion of residents within 250m suffering from a long term or limiting illness (26.2%) is considerably higher than within 1km (15.1%), the RB of Kensington and Chelsea (13.6%) and Greater London level (15.5%).

H.1.14 The proportion of residents who claim disability living allowance within 250m (4.6%) are slightly higher than within 1km (3.9%) and at a borough level (3.4%), though broadly in line with the Greater London average (4.5%).

Vol 13 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (RB of Kensington and Chelsea)	Greater London
Long term limiting sick	26.2%	15.1%	13.6%	15.5%
Disability living allowance	4.6%	3.9%	3.4%	4.5%

H.1.15 In the Middle Layer Super Output Area (MSOA)[iii]5 in which the site falls, adult obesity falls in the lowest quintile (ie, the lowest being the best) relative to Greater London. Levels of child obesity fall within the second highest quintile relative to Greater London.

H.1.16 In terms of the rates of adults and children undertaking physical activity, as measured borough wide, RB of Kensington and Chelsea ranks within the highest quintile (ie, the highest being the best) relative to Greater London.

H.1.17 Death rates by respiratory disease, circulatory disease, cancer and strokes in the MSOA are all in the lowest quintile (ie, the lowest being the best) within the borough. Heart disease is slightly more prevalent however and falls within the second lowest quintile within the borough.

H.1.18 Male and female life expectancy in the MSOA are in the highest quintile within the borough (ie, the highest being the best) with average life expectancy for both male and female residents of 84.9 to 93.1 years.

Lifestyle and deprivation indicators

H.1.19 Vol 13 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that within 250m of the site 67.8% residents do not own cars, which is higher than within both 1km (53.0%), the borough wide level (50.4%) and the Greater London level (37.5%).

H.1.20 Within 250m there is no recorded incidence of income deprivation[iv] or overall deprivation. Within 1km income deprivation (9.9%) is lower than the RB of Kensington and Chelsea level (20.8%) and considerably lower than the Greater London level (30.8%). Overall deprivation within 1km (5.2%) is considerably lower than both the borough wide (22.9%) and Greater London levels (24.5%).

[iii] 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.

[iv] 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.

Vol 13 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 (RB of Kensington and Chelsea)	Greater London
No car households	67.8%	53.0%	50.4%	37.5%
Income	0.0%	9.9%	20.8%	30.8%
Overall	0.0%	5.2%	22.9%	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 Chelsea 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 London Borough [RB] of Kensington and Chelsea) and for Greater London.

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

Employment and businesses

H.2.4 Within 250m of the site there are approximately 870 jobs.[vi] Vol 13 Table H.5[vii] illustrates the breakdown of employment by sector based on the UK Standard Industrial Classification (SIC) 2007[7]. It presents data for those sectors which account for more than 2% of total employment within approximately 250m. It can be seen that:

a. Human Health and Social Work Activities account for 81% of employment within 250m, around ten times more than within both the RB of Kensington and Chelsea (9%) and Greater London (8%).

b. Information and Communication Activities account for 3% of employment within 250m, slightly less than within the RB of

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

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

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

Kensington and Chelsea (4%) and considerably lower than within Greater London (7%).

c. Education accounts for 3% of employment within 250m, around half of that recorded within both the RB of Kensington and Chelsea (6%) and Greater London (7%).

d. Professional, Scientific and Technical Activities account for 2% of employment within 250m of the site, considerably less than within both the RB of Kensington and Chelsea (7%) and Greater London (11%).

e. Other Service Activities account for 2% of employment within 250m of the site, around half of that recorded within the RB of Kensington and Chelsea (5%) and Greater London (4%).

Vol 13 Table H.5 Socio-economics – employment by top five sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (RB of Kensington & Chelsea)**	**Greater London**
Human Health and Social Work Activities	81%	9%	8%
Information and Communication	3%	4%	7%
Education	3%	6%	7%
Professional, Scientific and Technical Activities	2%	7%	11%
Other Service Activities	2%	5%	4%
Other (including unclassified)	10%	69%	63%

H.2.5 Within approximately 250m of the site there are approximately 50 businesses (defined here as business locations[viii]). The split of businesses by sector within 250m broadly reflects the breakdown of employment by sector set out in Vol 13 Table H.5, with Human Health and Social Work Activities (19%) accounting for the largest proportion of businesses. Other Service Activities (8%), Professional, Scientific and Technical Activities (8%), Education (5%) and Information and Communication (5%) also account for relatively large proportions of businesses.

H.2.6 Vol 13 Table H.6 illustrates the size of businesses in terms of the number of employees at each business location / unit. At all geographical levels, businesses within the smallest size band (1 to 9 employees) account for the greatest proportion. Within approximately 250m of the site 92% of business units have 1 to 9 employees, which is somewhat higher than

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

within both the RB of Kensington and Chelsea (85%) and Greater London (88%). However there are a somewhat greater proportion of large businesses than within the wider geographical areas, with 2% of businesses within 250m employing more than 250 people compared to 0% within the RB of Kensington and Chelsea and Greater London respectively.

H.2.7 For the sectors accounting for the greatest proportion of jobs and businesses within approximately 250m, the size banding of businesses varies. In the Professional, Scientific and Technical Activities sector 100% of businesses have 1 to 9 employees, whereas 73% of Human Health and Social Work Activities and 67% of Information and Communication businesses are of this size. This is compared to an average across all sectors of 92%.

H.2.8 Within the Human Health and Social Work Activities sector 18% of businesses employ ten to 24 people which is considerably greater than the average across all sectors of 7%. A further 9% of businesses within this sector employ over 250 employees which is considerably more than the average across all sectors of 2%. These businesses are likely to be associated with nearby institutions such as the Royal Hospital Chelsea and The Lister Hospital. All businesses engaged in Professional, Scientific and Technical Activities employ between one to nine employees.

Vol 13 Table H.6 Socio-economics – businesses by size band (number of employees)

Assessment area / sector	Size band (number of employees)					
	1-9	10-24	25-49	50-99	100-249	250+
Immediate area (250m)	92%	7%	0%	0%	0%	2%
Human Health and Social Work Activities	73%	18%	0%	0%	0%	9%
Information and Communication	67%	33%	0%	0%	0%	0%
Professional, Scientific and Technical Activities	100%	0%	0%	0%	0%	0%
Borough wide (RB of Kensington & Chelsea)	85%	10%	3%	1%	0%	0%
Greater London	88%	8%	2%	1%	1%	0%

H.3 Baseline - Open space usage surveys

H.3.1 Please refer to Volume 2 Appendix H for details on the methodology used for the open space usage surveys and subsequent analysis.

Survey dates and times

H.3.2 Surveys were undertaken as follows.

Summer

a. Saturday 20th August 2011, 10am to 2pm (partly sunny, 19°C)

b. Sunday 21st August 2011, 2pm to 5pm (sunny, 23°C)

c. Thursday 25th August, 10am to 8pm (sunny, 21°C).

Autumn

d. Saturday 15th October 2011, 10am to 4pm (sunny, 17°C)

e. Friday 18th October 2011, 10am to 5pm (sunny, 12°C).

Earlier Surveys - Spring

H.3.3 In addition, the Royal Hospital Gardens and Ranelagh Gardens were surveyed in a walk over lasting for approximately 20 to 30 minutes each on three survey days in Spring 2011:

a. Saturday 16th April 2011, 4pm to 5pm (cloudy, 17°C)

b. Sunday 17th April 2011, 3.30pm to 4.30pm (sunny, 20°C)

c. Tuesday 19th April 2011, 11am to 12pm (sunny, 23°C).

2012 RHS Chelsea Flower Show

H.3.4 Surveys of the Thames Path and National Cycle Route 4 (NCR4) were undertaken during the 2012 RHS Chelsea Flower Show on the following days:

a. Wednesday 23rd May 2012, 4pm to 7pm (sunny, 24°C)

b. Saturday 27th May 2012, 4pm to 7pm (sunny, 26°C).

Survey points and zones

H.3.5 Vol 13 Figure H.1 (see separate volume of figures) identifies the location of the survey areas listed in Vol 13 Table H.7 below.

Vol 13 Table H.7 Socio-economics – survey zones and duration of survey period

Name	Location	On-site survey times
Survey point 1	Thames Path and NCR 4, on south side of A3212 Chelsea Embankment	15 minutes (concurrent with survey point 2)
Survey point 2	Pavement and NCR4, on north side of A3212 Chelsea	15 minutes (concurrent with survey point 1)

Name	Location	On-site survey times
	Embankment	
Survey zone 3	Royal Hospital Gardens	10 to 15 minutes walkthrough
Survey zone 4	Ranelagh Gardens: northern lawn and pavilion	20 minute walkthrough
Survey zone 5	Ranelagh Gardens: north central lawn	
Survey zone 6	Ranelagh Gardens: south central lawn and wildflower field	
Survey zone 7	Ranelagh Gardens: southern lawn	

Site specific considerations

H.3.6 At this location the Thames Path runs along the south side of an 'A' road, but there is a parallel route on the north side of the road which is also used by pedestrians, including those going to and from the Royal Hospital Gardens. For this reason, both sides of the road were surveyed in order to capture the different usage of the south and north sides of the A3212 Chelsea Embankment. The south path runs along the river wall. Cyclists were recorded on both the Thames Path itself, which forms part of the NCR4 at this location (ie, on the pavement) and on the road.

H.3.7 Weather conditions worsened with sudden, prolonged rainfall after a previously sunny morning, at around 2pm on Saturday 20th August. The survey was suspended and resumed at 2pm the next day when weather conditions were considerably sunnier.

H.3.8 In the autumn surveys, the eastern half of the grounds of the Royal Hospital Gardens was closed due to an event that had been held in the grounds. The direct route through the Royal Hospital Gardens from Chelsea Embankment to Ranelagh Gardens was closed at this time and so although it was still possible to access the grounds, usage of the park is likely to have been lower on that occasion. However, given the frequency with which events are held in the Royal Hospital Gardens, this situation was not extraordinary.

Key findings and observations

Survey points 1 and 2 – Thames Path south and north

H.3.9 A high number of users were recorded using the Thames Path on all survey days. Usage of the Thames Path on the southern side of Chelsea Embankment road (survey point 1) was considerably higher on the weekend surveys. In contrast, the pedestrian pavement on the northern side of the road (survey point 2) had more constant levels of use.

H.3.10 The main users of the Thames Path were recreational walkers and joggers (over 80% on all survey days), with lower incidences of use by on path cyclists and dog walkers.

H.3.11 A peak usage level of 25 joggers was recorded on a summer weekend morning survey in one survey period at point 1.

H.3.12 Over 90% of Thames Path joggers and cyclists used the pavement on the south side of Chelsea Embankment (point 1) rather than the north pavement, indicating a preference for being closer to the river and its views. For walkers, the split was less pronounced though there was still a preference to use the southern side.

H.3.13 During the evening peak commute time, there was a high volume of on road cyclists travelling westbound on the south side of the road. It is assumed that this peak flow of travel would be reversed during the morning peak commute time, with higher volumes of users being recorded on the north side of the road than the south.

H.3.14 The number of cyclists riding on the Thames Path pavement was much lower than on road, with these users travelling at a slower pace indicating a preference by leisure users to use the pavement and commuters to use the road.

H.3.15 Users were predominantly White, averaging 90% in most 15 minute survey periods.

H.3.16 Recreational walkers were mostly young adults (18 to 39 years old), with smaller proportions being older adults (40 to 59 years old) or children aged zero to five years. Dog walkers were mainly older adults and the majority of joggers and cyclists (over 80% on average) appeared to be young adults.

H.3.17 See Vol 13 Table H.8 and Vol 13 Table H.9 for more details on usage of the Thames Path.

Vol 13 Table H.8 Socio-economics – usage level and type of user at survey point 1 (south side of A3212)

Date	Time of survey	Number of pedestrian users			Averaged per hour	Cyclists (on-path averaged per hour)	Cyclists (on-road averaged per hour)
		Walkers	Joggers	Dog walkers			
Summer							
Saturday 20th August 2011	10:05 - 10:20	8	23	-	124	8	28
	11:05 - 11:20	14	25	-	156	16	52
	12:05 - 12:20	4	14	-	72	8	28
	13:05 - 13:20	3	7	-	40	-	4
Sunday 21st August 2011	14:05 - 14:20	7	3	2	48	12	8
	15:05 - 15:20	10	5	-	60	0	36
	16:05 - 16:20	16	5	-	84	32	24
Thursday	10:00 - 10:15	7	1	-	32	-	4

Date	Time of survey	Number of pedestrian users			Averaged per hour	Cyclists (on-path averaged per hour)	Cyclists (on-road averaged per hour)
		Walkers	Joggers	Dog walkers			
	11:00 - 11:15	1	-	-	4	-	-
	12:00 - 12:15	13	-	-	52	8	-
	13:00 - 13:15	2	1	-	12	16	-
	14:00 - 14:15	1	-	-	4	24	-
	15:00 - 15:15	2	1	-	12	-	-
	16:05 - 16:20	4	5	-	36	16	20
	17:05 - 17:20	9	5	-	56	12	116
	18:05 - 18:20	7	15	-	88	8	468
	19:00 - 19:15	13	26	-	156	20	256
Autumn							
Saturday 15th October 2011	10:30 - 10:45	9	20	1	120	4	20
	11:50 - 12:05	9	17	-	104	12	20
	12:50 - 13:05	14	11	-	100	8	28
	13:50 - 14:05	18	13	-	124	12	72
	14:45 - 15:00	20	5	1	104	24	36
Friday 21st October	10:00 - 10:15	1	6	-	28	-	40
	11:00 - 11:15	4	5	-	36	4	4
	12:00 - 12:15	3	3	-	24	-	24
	14:00 - 14:15	5	2	-	28	4	20
	15:00 - 15:15	4	-	-	16	8	20
	16:00 - 16:15	2	1	-	12	24	48

Vol 13 Table H.9 Socio-economics – usage level and type of user at survey point 2 (north side of A3212)

Date	Time of survey	Number of users				Averaged by hour	Cyclists (on-road averaged per hour)
		Walkers	Joggers	Dog walkers	Cyclists (on-path)		
Summer							
Saturday 20th August 2011	10:05 - 10:20	4	3	-	-	28	20
	11:05 - 11:20	2	1	-	-	12	48
	12:05 - 12:20	2	1	-	-	12	36
	13:05 - 13:20	5	-	2	-	28	-
Sunday 21st August 2011	14:05 - 14:20	2	-	-	-	8	28
	15:05 - 15:20	7	3	-	-	40	28
	16:05 - 16:20	8	-	-	2	40	28
Thursday	10:00 - 10:15	7	1	-	1	36	-

Date	Time of survey	Number of users				Averaged by hour	Cyclists (on-road averaged per hour)
		Walkers	Joggers	Dog walkers	Cyclists (on-path)		
	11:00 - 11:15	1	-	-	-	4	-
	12:00 - 12:15	13	-	-	-	52	8
	13:00 - 13:15	2	1		-	12	16
	14:00 - 14:15	1	-	-	-	4	24
	15:00 - 15:15	2	1	-	-	12	-
	16:05 - 16:20	16	-	-	-	64	12
	17:05 - 17:20	12	-	1	-	52	84
	18:05 - 18:20	14	-	-	1	60	88
	19:00 - 19:15	2	2	-	-	16	68
Autumn							
Saturday 15th October 2011	10:30 - 10:45	4	2	-	-	24	-
	11:50 - 12:05	7	-	1	-	32	40
	12:50 - 13:05	7	-	-	1	32	48
	13:50 - 14:05	6	-	-	-	24	32
	14:45 - 15:00	14	-	-	-	56	28
Friday 21st October 2011	10:00 - 10:15	3	1	1	-	20	40
	11:00 - 11:15	10	-	1	-	44	4
	12:00 - 12:15	5	-	1	-	24	24
	14:00 - 14:15	11	-	1	-	48	20
	15:00 - 15:15	7	-		1	32	20
	16:00 - 16:15	9	1	-	-	40	48

2012 RHS Chelsea Flower Show

H.3.18 The pavement on the north of Chelsea Embankment Road was recorded as being well used during the surveys, in large part as a result of its proximity to the show's main exit at the Bull Ring gate. A peak usage level of 688 movements per hour was recorded at this point on the weekday survey.

H.3.19 The southern (Thames Path) pavement experienced more moderate usage, with a peak usage level of 25 users per hour being recorded on the weekend survey.

H.3.20 Usage of both the southern (NCR4) pavement and road for cycling was recorded as being similar to usage levels recorded during summer and autumn surveys.

H.3.21 See Vol 13 Table H.10 and Vol 13 Table H.11 for more details.

Vol 13 Table H.10 Socio-economics – usage level and type of user at survey point 2 (south side of A3212)

Date	Time of survey	Number of users				Averaged by hour	Cyclists (on-road) averaged per hour
		Walkers	Joggers	Dog walkers	Cyclists (on-path)		
Summer							
Tuesday 23rd May 2012	16:00 - 16:15	13	-	-	5	72	36
	16:30 - 16:45	14	-	-	1	60	68
	17:00 - 17:15	4	-	-	3	28	84
	17:30 - 17:45	21	-	-	7	112	376
	18:00 - 18:15	14	-	-	3	68	400
	18:30 - 18:45	14	-	-	1	60	32
Saturday 26th May 2012	16:00 - 16:15	55	-	-	4	256	16
	16:30 - 16:45	60	-	-	-	240	0
	17:00 - 17:15	45	3	-	11	208	44
	17:30 - 17:45	48	4	-	11	228	44
	18:00 - 18:15	26	10	-	10	164	40
	18:30 - 18:45	10	3	-	8	52	0

Vol 13 Table H.11 Socio-economics – usage level and type of user at survey point 2 (north side of A3212)

Date	Time of survey	Number of users				Averaged by hour	Cyclists (on-road averaged per hour)
		Walkers	Joggers	Dog walkers	Cyclists (on-path)		
Summer							
Tuesday 23rd May 2012	16:00 - 16:15	164	4	3	1	688	12
	16:30 - 16:45	93	5	-	-	392	64
	17:00 - 17:15	119	7	-	6	528	84
	17:30 - 17:45	137	11	-	-	592	84
	18:00 - 18:15	109	3	-	4	464	120
	18:30 - 18:45	80	5	-	1	344	4
Saturday 26th May 2012	16:00 - 16:15	130	-	-	-	520	36
	16:30 - 16:45	135	-	-	-	540	72
	17:00 -	135	-	-	-	540	60

Date	Time of survey	Number of users				Averaged by hour	Cyclists (on-road averaged per hour)
		Walkers	Joggers	Dog walkers	Cyclists (on-path)		
	17:15						
	17:30 - 17:45	110	-	-	-	440	24
	18:00 - 18:15	82	-	-	-	328	52
	18:30 - 18:45	28	-	-	-	112	60

Survey point 3 – Royal Hospital Gardens

Summer and autumn

H.3.22 The Royal Hospital Gardens were used by a relatively low number of users at fairly constant levels on both weekdays and weekends.

H.3.23 During summer surveys, the majority of users observed were recreational walkers and dog walkers (over 70% on each survey day), who were mostly walking through from north to south or vice versa.

H.3.24 During autumn, the west side of the gardens was marked out as a football pitch and footballers accounted for significant proportions of total user numbers on these surveys. The weekday survey recorded two separate groups of primary school children (aged 5 to 11) and organisers (aged 18 to 39) using the lawn.

H.3.25 There were also occasional uses of the space for passive recreation. There was use by occasional joggers (generally male, White young adults) and one older person using an electric wheelchair was recorded.

H.3.26 The majority of users were White (over 95%). See Vol 13 Table H.12 for more details.

Vol 13 Table H.12 Socio-economics – average usage level and type of user at survey zone 3

	Time of survey	Average number of users during 10 minute observation periods					
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation	Active formal recreation*
Summer							
Saturday 20th August 2011	10:00 - 14:00	6	-	1	-	1	-
Sunday 21st August 2011	14:00 - 17:00	7	-	1	-	2	-
Thursday 25th August 2011	10:00 - 20:00	6	-	1	-	1	-
Autumn							

	Time of survey	Average number of users during 10 minute observation periods					
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation	Active formal recreation*
Saturday 15th October 2011	10:00 - 16:00	2	-	1	-	2	20 (for 2 hours)
Friday 21st October 2011	10:00 - 17:00	2	-	2	-	2	40 (for 2 hours)

** At times when football pitch was in-use*

Spring

H.3.27 No more than 20 people were recorded in the grounds at any one time over the course of the three surveys.

H.3.28 Users were generally using the grounds as a thoroughfare, though some users were recorded sitting on benches on Sunday 17th April.

H.3.29 Most users were in groups of young adults or family groups. See Vol 13 Table H.13 for more details.

Vol 13 Table H.13 Socio-economics – usage level at Royal Hospital Gardens during Spring surveys

Date	Time	Approximate number of users (at any one time)
Saturday 16th April 2011	16:00 - 17:00	5 - 10
Sunday 17th April 2011	15:30 - 16:30	20
Tuesday 19th April 2011	11:00 - 12:00	4

Survey zones 4, 5, 6 and 7 – Ranelagh Gardens

Summer and autumn

H.3.30 As a whole the gardens were used mainly by people walking or sitting. A peak of 66 users were recorded in one 20 minute observation period (the time it took to circuit the garden), though 50 of these users were a group of schoolchildren and their supervisors. Other than this occasion, the maximum number of users recorded in the gardens in any single observation period was 34. See Vol 13 Table H.14 for further details.

H.3.31 The northern lawn (survey zone 4) was observed to be the most heavily used, becoming considerably busier from 3pm onwards, both on weekdays and weekends. Users generally spent between 15 minutes and 2 hours on average in this area.

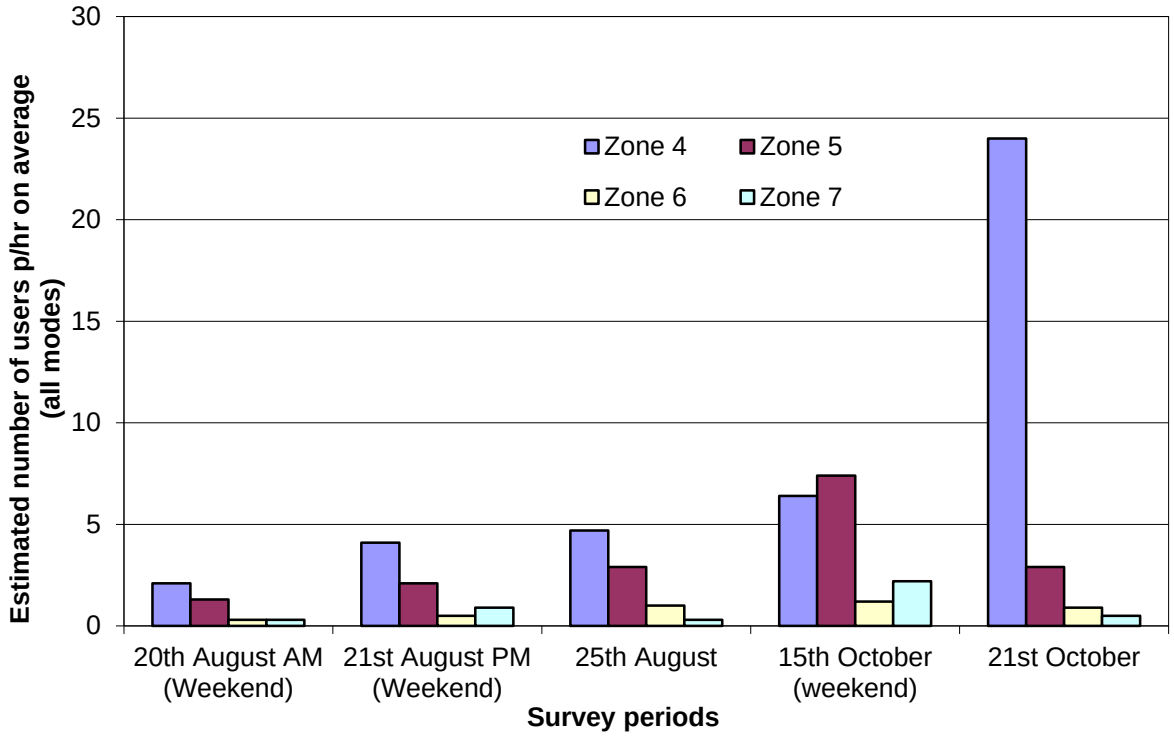
H.3.32 Low numbers of users were recorded in the more southerly lawns (particularly Zones 6 and 7), with no users often being recorded in these areas during some survey periods.

H.3.33 Walking and passive recreation (sitting, picnics, reading etc) were the predominant uses recorded in zones 4 to 7. Seating is concentrated around the northern lawn (zone 4), with lone benches in the zones in the

southerly parts of the gardens. to the south, though few instances of use of these were recorded.

H.3.34 The vast majority of users of these zones were White (over 90% on each survey day), and users were mainly small groups or pairs of older adults (40 to 59 years old), often accompanied by young children (under 12 years old), in addition to lone users typically aged 60 and over (assumed to be residents of the Royal Hospital Chelsea given that they were in uniform). See Vol 4 Plate H.1 and Vol 13 Table H.14 for further details.

Vol 4 Plate H.1 Socio-economics – usage level (averaged per hour) at Ranelagh Gardens (zones 4 to 7) in summer and autumn



Vol 13 Table H.14 Socio-economics – usage level and type of user at Ranelagh Gardens (zones 4 to 7) in summer and autumn

Date	Time of survey	Number of users			Total
		Walkers / wheelchair user	Passive recreation	Active recreation (informal)	
Summer					
Saturday 20th August	10:30 - 10:50	-	3	-	3
	11:30 - 11:50	2	7	7	16
	12:30 - 12:50	10	9	3	22
	13:30 - 13:50	2	-	-	2
Sunday 21st	14:30 - 14:50	-	8	-	8

Date	Time of survey	Number of users			Total
		Walkers / wheelchair user	Passive recreation	Active recreation (informal)	
August	15:30 - 15:50	12	17	5	34
	16:30 - 16:50	4	29	3	36
Thursday 25th August	10:30 - 10:50	2	-	-	2
	11:30 - 11:50	9	-		9
	12:30 - 12:50	1	1	3	5
	13:30 - 13:50	5	11	-	16
	14:30 - 14:50	9	2	-	11
	15:30 - 15.50	15	4	-	19
	16:30 - 16:50	10	15	-	25
	17:30 - 17:50	3	10	-	13
	18:30 - 18:50	-	6	-	6
	19:30 - 19:50	1	3	--	4
Autumn					
Saturday 15th October	11:00 - 11:20	5	9	8	22
	12:00 - 12:20	13	6	3	22
	13:00 - 13:20	2	4	2	8
	14:00 - 14:20	2	5	-	7
	15:00 - 15:20	11	6	2	19
Friday 21st October	10:25 - 10:45	5	2	54	61
	11:25 - 11:45	3	-	52	55
	12:25 - 12:45	2	-	-	2
	14:25 - 14:45	2	1	-	3
	15:25 - 15:45	13	-	-	13
	16:25 - 16:45	7	-	-	7

Spring

a. On each of the three survey visits, approximately 25 to 35 people were recorded during a complete circuit of the gardens.

b. Main activities recorded were walking and relaxing on lawns and benches, with children observed to be engaging in informal play.

c. Weekday users were almost exclusively older mothers (40 to 59 years old) with young children (mostly aged 0 to 5 years old). On the weekend survey, older people (aged 60+ years old and who appeared

to be Royal Hospital Chelsea residents) accompanied by family members were recorded.

d. During the spring surveys, most users were concentrated on the northern lawn, consistent with the findings of the later summer and autumn surveys.

e. See Vol 13 Table H.15 for more details

Vol 13 Table H.15 Socio-economics – usage at Ranelagh Gardens during Spring surveys

Date	Time	Approximate number of users*
Saturday 16th April	16:00 – 17:00	25
Sunday 17th April	15:30 – 16:30	35
Tuesday 19th April	11:00 – 12:00	35

** As observed during a single 30 minute walk over survey*

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[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.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea Embankment Foreshore appendices

Appendix I: Townscape and visual

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

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Creating a cleaner, healthier River Thames

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Appendix I: Townscape and visual

I.1 Introduction

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

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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

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

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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 Chelsea Embankment Foreshore site is provided in Vol 13 Table K.1.

Vol 13 Table K.1 Summary of 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

K.1.2 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey – BGS (BGS, 2009)[1], is shown in Vol 13 Figure 13.4.1 and Vol 13 Figure 13.4.2 respectively (see separate volume 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 ground investigation boreholes drilled off site and up to 300m distance from the site; these are boreholes SR1087A, PR1088A, SR1089 and PR1090. In addition two overwater boreholes, SR2067 and SR2068, have been used to assess the lateral continuity of the site geology. The locations of boreholes around the site are shown in Vol 13 Figure 13.4.1 (see separate volume of figures). The depths and thicknesses of geological layers encountered are summarised in Vol 13 Table K.2.

Vol 13 Table K.2 Groundwater - anticipated ground conditions

Formation	Top elevation* (mATD)**	Depth below river bed (m)	Thickness (m)
Alluvium	100.0	0.0	1.4
River Terrace Deposits	98.6	1.4	2.85
London Clay			

Formation	Top elevation* (mATD)**	Depth below river bed (m)	Thickness (m)
B	95.75	4.25	12.75
A3ii	83.00	17.00	10.60
A3i	72.40	27.60	2.90
A2	69.50	30.50	11.10
Harwich	58.4	41.60	0.10
Lambeth Group			
USB	58.30	41.70	2.40
UMB	55.90	44.10	5.70

** Based on assumed ground level of 105.4mATD*
*** 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

K.1.4 The CSO drop shaft at the Chelsea Embankment Foreshore site would extend down to approximately 59.96mATD and would pass through the Alluvium, River Terrace Deposits, London Clay Formation, units B, A3ii and A3i and into the London Clay Formation, unit A2. The base slab would extend to approximately 56.96mATD and would be constructed within the Upper Shelly Beds of the Lambeth Group.

K.1.5 The shallow interception chamber, culvert and valve chamber approximately 5.9m deep, as assumed for the purposes of this assessment, would extend down to 99.1mATD into the Alluvium. The deep overflow chamber, culvert and valve chamber would extend down 17.5m to approximately 88mATD and into the London Clay Formation, unit B.

K.1.6 The short connection tunnel would be constructed within the London Clay Formation, unit A2, with a possible interception of the Harwich Formation and top of the upper part 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 1.4m thick at the Chelsea 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 2.85m thick at the Chelsea 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 Chelsea 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 37.35m thick at the Chelsea Embankment Foreshore site.

K.1.10 The Harwich Formation is expected to be 0.1m thick at the Chelsea Embankment Foreshore site and comprises of fine-grained glauconitic sand and rounded black flinty pebble beds, commonly deposited in a series of superimposed channels.

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 expected to be 2.4m thick at the Chelsea 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, with up to 50% silt and sand. The Upper Mottled beds are expected to be 5.7m thick at the Chelsea Embankment Foreshore site.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the Chelsea Embankment Foreshore is shown in Vol 13 Table K.3.

Vol 13 Table K.3 Groundwater - anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial deposits	Alluvium	Confining layer
	River Terrace Deposits	Upper aquifer
Thames	London Clay	Aquiclude*
	Harwich	Aquitard** / aquifer
Lambeth	Upper Shelly Beds	Aquitards

** 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[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].*

K.2.2 The Alluvium, overlying the River Terrace Deposits or upper aquifer, was drilled dry in the ground investigation boreholes, with groundwater encountered within the River Terrace Deposits. This suggests that the Alluvium acts to confine these deposits.

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” (EA, 2012).

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 Chelsea Embankment Foreshore site.

K.2.5 The CSO drop shaft would pass through the upper aquifer and then into the London Clay Formation (B, A3ii, A3i and A2 sub divisions). The London Clay Formation is generally acknowledged as an aquiclude between the upper and lower aquifers. Any groundwater present in a majority of the London Clay Formation is likely to consist of localised seepages and/or minor flows. It is anticipated that below the River Terrace Deposits the shaft would be excavated in predominantly dry London Clay Formation with the exception of minor seepage at various horizons, namely silt or claystone horizons. In unit A3ii, the presence of fine sand laminea/lenses at this horizon, may act as horizontal conduits for migration of groundwater from a nearby source.

K.2.6 The base slab would extend through the Harwich Formation, which may form a minor aquifer unit where it is isolated from the lower aquifer by the Lambeth Group. There may be limited connection via erosive features to the lower aquifer.

K.2.7 The base slab would be founded in the Upper Shelly Beds of the Lambeth Group. Several confined groundwater bodies are anticipated to be encountered within the Lambeth Group. Groundwater inflows are expected during excavation within the Upper Shelly Beds (USB) with potentially small inflows.

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 three off site ground investigation boreholes (PR1088A, SR1091 and SR1089). These boreholes have response zones[i] and monitor groundwater levels in the River Terrace Deposits and in the Upper Shelly Beds. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 13 Table K.4. The manual dip and logger data collected from these monitoring boreholes is shown in Vol 13 Table K.5.

Vol 13 Table K.4 Groundwater - monitoring boreholes

Borehole	Response zone (mATD)	Strata	Monitoring
PR1088A (U)	94.89-98.89	River Terrace Deposits	Logger and fortnightly dips
SR1091 (U)	97.24-100.34	River Terrace Deposits	Fortnightly dips
SR1089 (U)	44.60-45.80	Harwich Formation/ Upper Shelly Beds	Fortnightly dips

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

Vol 13 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
PR1088A (U)	18/11/2009 – 01/05/2012	5.30 (June 2011)	99.60 (June 2011)	6.13 (November 2011)	98.76 (November 2011)	5.69	99.20
SR1091 (U)	27/10/2009 – 10/04/2012	4.50 (October 2010)	99.84 (October 2010)	5.07 (March 2012)	99.27 (March 2012)	4.77	99.57
SR1089 (U)	27/10/2009 – 19/03/2012	19.20 (February 2011)	84.44 (February 2011)	23.05 (November 2011)	80.59 (November 2011)	20.74	82.91

K.3.3 Of the two monitoring boreholes within the River Terrace Deposits, the monitoring borehole SR1091 is closest to the Chelsea Embankment Foreshore site (at 280m) and therefore considered to be the most representative of groundwater level conditions in the River Terrace Deposits at the site. The recorded water levels in the River Terrace Deposits here range from 99.27 to 99.84mATD. These water levels consistently remain above the top of the formation at 98.6mATD, suggesting that this unit is fully saturated and confined by the overlying Alluvium at this location.

K.3.4 The recorded water levels (piezometric head) in the Harwich Formation/ Upper Shelly Beds range from 80.59 to 84.44mATD. These levels consistently remain above the top of the Harwich Formation at 58.4mATD, suggesting that these units are fully saturated and are confined by the overlying London Clay Formation.

K.3.5 A plot of groundwater levels within the River Terrace Deposits or upper aquifer in the vicinity of the site is shown in Vol 13 Figure 13.4.3. (see separate volume of figures). The two monitoring boreholes close to the site are parallel and in close proximity to the River Thames and as such it is difficult to determine the direction of groundwater flow within this waterbody. However it is expected that the direction of groundwater movement is to the south 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.4 Groundwater abstractions and protected rights

Groundwater licensing policy

K.4.1 The London Catchment Abstraction Management Strategy (CAMS), (EA, 2006)[5] does not identify a condition status for the upper aquifer.

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

K.4.3 The estimated dewatering volumes required at Chelsea Embankment Foreshore site from the Lambeth Group of less than 200m^3/d, are 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.

K.4.4 Any water entering the excavation from either the superficial deposits, from minor seepages through silt layers in the London Clay Formation or from water-bearing horizons of the Harwich Formation or the Lambeth Group would be pumped to the River Thames via appropriate settlement tanks.

Licensed abstractions

K.4.5 The EA licenses abstraction from groundwater within London for all sources in excess of 20m^3/d. Groundwater abstractions within 1km of the site have been identified.

K.4.6 There are two licensed groundwater abstractions from the River Terrace Deposits or upper aquifer located within 1km of the Chelsea Embankment Foreshore site.

K.4.7 The nearest licensed groundwater abstraction within the River Terrace Deposits (28/39/39/0225) is located approximately 140m to the northeast of the Chelsea Embankment Foreshore site, is held by the Royal Horticultural Society and is used for agricultural (horticultural watering) purposes (see Vol 13 Table K.6).

K.4.8 The next nearest licensed groundwater abstraction within the River Terrace Deposits (28/39/39/0223) is located approximately 1.3km northeast of the Chelsea Embankment Foreshore site, is held by London Underground Limited and is used for industrial, commercial and public services (non-evaporative cooling) purposes (see Vol 13 Table K.6).

K.4.9 The licensed abstractions from the lower aquifer (Chalk) would be unaffected due to construction taking place entirely within the upper aquifer, the London Clay Formation and the Upper Shelly Beds (Lambeth Group).

K.4.10 There are no known unlicensed groundwater abstractions within the upper aquifer located within a 1km radius of the site.

Vol 13 Table K.6 Groundwater - licensed abstractions

Licence number	Licence holder	Purpose	Aquifer
28/39/39/0225	Royal Horticultural Society	Agricultural (horticultural watering)	River Terrace Deposits
28/39/39/0223	London Underground Limited	Industrial, commercial and public services (non-evaporative cooling)	River Terrace Deposits

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 Chelsea Embankment Foreshore site does not lie within a modelled SPZ, the nearest being at 0.2km to the east for a Chalk source. This is an SPZ 2, defined as a 400 day travel time to a source, for a Thames Water Utilities source at Battersea Pumping Station, which abstracts from the Chalk (see Vol 13 Figure 13.4.2 in separate volume of figures). The licensed abstractions from the lower aquifer (Chalk) would be unaffected due to construction taking place entirely within the upper aquifer, the London Clay Formation and the Upper Shelly Beds (Lambeth Group).

K.5.3 A capture zone[ii6] for the licensed groundwater abstraction source 28/39/39/0225 has been estimated using licence information. The capture zone extends into onshore parcel of land required for the Chelsea Embankment Foreshore site but remains at approximately 75m from the foreshore parcel which is to house the drop shaft. This abstraction source is considered to be located across hydraulic gradient of the Chelsea Embankment Foreshore site.

K.5.4 A capture zone for the licensed groundwater abstraction source 28/39/39/0223 has been estimated using licence information. The capture zone extends into onshore parcel of land required for the Chelsea Embankment Foreshore site but remains at approximately 0.9km from the foreshore parcel which is to house the drop shaft. This abstraction source is considered to be located up hydraulic gradient of the Chelsea Embankment Foreshore site.

K.6 Environmental designations

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

[ii] Capture zone - a zone of contribution around a well that encompasses all areas or features that supply groundwater to the well.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical land use mapping, reviewed as part of the land quality assessment, at the Chelsea Embankment Foreshore site identified no potentially contaminative land uses on site or in the immediate vicinity of the site (Vol 13 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 baseline groundwater quality data presented in Vol 13 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 offsite and up to 1km away (SR1091, PR1088, PR1094, SA1084 (for locations see Vol 13 Figure 13.4.1 in separate volume of figures). 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 several exceedances of the relevant standards, including for ammonia, chloride, sodium, pesticides and turbidity at PR1088 (within 310m of the site), for heavy metals, polycyclic aromatic hydrocarbons (PAH's) and phenols at PR1094 (within 840m of the site) and for heavy metals and hydrocarbons at SA1084 (within 1050m of the site). 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]. Phenols may be formed naturally by the decomposition of organic materials but are also a constituent of coal tar[10]. In addition, PAH's and phenols are considered to be Priority Hazardous Substances under the Water Framework Directive[11].

K.7.4 The EA monitors groundwater quality at a number of points across London. The nearest EA monitoring is at Dolphin Square at approximately 1km from the Chelsea Embankment Foreshore site. However this borehole monitors water quality in the lower aquifer only and is therefore not relevant as construction would take place entirely with the upper aquifer, the London Clay Formation and the Upper Shelly Beds (Lambeth Group).

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show several exceedances of the human health screening values[12] (soil guideline values designed to be protective of human health) with respect to hydrocarbons and heavy metals within the River Terrace Deposits. Further detail is provided in the land quality assessment (see Vol 13 Appendix F).

Vol 13 Table K.7 Groundwater – groundwater quality results

Source of data*				SI	TT	TT	TT	TT	TT	TT	TT	SI	SI
Name				SR1091	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1088	PR1094	SA1084
Hydrogeological unit**				RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			280m	310m	310m	310m	310m	310m	310m	310m	837m	1053m
Chemical	Value	Units	Source	2009	22/8/2011	2/11/2011	9/1/2012	23/3/2012	2/5/2012	14/8/2012	17/8/2012	2009	2009
1,1 - Dichloroethane	10	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	<1.2
1,1 - Dichloroethene	30	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	<1.2
1,1 - Dichloropropene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.3
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-	<0.08	<0.08	<0.08	-	< 0.08	<0.08	-	-	<1.3
1,1,1,2 - Tetrachloroethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.3
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-	<0.2	<0.2	<0.2	-	< 0.2	<0.2	-	-	<2.2
1,1,2,2 - Tetrachloroethane {Acetosan}{Bonaform}{Cas Rn 79-34-5}	-	ug/l	None	-	-	-	-	-	-	-	-	-	<5.2
1,2 - Dibromo - 3 - Chloropropane	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<9.8
1,2 - Dibromoethane	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<2.3
1,2 - Dichlorobenzene	1000	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	<1
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-	<0.12	<0.12	<0.12	-	< 0.12	<0.12	-	-	<3.3
1,2 - Dichloroethene (Trans)	30	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	<1.9
1,2 - Dichloropropane	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<3
1,2,3 - Trichlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<3.1
1,2,3 - Trichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<7.8
1,2,4 - Trichlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
1,3 - Dichlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
1,3 - Dichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2.2
1,3 - Dichloropropene (Trans)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<3.5
1,3,5 - Trichlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
1,3,5 - Trimethylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2 - Chloronaphthalene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2 - Chlorophenol	50	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	<1
2 - Chlorotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.9
2 - Methylnaphthalene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2 - Methylphenol {O-Cresol}	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2 - Nitroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2 - Nitrophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2,2 - Dichloropropane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<3.8
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	<0.4	-	-	-	-	-	-	-	<0.1	<1
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	<0.4	-	-	-	-	-	-	-	<0.1	<1
2,4 - Dinitrotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2,4,5 - Trichlorophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
2,4,6 - Trichlorophenol	-	ug/l	None	<0.4	-	-	-	-	-	-	-	<0.1	<1
2,6 - Dichlorophenol	-	ug/l	None	<0.4	-	-	-	-	-	-	-	<0.1	-
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-
2,6 - Dinitrotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
3 - Nitroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	-
4 - Bromophenylphenyl ether	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	<0.4	-	-	-	-	-	-	-	<0.1	<1
4 - Chloroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1

4 - Chlorophenyl phenyl ether	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
4 - Isopropyltoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2.6
4 - Nitroaniline	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
4 - Nitrophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	<0.0500	-	-	-	-	<1
Acenaphthene	-	ug/l	None	<0.01	-	-	-	-	-	-	-	<0.01	<0.015
Acenaphthylene	-	ug/l	None	<0.01	-	-	-	-	-	-	-	<0.01	<0.011
Acenapthene	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-
Acenapthylene	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-
Aliphatics >C10-C12	-	ug/l	None	140	-	-	-	-	-	-	-	<1	<10
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	670	-	-	-	-	-	-	-	10	<10
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	1	-	-	-	-	-	-	-	43	<10
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	<1	-	-	-	-	-	-	-	120	<10
Aliphatics >C6-C8	-	ug/l	None	<0.1	-	-	-	-	-	-	-	<0.1	<10
Aliphatics >C8-C10	-	ug/l	None	<0.1	-	-	-	-	-	-	-	6.3	<10
Aliphatics C5-C6	-	ug/l	None	<0.1	-	-	-	-	-	-	-	<0.1	<10
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	-	<4	-	-	-	-	-	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	270	340	307	294	-	287	-	315	350	-
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	0.076	-	-	-	-	-
Aluminium Total	200	ug/l as Al	DWS 2010	-	37	62	0.034	-	0.013	0.057	-	-	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	2.7	3.4	3.8	-	2.72	2.84	-	-	-
Ammoniacal nitrogen	-	mg/l	None	4.3	-	-	-	-	-	-	-	23	3.25
Anthracene	0.1	ug/l	SW WFD	<0.01	-	-	-	<0.01	-	-	-	0.01	<0.015
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	0.3	-	-	-	-	-
Aromatics >C7-C8	50	ug/l	WFD 2010	<0.1	-	-	-	-	-	-	-	<0.1	<10
Aromatics >EC10-EC12	-	ug/l	None	30	-	-	-	-	-	-	-	36	<10
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	66	-	-	-	-	-	-	-	96	<10
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	9	-	-	-	-	-	-	-	75	<10
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	None	17	-	-	-	-	-	-	-	350	<10
Aromatics >EC8-EC10	-	ug/l	None	<0.1	-	-	-	-	-	-	-	<0.1	<10
Aromatics C6-C7	1	ug/l	DWS 2010	<0.1	-	-	-	-	-	-	-	<0.1	<10
Arsenic Total	10	ug/l as As	DWS 2010	<1	4.1	4.8	4.1	-	3.2	3.9	-	2	10.5
Atrazine { }	0.1	ug/l	DWS 2010	-	<0.00300	<0.00300	<0.04000	-	<0.00800	<0.00800	-	-	-
Azobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	120	-	-	-	-	-
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	130	-	-	-	-	-
Bentazone	0.1	ug/l	DWS 2010	-	<0.00800	<0.00800	<0.00800	-	<0.00800	<0.00800	-	-	-
Benz[a]-Anthracene	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-
Benzene	1	ug/l	DWS 2010	<1	<0.07	<0.07	<0.07	<0.07	< 0.07	<0.07	-	<1	<1.3
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	0.1	-	-	-	-	-
Benzo (a) anthracene	-	ug/l	None	<0.01	-	-	-	-	-	-	-	<0.01	<0.009
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.01	<0.00500	<0.00500	<0.00500	<0.01	<0.00500	<0.00500	-	<0.01	<0.009
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<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	<0.016
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	-	-	-	<0.01	-	-	-	<0.01	<0.027
Bifenthrin	-	ug/l	None	-	-	-	-	0.01400	-	-	-	-	-
Bis (2 - chloroethoxy) methane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Bis (2 - chloroethyl) ether	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Bis(2-ethylhexyl) phthalate	1.3	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	<2
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	190	-	-	-	-	-
Boron Total	1000	ug/l as B	DWS 2010	910	210	200	180	-	0.2	0.21	-	290	-

Bromate	10	ug/l as BrO3	DWS 2010	-	<0.5	<0.5	<0.5	-	< 5.0	<0.5	-	-	-
Bromobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2
Bromochloromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.9
Bromodichloromethane	100	ug/l	WS Regs 20	-	-	-	-	-	-	-	-	-	<0.9
Bromoform	100	ug/l	WS Regs 20	-	-	-	-	-	-	-	-	-	<3
Bromomethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2
Butyl benzyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Cadmium Total	5	ug/l as Cd	DWS 2010	<2	<1.5	<1.5	<1.5	<1.5	< 1.5	<1.5	-	<2	<0.22
Calcium Total	250	mg/l as Ca	DWS 2010	-	150	160	210	-	220	-	200	-	-
Carbazole	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	0.01000	0.01000	0.01100	-	0.00800	<0.00500	-	-	-
Carbetamide	-	ug/l	None	-	<0.00600	0.00800	0.00800	-	<0.01000	<0.01000	-	-	-
Carbon Dioxide	-	ug/l	None	-	-	-	-	55000	-	-	-	-	-
Carbon disulphide	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.3
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	2.5	-	-	-	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-	<0.07	<0.07	<0.07	-	< 0.070	<0.070	-	-	<1.4
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	-
Chloride	250	mg/l as Cl	DWS 2010	62	291	389	515	-	621	-	591	64	-
Chlorobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<3.5
Chloroethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2.5
Chloroform	100	ug/l	WS Regs 20	-	<0.6	<0.6	<0.6	-	< 0.600	<0.600	-	-	<1.8
Chloromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.7
Chlortoluron	2	ug/l	FW List II	-	0.00600	0.00600	0.00600	-	<0.01000	<0.01000	-	-	-
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	16	-	17	-	-	-
Chromium Total	50	ug/l as Cr	DWS 2010	<5	15	16	16	-	15	-	-	<5	2.3
Chrysene	-	ug/l	None	<0.01	-	-	-	<0.01	-	-	-	<0.01	<0.013
cis-1,3 - Dichloropropene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.9
cis-1-2-Dichloroethene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2.3
Clopyralid	-	ug/l	None	-	<0.01900	<0.01900	<0.01900	-	<0.01900	<0.01900	-	-	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	976	-	-	-	-	-	-	-	947	-
Copper Total	2000	ug/l as Cu	DWS 2010	6	<5.5	<5.5	<5.5	-	< 5.5	<5.5	-	8	3.36
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	<0.00500	-	-	-	-	-
Cresols	-	ug/l	None	<0.4	-	-	-	-	-	-	-	820	-
Cyanazine	0.1	ug/l	DWS 2010	-	<0.00700	<0.00700	<0.00700	-	<0.00800	<0.00800	-	-	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20	-	-	-	-	-	-	-	<20	-
Cyanide (Total)	50	ug/l as CN	DWS 2010	<40	-	-	-	-	-	-	-	<40	-
Cypermethrin	0.0001	ug/l	WFD 2010	-	0.19	<0.1	<0.1	-	< 0.100	<0.100	-	-	-
Cypermethrin ID	-	Code	None	-	-	-	-	21	-	-	-	-	-
Dalapon	-	ug/l	None	-	<0.05000	<0.05000	<0.05000	-	<0.05000	-	-	-	-
Di - n - octyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	<5
Diazinon	0.1	ug/l	DWS 2010	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	-
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.01	-	-	-	<0.01	-	-	-	<0.01	<0.016
Dibenzofuran	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Dibromochloromethane	100	ug/l	WS Regs 20	-	-	-	-	-	-	-	-	-	<1.7
Dibromoethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2.7
Dichlorodifluoromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.3
Dichloromethane	20	ug/l	WFD 2010	-	<3	<3	<3	-	< 3.0	<3.0	-	-	<3.7
Dichlorprop	0.1	ug/l	DWS 2010	-	<0.01100	<0.01100	<0.01100	-	<0.01100	<0.01100	-	-	-
Diethyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Dimethyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Di-n-butyl phthalate	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Diuron	0.1	ug/l	DWS 2010	-	0.04300	0.03300	<0.10000	-	0.04100	0.04700	-	-	-

Enterococci (Species)	-	Nr/100ml	None	-	-	-	-	0	-	-	-	-	-
Escherichia coli (Confirmed)	0	Nr/100ml	WS Regs 20	-	-	-	-	0	-	-	-	-	-
Ethofumesate	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-
Ethylbenzene	-	ug/l	None	<1	-	-	-	-	-	-	-	<1	<10
Fenuron	-	ug/l	None	-	-	-	-	<0.01	-	-	-	-	-
Fluoranthene	0.2	ug/l	EEC MAC	<0.01	-	-	-	<0.01	-	-	-	0.01	<0.014
Fluorene	-	ug/l	None	<0.01	-	-	-	<0.01	-	-	-	0.02	<0.014
Fluoride	1.5	mg/l as F	DWS 2010	-	0.4	0.36	0.25	-	0.33	0.488	-	-	-
Glyphosate	-	ug/l	None	-	<0.01400	<0.01400	<0.01400	-	<0.01400	<0.01400	-	-	-
GRO C4-C12	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Hexachloro 1,3 Butadiene	0.1	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	<1
Hexachlorobenzene	0.01	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	<1
Hexachlorocyclopentadiene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2
Hexachloroethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.01	-	-	-	<0.01	-	-	-	<0.01	<0.014
Iodide Ion	-	ug/l as I	None	-	-	-	-	41	-	-	-	-	-
Irgarol 1051	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	5.6	-	-	-	-	-
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	5.6	-	-	-	-	-
Isophorone	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2
Isopropylbenzene (Cumene)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.4
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	0.00800	0.00600	<0.05000	-	<0.00800	<0.00800	-	-	-
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	<5.00	-	-	-	-	-
Lead Total	10	ug/l	WS Regs 20	<4	<5	<5	<5	-	< 5	5	-	15	0.559
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	-	-	-	-	33	-	-	-	-	-
Magnesium Total	50	mg/l as Mg	EEC MAC	11	23	26	34	-	36	-	32	9	-
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	0.28	-	-	-	-	-
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	0.29	-	-	-	-	-
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	-
Mecoprop { }	0.1	ug/l	DWS 2010	-	<0.01000	<0.01000	<0.01000	-	<0.01000	<0.01000	-	-	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.05	<0.002	0.006	<0.002	-	< 0.002	0.002	-	<0.05	<0.01
Metazachlor	-	ug/l	None	-	<0	<0	<0	-	< 0	<0.00800	-	-	-
Methane	-	ug/l	None	-	-	-	-	42	-	-	-	-	-
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	<5	-	-	-	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<1	-	-	-	-	-	-	-	<1	<1.6
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	<0.10000	-	-	-	-
n - Butylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2
Naphthalene	1.2	ug/l	WFD D 10	<0.01	-	-	-	0.12	-	-	-	1.5	<0.1
Nickel Total	20	ug/l as Ni	DWS 2010	<10	<4	<4	<4	-	5	<4	-	<10	4.93
Nitrate - N	11.3	mg/l as N	WS Regs 20	1.9	<0.043	<0.043	<0.043	-	< 0.068	<0.068	-	<0.1	<0.0677
Nitrobenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	0.519	-	-	-	-	-
N-nitrosodi-n-propylamine	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1
Orthophosphate	-	mg/l as P	None	-	-	-	-	0.25	-	-	-	-	-
Oxamyl	-	ug/l	None	-	-	-	-	<0.00500	-	-	-	-	-
o-Xylene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.7
PAH 16 Total	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.1
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	0.12	-	-	-	-	-
PCB Congener 028	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
PCB Congener 052	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015

PCB Congener 101	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
PCB Congener 118	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
PCB Congener 138	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
PCB Congener 153	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
PCB Congener 180	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
PCB Total of 7 Congener (Aqueous)	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<0.015
Pentachlorophenol	9	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	<3
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	<0.10000	<0.10000	-	-	<0.10000	-	-	-
pH	10	pH units	DWS 2010	7.1	-	-	-	-	-	-	-	6.7	8
Phenanthrene	-	ug/l	None	0.02	-	-	-	<0.01	-	-	-	0.07	<0.022
Phenol	0.5	ug/l	EEC MAC	<0.4	-	-	-	-	-	-	-	14	<2.0
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	-	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	<8.0	<8.0	24.0	-	<8.0	<8.0	-	-	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	<0.2	-	-	-	-	-	-	-	1.8	-
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	20	-	-	-	-	-
Potassium Total	-	mg/l as K	None	-	15	17	20	-	22	-	20	-	-
Preparation (Purge And Trap)	-	Text	None	-	-	-	-	-	-	Prepared	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	<0.00400	<0.00400	-	-	<0.00500	<0.00500	-	-	-
Propetamphos	0.1	ug/l	DWS 2010	-	<0.00500	<0.00500	<0.00500	-	<0.00500	<0.00500	-	-	-
Propylbenzene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<2.6
Pyrene	-	ug/l	None	<0.01	-	-	-	<0.01	-	-	-	0.09	<0.015
SECB	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.7
Selenium	10	ug/l as Se	DWS 2010	<3	-	-	-	<0.4	-	-	-	<3	2.69
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	18	-	-	-	-	-
Simazine	0.1	ug/l	DWS 2010	-	<0.00900	<0.00900	<0.04000	-	<0.00400	<0.00400	-	-	-
Sisumxylene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Sodium Total	200	mg/l as Na	DWS 2010	88	180	180	230	-	250	-	270	54	-
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	0.76	-	-	-	-	-
Strontium Total	-	ug/l as Sr	None	-	-	-	-	0.8	-	-	-	-	-
Styrene	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.2
Sulphate	250	mg/l as SO4	DWS 2010	87	180	173	161	-	175	-	182	12	146
Sulphide	-	ug/l	None	<250	-	-	-	<29.0	-	-	-	<10	-
Sum of BTEX	-	ug/l	None	-	-	-	-	-	-	-	-	-	<10
Terbutryn	0.1	ug/l	DWS 2010	-	<0.00300	<0.00300	<0.00300	-	<0.00500	0.00700	-	-	-
tert - Butylbenzene	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<2
Tetrachloroethene (Per/Tetrachloroethylene)	10	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<1.5
Tetrachloroethylene	-	ug/l	None	-	<0.09	<0.09	<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	-	-	-	-	0.078	-	-	-	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<1	-	-	-	<0.55	-	-	-	<1	<1.4
Total Aliphatic TPH	-	ug/l	None	810	-	-	-	-	-	-	-	180	-
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	120	-	-	-	-	-	-	-	550	-
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	72	-	-	-	-	-	-	-	3100	-
Total Monohydric Phenols (W)	-	ug/l	None	-	-	-	-	-	-	-	-	-	<15.0
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-	<0.07	<0.07	<0.07	-	< 0.07	<0.07	-	-	<2.5
Trichlorofluoromethane	-	ug/l	None	-	-	-	-	-	-	-	-	-	<1.3

Trietazine	-	ug/l	None	-	<0.00600	<0.00600	<0.00600	-	<0.00800	<0.00800	-	-	-
Trifluralin	0.1	ug/l	DWS 2010	-	<0.01000	<0.01000	<0.01000	-	<0.01000	-	-	-	-
Turbidity	1	FTU	WS Regs 20	-	45	51.1	54.1	-	49.9	-	50.3	-	-
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	<0.1	-	-	-	-	-
Vinyl Chloride	0.5	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	<1.2
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<1	<0.09	0.13	<0.09	<0.180	< 0.09	<0.09	-	<1	<10
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	<0.09	-	-	-	-	-
Zinc Total	50	ug/l as Zn	DWS 2010	<1	<5	8	<5	-	36	13	-	8	<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: MG – Made Ground, RTD – River Terrace Deposits*

K.8 Groundwater status

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

K.8.2 The Thames River Basin Management Plan (RBMP)[13] shows no groundwater body designation for either the upper or lower aquifers within the area in which the Chelsea Embankment Foreshore site is located; therefore no baseline assessment of quantitative or chemical status is available.

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

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

K.8.5 Only eight out of forty-six groundwater bodies within the Thames River basin district are at good status overall; this is not expected to change by 2015 (EA, 2009)[13].

K.8.6 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)[13]:

- The control pollution to groundwater that may arise from any development which takes place on land.
- Prevent input of nitrates to groundwater body.
- Prevent inputs to and mitigate potential mobilisation of copper, other metals and hazardous substances in groundwater.
- 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.
- Prevent direct discharges of pollutants to groundwater.

K.9 Data sources

K.9.1 A list of data used for the Chelsea Embankment Foreshore site assessment is given in Vol 13 Table K.8.

Vol 13 Table K.8 Groundwater - desk based baseline data sources

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

Source	Data	Date received	Notes
Tideway Tunnel project			
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 Tideway Tunnel project (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] USGS. Glossary of Hydrologic Terms in The Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport": Department of Interior, U.S. Geological Survey, Office of Water Data Coordination, 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. *The London Catchment Abstraction Management Strategy (CAMS*). Final Strategy Document (2006). Available at: http://publications.environment-agency.gov.uk/PDF/GETH0406BKRM-E-E.pdf.

[6] Hiscock, K. Hydrogeology, Principles and Practice. Blackwell Publishing. 2005.

[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] Environment Agency. Soil Guideline Values for phenol in soil. Science Report SC050021 / Phenol SGV (2009). Available at: http://www.environment-agency.gov.uk/static/documents/Research/SCHO0709BQRN-e-e.pdf.

[11] 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. Commission of the European Communities (2009). Available at: http://ec.europa.eu/environment/water/water-dangersub/pdf/com_2006_397_en.pdf?lang=_e.

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

[13] 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

Environmental Statement

Doc Ref: **6.2.13**

Volume 13: Chelsea Embankment Foreshore appendices

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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Environmental Statement

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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 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 Chelsea Embankment Foreshore is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The Chelsea Embankment Foreshore site lies within the Royal Borough (RB) of Kensington and Chelsea. The borough has produced a Strategic Flood Risk Assessment (SFRA) (JBA and Entec, 2010)[2] which outlines the main flood sources to the Borough. Key sources of flood risk in the Borough are from surface water and sewer flooding, and the residual risk associated with the failure of the Thames tidal defences.

M.1.5 The Kensington and Chelsea SFRA confirms 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 risk of flooding is therefore a residual risk associated with a breach in the defences.

M.1.6 According to the SFRA:

a. The site is within Flood Zone 3.

b. There have been 'between 51-100' sewer flooding incidences recorded by Thames Water in the last ten years in the vicinity.

c. The site is within the Rapid Inundation Zone (RIZ) and carries a high residual risk from both breaching and overtopping.

d. The existing flood defence near the site is in good condition but is identified as a likely breach location.

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

Surface Water Management Plan

M.1.8 The Council, in partnership with the Greater London Authority (GLA), Thames Water and the EA has produced a Surface Water Management Plan (SWMP) (Greater London Authority, 2012)[3] as part of the Drain

London project. The SWMP sets out the preferred surface water management strategy for the borough.

M.1.9 According to the SWMP:

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

b. Pluvial modelling indicates the area along Chelsea Embankment, to the north of the site, to have surface water flooding depths of 0.25 – 0.5m for the AEP + 30% climate change.

c. The hazard for this area is moderate (danger for some).

Regional policy

Thames Estuary 2100

M.1.10 The Chelsea Embankment Foreshore site lies within the London City Policy Unit which has been assigned the 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 identifies the local sources of flood risk (relative to the Chelsea Embankment site) as including:

a. tidal flooding from the River Thames

b. pluvial (heavy rainfall) and urban drainage sources

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

M.1.12 Flood Mitigation currently managing flooding from these sources include:

a. the Thames Barrier and secondary tidal defences along the Thames frontage (the Thames Tidal Defence)

b. Combined Sewer Overflows (CSOs) for mitigation of urban drainage

c. flood forecasting and warning.

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

M.1.14 It is acknowledged that there are long lengths of eroding foreshore at Chelsea Embankment and that it may be necessary to set the defences back to avoid erosion damage.

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) (Greater London Authority, 2009)[5] encourages small scale set back of development from the river walls where possible. The aim of this is to enable

[i] Area susceptible to surface water flooding.

modification, raising and maintenance in a sustainable 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 tidal 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. 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] JBA and Entec. *Kensington, Chelsea, Hammersmith and Fulham Strategic Flood Risk Assessment*. (2010).

[3] Greater London Authority. *Royal Borough of Kensington and Chelsea Surface Water Management Plan*. (2012).

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

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Appendix N: Development schedule

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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 13 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 13 Table N.1 Development schedule for Chelsea 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)	2018 (peak construction year for T&V assessment)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
South Grounds Royal Hospital Royal Hospital Road Note: not Mayoral referral scheme but included as close to the site and has the potential to generate traffic.	35m north	PP/11/02785	Royal Hospital Chelsea and Masterpiece London	Temporary use of the South Grounds of the Royal Hospital Chelsea for Masterpiece London Art and Antiques Fair for a period of nine days 26 June 2012 to 4 July 2012 to include the erection of a temporary marquee from 8 June 2012 to 18 July 2012 inclusive, temporary plant, temporary disabled parking and other temporary associated works ancillary to this use.	B	Assume similar event back to back with RHS Flower Show (June-July).	Assume similar event back to back with RHS Flower Show (June-July).	Assume similar event back to back with RHS Flower Show (June-July).	Assume similar event back to back with RHS Flower Show (June-July).	This permission is limited to a specific time period in 2012. However, it is likely that a similar event will be held in a similar part of the grounds and at a similar time (back to back with the RHS Flower Show so from June to July), subject to a new planning permission for the relevant year.	Base case (all years)
Bullring Gate, South Grounds, Royal Hospital, Royal Hospital Road Note: not Mayoral referral scheme but included as close to the site and has the potential to generate traffic.	40m north	PP/10/01535		Installation of a site/pay office and storage container for use for Christmas tree sales for no more than 28 days in anyone year with associated lighting to illuminate site sale hours.	B	Assume this would occur during December 2017.	Assume this would occur during December 2018.	Assume this would occur during December 2019.	Assume this would occur during December 2023.	Professional judgement - it is a consent that is capable of being implemented and seeks to sell trees for Christmas.	Base case (all years)
Chelsea Barracks Chelsea Bridge Road	Approx 205m north	10/10496/OUT (associated with this: 08/10134/ADFULL (soil tests); 09/01921/ADFULL (COCP); 09/04699/ADFULL (archaeology);	Project Blue (Guernsey) Ltd	Demolition of existing former barracks buildings and warehouse (Dove Walk) in connection with the redevelopment of the site for mixed use purposes comprising residential (a maximum of 448 units), sports centre (Class D2), retail (flexible use within Class A1/A2/A3), health centre	B	Under construction	Under construction	Under construction	100% complete & operational	Paragraph 1.67 of the Environmental Statement NTS accompanying the application states construction will last nine years, starting in 2011 and finishing in 2019. Given that construction appears at least one year	**2017:** No base case Cumulative = whole development **2018:** No base case Cumulative = whole development

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)	2018 (peak construction year for T&V assessment)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
		10/10497/LBC (listed building works) and 10/11062/FULL (test geothermal borehole)		(Class D1), non-residential institution/leisure uses (flexible use within Classes D1 and/or D2); hard and soft landscaping and open space; reconfigured and new vehicular and pedestrian accesses and works to the public highway; together with all associated works including the construction of basement to provide ancillary vehicular and cycle parking, circulation, servicing and plant areas. Alterations to perimeter railings.						delayed, assume 2020 construction completion. No phasing information available so remains unknown whether it will be phased opening or not. Therefore assumed to be under construction for full nine year period.	**2019:** No base case Cumulative = whole development **2023:** Base case = whole development No cumulative
Royal Hospital Royal Hospital Road Note: not a Mayoral referral scheme but included as potentially one of the closest residential receptors to the site.	Approx 220m northwest	PP/11/02556 (associated with it: LB/11/02557)	The Royal Hospital Chelsea	Change of use of Gordon House, the Orangery and Creek Lodge to single family dwelling house with ancillary accommodation, internal and external alterations including dismantling and re-erection of boundary wall and reinstatement of railings and landscaping; construction of new annex building with basement, landscaping and associated works.	B	100% complete & operational	100% complete & operational	100% complete & operational	100% complete & operational	Landowner advised on construction timescales in a meeting 18 Nov 2011. Assumed that it will be built and occupied by Site Year 1 of construction.	Base case (all years)
				Restoration, extension, alterations and conversion of the Power Station building to provide retail, residential flats,	B	Phase 1 (RS-1) and Phase 2 (PS) are complete and	Phase 1 (RS-1), Phase 2 (PS) and Phase 3 (RS-4 & O-1)	Phase 1 (RS-1), Phase 2 (PS) and Phase 3 (RS-4 & O-1)	Phase 1 (RS-1), Phase 2 (PS), Phase 3 (RS-4 & O-		**2017:**

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)	2018 (peak construction year for T&V assessment)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
Battersea Power Station	Approx 470m southeast	2009/3575 Applications 2009/3576, 2009/3577 and 2009/3578 also accompany the Battersea Power Station application.	REO (Power Station) Ltd	business, cultural, hotel and conference facilities, event space and incidental accommodation; the demolition of other buildings and development of the land surrounding the Power Station and adjacent/ nearby sites to provide retail, restaurants bars and cafes, offices, hotel, residential, community and cultural space, assembly and leisure space, student housing, serviced apartments, an energy centre and basement plant; parking for cars, coaches, motorcycles and bicycles; new access and internal road system and servicing; 'off-site' highway works; works to the jetty to facilitate river transport and fuel delivery, including alterations to the river wall; provision of open space and landscaping works.		operational. Phase 3 (RS-4 & O-1) is under construction.	are complete and operational. Phase 4 (RS-5), part of Phase 5 (RS-2) and Phase 6 (RS-2) are under construction.	are complete and operational. Phase 4 (RS-5), part of Phase 5 (RS-2) and Phase 6 (RS-2) are under construction.	1), Phase 4 (RS-5), part of Phase 5 (RS-2) and Phase 6 (RS-2) are complete and operational. Part of Phase 5 (RS-6) and Phase 7 (RS-WF) are under construction.	Environmental Statement (Chapter 5 Site preparation and construction page 5-2) and Design & Access Statement. Decision notice requires development to be implemented within five years of the date of decision notice (23 August 2011) Assumptions regarding % complete in each assessment year are based on professional judgement using phasing information obtained from Design & Access Statement.	Base case = Phases 1 & 2 Cumulative = Phase 3 **2018:** Base case = Phases 1, 2 & 3 Cumulative = Phase 4, part of 5 (RS-2) & Phase 6 **2019:** Base case = Phases 1, 2, 3 & 4 Cumulative = Part of 5 (RS-2) & Phase 6 **2023:** Base case = Phases 1, 2, 3, 4, part of 5 (RS-2) & 6. Cumulative = Part of Phase 5 (RS-6) & 7
Riverlight, (Tideway Industrial Estate)	Approx 1km southeast	2011/3748	St James Group Limited	Redevelopment of the site to provide a residential-led mixed-use development of six buildings between twelve and twenty storeys (plus two basement levels) comprising 806 residential units, including affordable housing, flexible commercial uses at ground and first floor levels including retail, financial and professional services, restaurant/café and bar uses, healthcare facilities, a crèche and gallery space (A1/A2/A3/A4 and D1 uses), together with ancillary uses including a concierge/ management suite, a business suite and leisure facilities, and associated car and bicycle	A	90% complete & operational Assume that Blocks B, C, D, E and F are complete and occupied. Assume that Block A is under construction.	100% complete & operational	100% complete & operational	100% complete & operational	Email from developer St James Ltd (31/01/12) Phasing is proposed east to west – source: discussions with developer. *application supersedes previous 2010/3739	**2017:** Base case = Blocks B, C, D, E & F Cumulative = Block A **2018:** Base case = all blocks No cumulative **2019:** Base case = all blocks No cumulative **2023:** Base case = all blocks No cumulative

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)	2018 (peak construction year for T&V assessment)	2019 (peak construction traffic year)	2023 (Year 1 of operation)		
				parking and landscaping including provision of a riverside walk.							
Northern Line Extension	Approx 800m southeast (Battersea Power Station) Approx 1.6km southeast (Nine Elms Station)	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 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	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 **2019 & 2023:** Base case

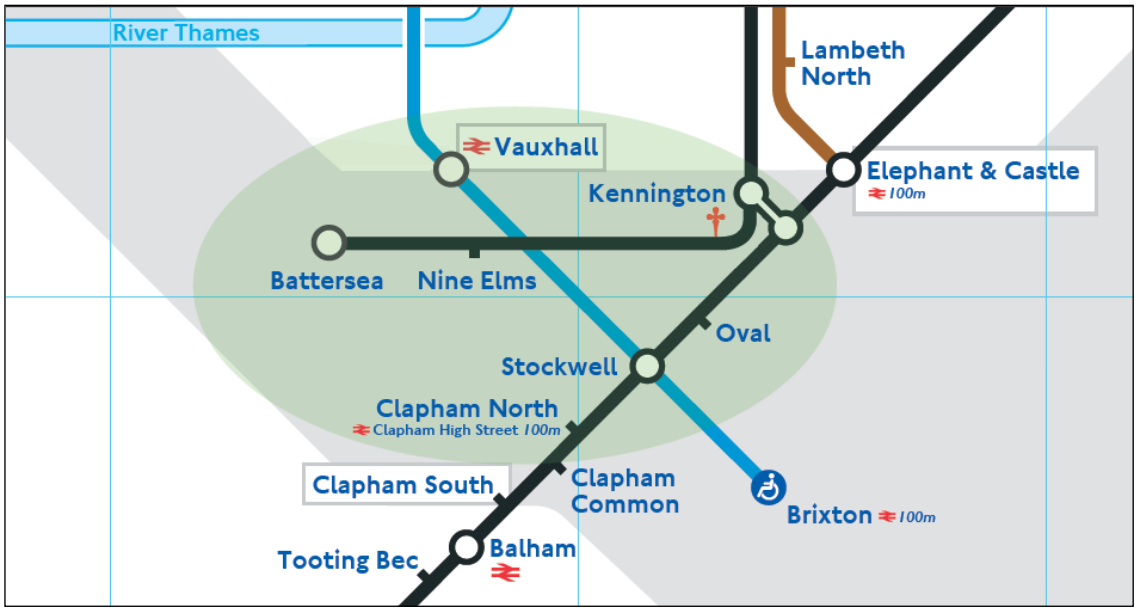
Note: phasing and site layout information has been sourced from local authority planning portals unless otherwise indicated.

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.

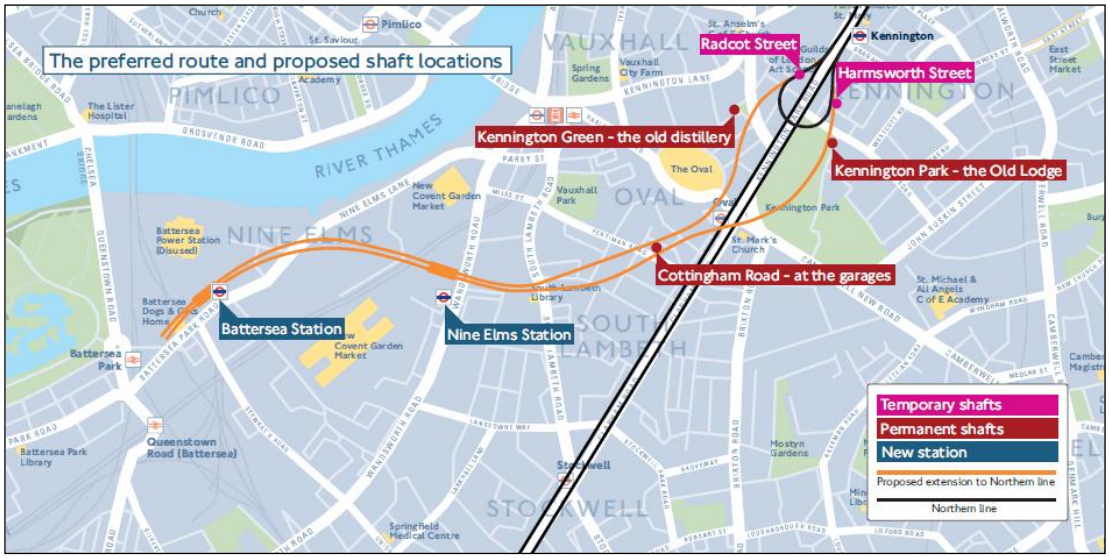
N.2.2 The NLE would extend the Northern Line from Kennington (Charing Cross branch) to Battersea, as shown in Vol 13 Plate N.1 below.

Vol 13 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 Figure 1.2 below.

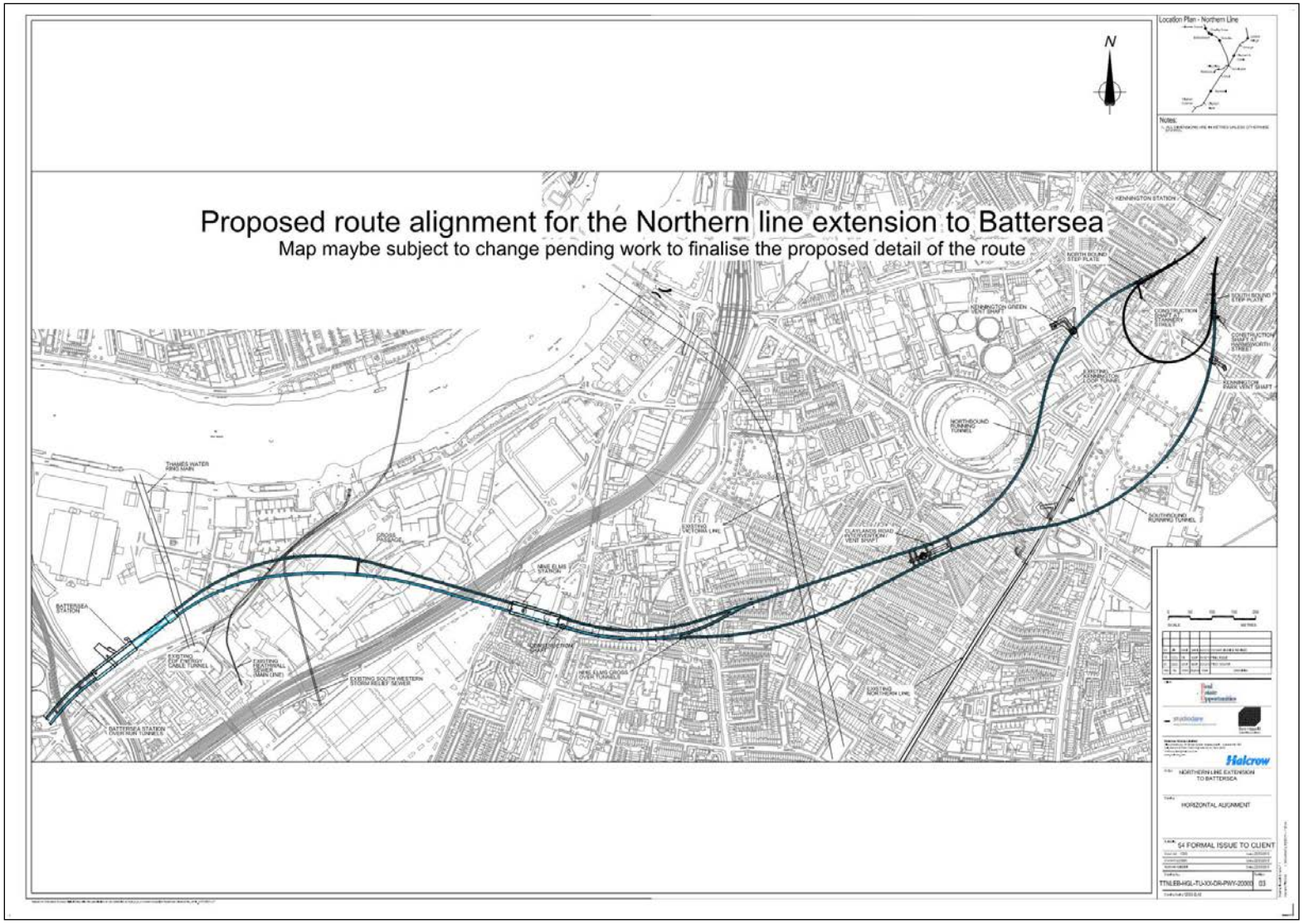
Vol 13 Plate N.2 Preferred route and proposed shaft locations of the Northern Line extension



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 13 Plate N.3 below.

Vol 13 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).

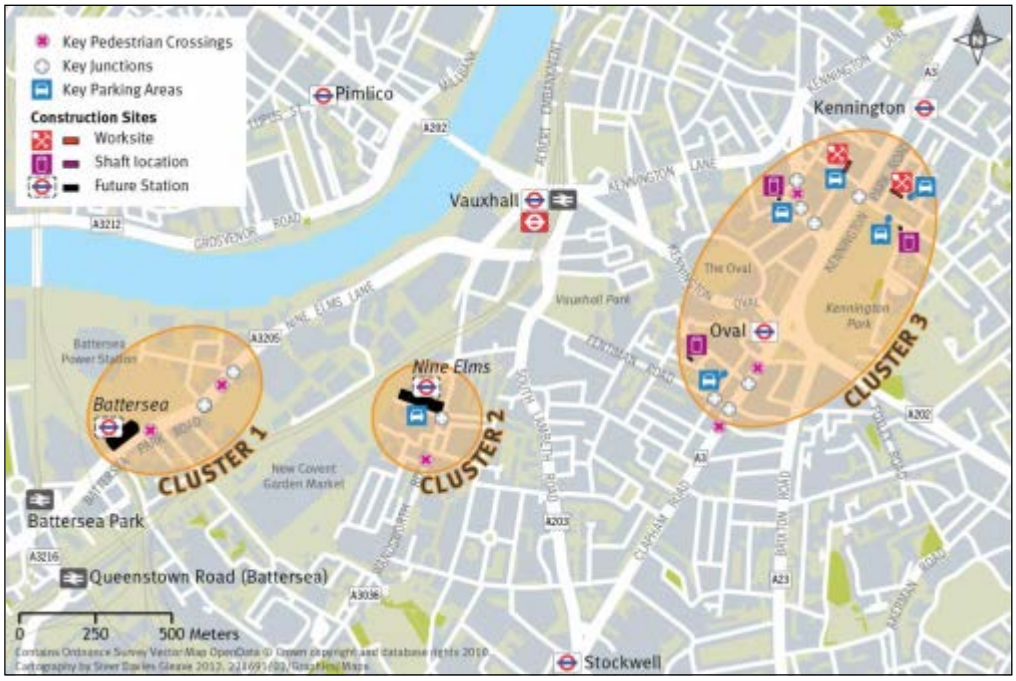
N.2.9 It is however noted that this remains subject to discussions with the Port of London Authority. Additionally, investigations are ongoing as to whether there can be greater use of rail and/or river, as well as the feasibility of on-site manufacturing.

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:

a. Cluster 1 – Battersea Park Road/Nine Elms Lane
    i Battersea Power Station
b. Cluster 2 – Wandsworth Road
    i Nine Elms Station (including Banham site)
c. 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.

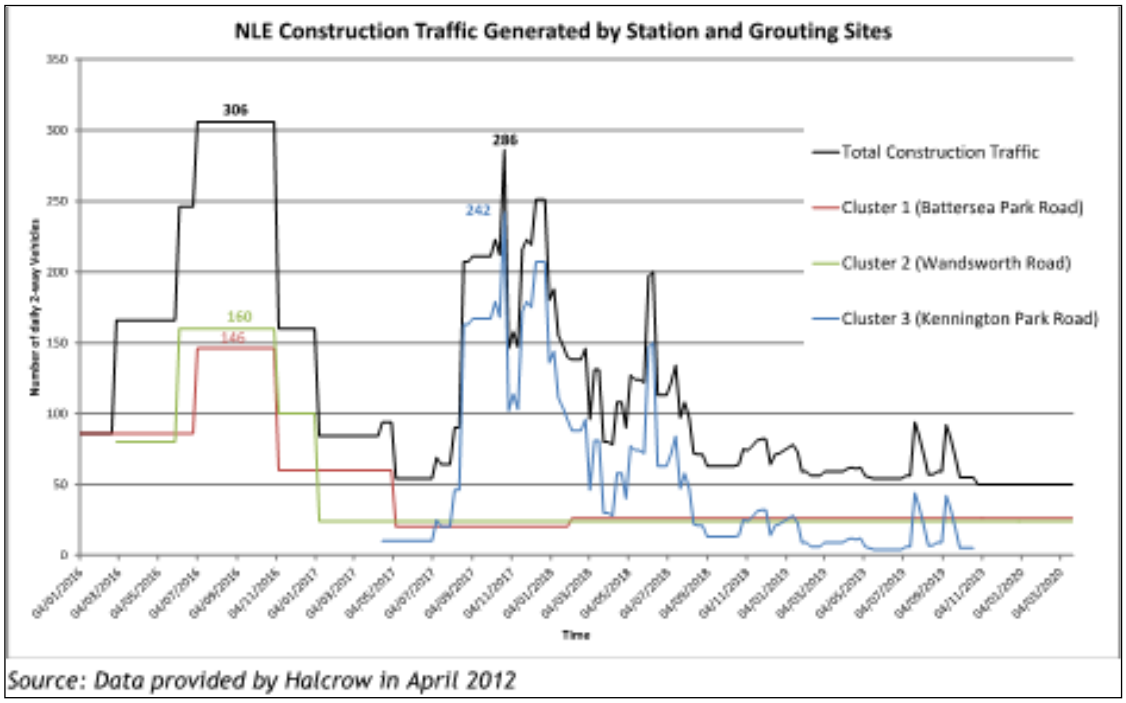
N.2.11 The aforementioned clusters are shown on Vol 13 Plate N.4 below:

Vol 13 Plate N.4 Northern Line Extension construction site clusters



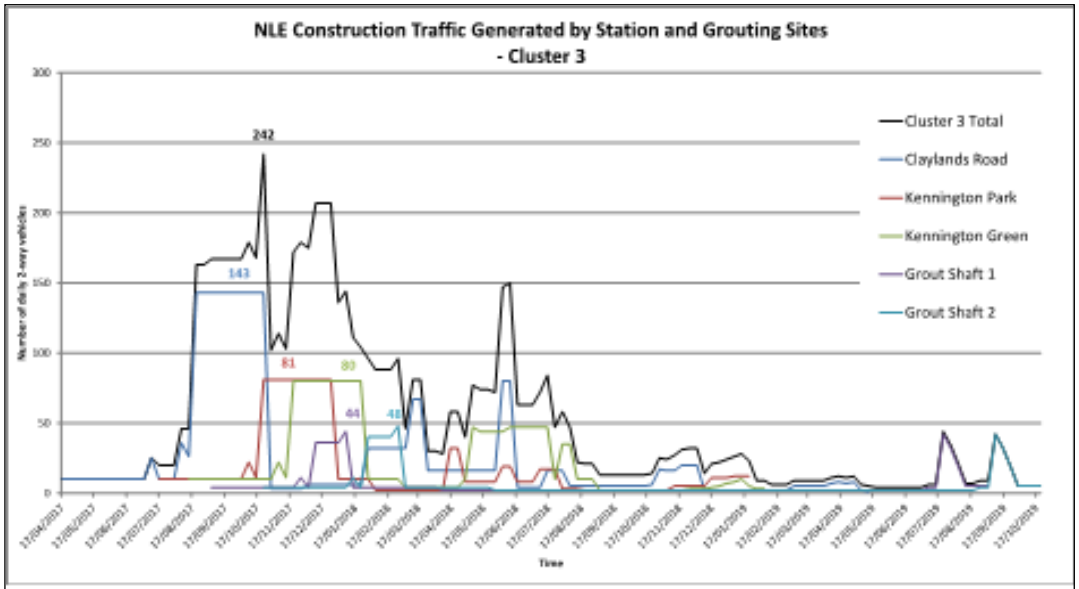
N.2.12 Daily two-way construction traffic, which includes all traffic going in and out of the construction sites in each cluster are shown in Vol 13 Plate N.5 below.

Vol 13 Plate N.5 Daily two-way construction traffic by all clusters



N.2.13 As cluster 3 includes five separate construction sites, Vol 13 Plate N.6 illustrates the traffic generated by each of these sites, both separately and in total.

Vol 13 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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