Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

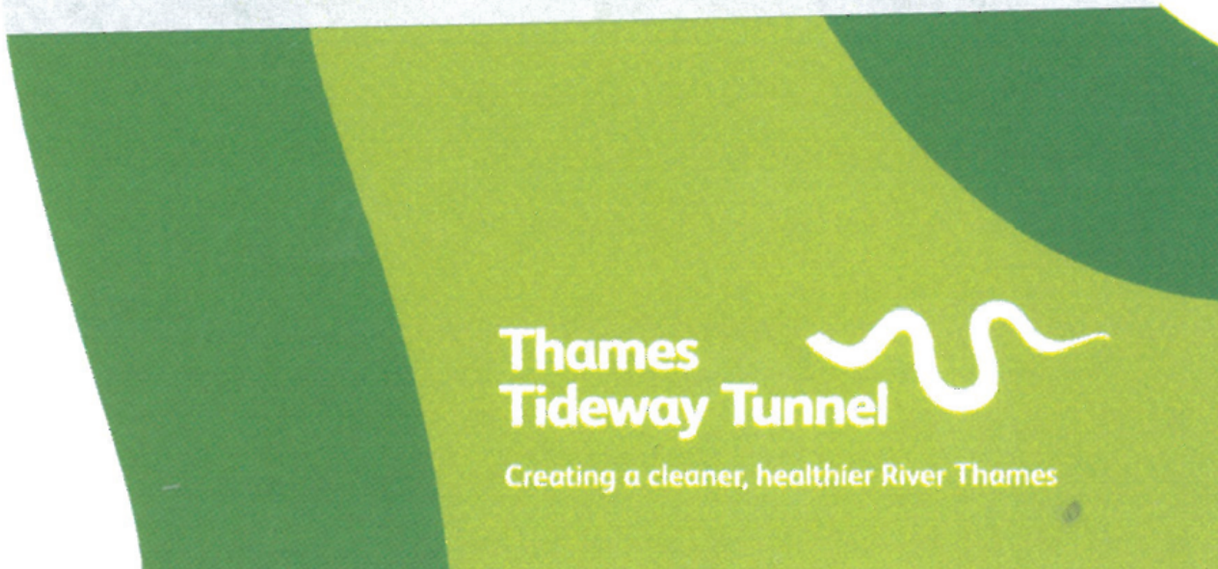
Documents for Certification
September 2014

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

Lindsay Speed

Sarah Fairbrother

September 2014



Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station appendices

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

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Application for Development Consent

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Volume 24: Greenwich Pumping Station appendices

Appendix A: Introduction

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Volume 24 Greenwich Pumping Station appendices

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 24 Greenwich Pumping Station 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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Volume 24 Appendices: Greenwich Pumping Station site assessment

Appendix B: Air quality and odour

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B.1 Model verification

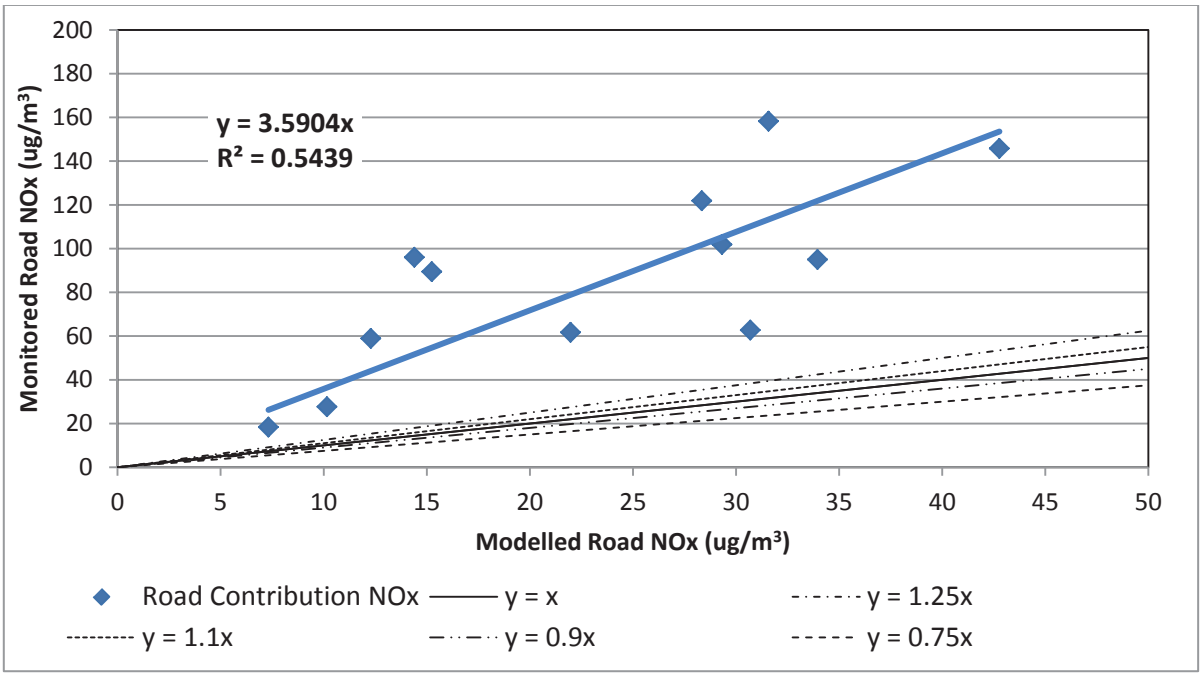
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at twelve diffusion tube sites (DCSM1, DCSM5-DCMS9, GPSM1-GPSM4 and GW43, GW48) as shown in Vol 24 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between 10% and 42%. 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.

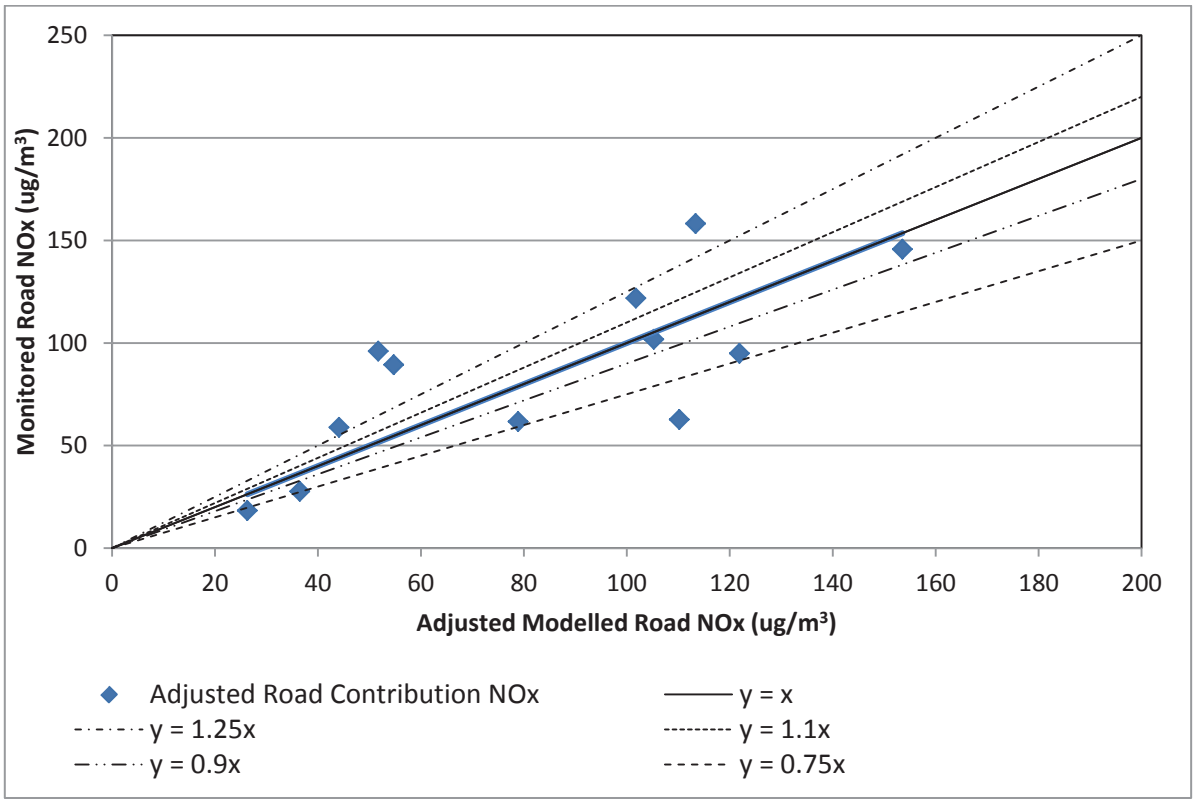
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 24 Plate B.1 below). An adjustment factor of 3.59 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09)[1] 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 24 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 24 Plate B.3 indicated that seven of the twelve modelled concentrations were within 10% of the measured value and that the other five were within 25% of the modelled value.

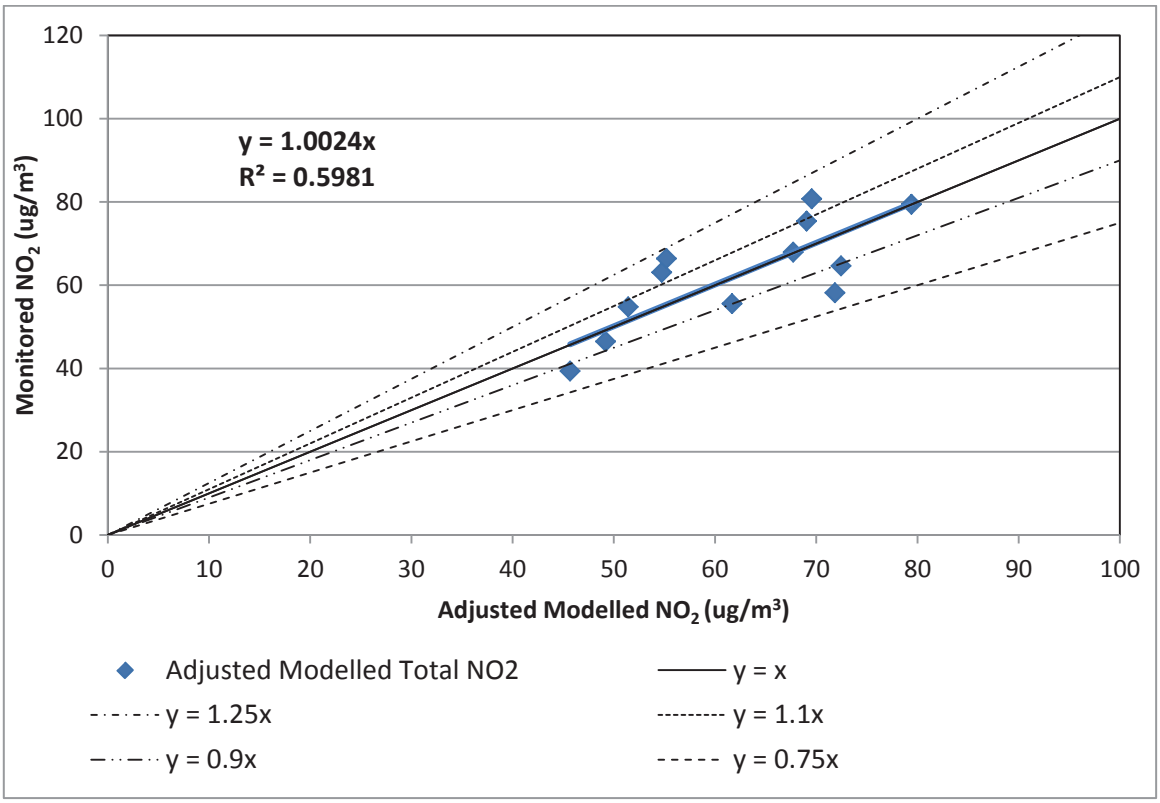
Vol 24 Plate B.1 Air quality - monitored road NO_x vs. modelled road NO_X



Vol 24 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 24 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 Greenwich Pumping Station site are shown in Vol 24 Table B.1.

Vol 24 Table B.1 Air quality - traffic data model inputs

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
CTC** survey	Brookmill Road A2210	20076	5.1	30	19.3	5.0	21089	0	21143	5.1%
CTC survey	Deptford Bridge A2	46512	9.3	30	19.3	5.0	48859	135	49025	9.5%
CTC survey	Deptford Broadway A2	35462	10.2	30	19.3	5.0	37252	92	37380	10.4%
CTC survey	Deptford Church Street A2209	27572	6.7	30	19.3	5.0	28963	44	29056	6.9%
ATC*** survey	Deptford Church Street A2209	20604	11.3	30	26.4	5.0	21644	48	21705	11.5%
CTC survey	Bronze Street	170	0.0	20	20.0	5.0	179	0	179	0.0%
CTC	Coffey Street	972	3.1	20	20.0	5.0	1021	10	1031	4.0%

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										
CTC survey	Deptford Church Street A2209	22002	7.3	30	26.4	5.0	23112	48	23174	7.5%
CTC survey	Creek Road A200	35340	6.6	30	25.3	5.0	37124	46	37184	6.7%
CTC survey	Creek Road A200	22161	5.8	30	25.3	5.0	23280	13	23294	5.9%
ATC survey	New Cross Road A2	29755	9.0	30	19.3	5.0	31257	92	31364	9.2%
CTC survey	Greenwich High Street A206	8884	6.2	30	13.4	5.0	9332	144	9494	7.6%
CTC survey	Norman Road (A208)	5060	7.0	30	14.9	5.0	5315	21	5337	7.4%
CTC survey	Greenwich High Street A206	11284	5.1	30	12.4	5.0	11854	0	11854	5.1%
CTC survey	Norman Road (A208)	5348	7.5	30	14.9	5.0	5618	13	5631	7.7%
ATC survey	Creek Road A200	20307	10.6	30	25.3	5.0	21332	0	21334	10.6%

Source	Road link	2010 baseline AADT*	Baseline % HGV >3.5t	Speed limit (mph)	Model input speed (mph)	Growth factor % (2009 - 2018)	Peak const-ruction year AADT	Peak construction year AADT scheme construction HGV (HGV >3.5t)	Peak construction year development case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
CTC survey	Creek Road A200	26470	5.1	30	25.3	5.0	27806	13	27821	5.2%
TFL Model	Church Street A206	10397	8.9	30	16.8	5.0	10922	0	11027	8.8%
TFL Model	Greenwich South Street A2211	5952	11.3	30	19.2	5.0	6253	0	6253	11.3%

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

B.3 Construction plant emission factors

B.3.1 For the purpose of the assessment, the following listed equipment in Vol 24 Table B.2 has been modelled for the peak construction year at the Greenwich Pumping Station site.

Vol 24 Table B.2 Air quality - construction plant assessment model inputs

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Site set up and general site	Ground level behind hoarding	Compressor 250cfm*	1	50	104	1.5×10^{-7}	9.5×10^{-9}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	4.7×10^{-7}	2.9×10^{-8}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	9.8×10^{-8}	6.1×10^{-9}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	3.4×10^{-9}	7.5×10^{-9}
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	5.3×10^{-8}	3.3×10^{-9}
	Ground level behind hoarding	Hiab*** lorry/crane	1	5	56	8.2×10^{-9}	5.1×10^{-10}
	Ground level behind hoarding	Well drilling rig	1	50	403	8.4×10^{-7}	5.2×10^{-8}
Long connection tunnel drive - Greenwich to Chambers Wharf	Ground level behind hoarding	150t crawler crane	1	50	240	3.5×10^{-7}	2.2×10^{-8}
	Ground level behind hoarding	Air compressor 600cfm*	2	50	224	6.5×10^{-7}	4.1×10^{-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	Dumper	1	25	81	5.9×10^{-8}	3.7×10^{-9}
	Ground level behind hoarding	Emergency generator - 200kW	1	5	200	2.9×10^{-8}	1.8×10^{-9}
	Ground level behind hoarding	Flatbed trucks for materials haulage	1	20	50	2.4×10^{-7}	1.8×10^{-9}
	Ground level behind hoarding	Flatbed trucks for segment haulage	1	20	50	2.4×10^{-7}	1.8×10^{-9}
	Ground level behind hoarding	Loading shovel	2	30	325	5.7×10^{-7}	3.6×10^{-8}
	Ground level behind hoarding	Telehandler 5t	2	80	60	2.8×10^{-7}	1.8×10^{-8}
	Within tunnel	Locomotives	4	100	180	8.8×10^{-5}	5.5×10^{-6}

*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. *** TBM – tunnel boring machine. ***Hiab – loader crane.*

References

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

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Thames Water Utilities Limited

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Appendix C: Ecology - aquatic

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Appendix C: Ecology - aquatic

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Appendix C: Ecology - aquatic

C.1 Introduction

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

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Appendix D: Ecology - terrestrial

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Appendix D: Ecology – terrestrial

D.1 Notable species survey report

Introduction

D.1.1 A Phase 1 Habitat Survey was undertaken on 17 December 2010 for the area of the site to the south of the DLR line (the southern section), and the 14 September 2011 the area of the site to the north of the DLR line (the northern section). Based on this, surveys for the following species have been undertaken:

a. bats

b. breeding birds

c. wintering birds

d. black redstarts *(Phoenicurus ochruros)*

e. invasive plants.

D.1.2 The purpose of the surveys is to determine the presence or likely absence of these species at and around 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 (paras D.1.5 to D.1.18). The results from the surveys are then presented (paras D.1.19 to D.1.40). The final section provides an interpretation of the results (paras. D.1.42 to D.1.51). Figures referred to in this report are contained within Vol 25 Abbey Mills Pumping Station Figures (see separate volume of figures).

D.1.4 Information on legislation, policy and methodology can be found in Vol 2 of the *Environmental Statement*. Information on site context can be found in Section 3 of this site assessment volume (Vol 24).

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 three stage bat survey was carried out. The first survey was a remote recording (bat triggering) survey using remote Anabat™ recording devices. Based on the habitat types identified during the Phase 1 Habitat Survey and their potential to support foraging, commuting or roosting bats, three locations were chosen for the installation of the remote recording devices, shown on Vol 24 Figure 6.4.3 (see separate volume of figures).

D.1.7 Location 1 is on the north side of the pumping station building. The location was selected to record potential roosting and foraging bat activity associated with the building.

D.1.8 Location 2 was attached to a mature tree in the south of the site. The location was selected to record foraging and commuting bat activity around this area of the site, over vegetation and buildings.

D.1.9 Location 3 is to the north of the site adjacent to the creek. The location was selected to record foraging and commuting bat activity along Deptford Creek and to record the movement of bats entering and leaving the site along this boundary.

D.1.10 The bat activity recorded during the remote recording surveys triggered the need for an additional dawn survey (see Vol 2 Methodology for bat triggering criteria). Therefore, a second stage of bat surveying was undertaken, comprising:

a. one dawn survey by four ecologists to assess the usage of the southern section of the site and immediate surrounds by bats

b. one dawn survey by two ecologists to assess the usage of the northern section of the site and immediate surrounds by bats.

D.1.11 The survey area for the bat activity (dawn) surveys, is shown in Vol 24 Figure 6.4.3 (see separate volume of figures).

D.1.12 During the bat activity surveys, bats were seen entering the Greenwich Pumping Station building. Therefore, targeted bat emergence and dawn re-entry surveys were undertaken of the pumping station building by two ecologists. The survey area for these additional bat surveys is shown on Vol 24 Figure 6.4.4.

Breeding birds

D.1.13 Breeding birds forage and nest within a range of habitats including grassland, scrub, trees and marginal aquatic habitats. Birds can also nest on and within buildings. The survey area, as shown in Vol 24 Figure 6.4.5 (see separate volume of figures), covers the southern section of the site where buildings, trees and introduced shrub have potential to support nesting birds.

D.1.14 Following completion of breeding bird surveys in the southern section, the proposed site boundary was extended to include the northern section of the site. As semi-natural habitat potentially used by notable nesting birds was absent from the northern section of the site, no breeding bird surveys were undertaken in this area.

Wintering birds

D.1.15 Wintering birds are mainly associated with aquatic habitats such as intertidal mudflats and marshes, marginal vegetation and wetlands, which they use for resting and foraging. Some wintering bird species are also associated with terrestrial habitats such as scrub and grassland, which they use for roosting at high tide or foraging. The survey area, as shown in Vol 24 Figure 6.4.6 (see separate volume of figures), covers intertidal

mud and running water within the Deptford Creek, where wintering birds are likely to forage and rest.

Black redstarts

D.1.16 Black redstarts nest on and within buildings and structures (mostly those that are derelict), and forage on sparsely-vegetated open areas. The buildings and the railway arches on and in close proximity to the site were identified as having potential to support nesting black redstart. Therefore, black redstart surveys were undertaken across the site and included buildings immediately adjacent to the site. The survey area is shown in Vol 24 Figure 6.4.7 (see separate volume of figures).

Invasive plants

D.1.17 Invasive plants that are listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) occur in a wide range of habitats, although they are more often associated with watercourses or wet areas, or within areas of disturbed ground, where material contaminated with seeds and rhizomes (sections of root that can re-grow), may have been imported into the area.

D.1.18 The invasive plants survey area, as shown on Vol 25 Figure 6.4.8 (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.1.19 In this section, the results of the desk study, notable species surveys and the invasive plant survey are presented. The results are then interpreted in paras. D.1.42 to D.1.51.

Desk study

D.1.20 Species data recorded within 500m of the site from 2001 to 2011, as supplied by Greenspace Information for Greater London (GIGL), are summarised in Vol 4 Table D.1.

Vol 4 Table D.1 Terrestrial ecology - species recorded within 500m of the site between 2001 - 2011

Common name	Species name (latin)	Record count
Mammals		
Unidentified bat	*Myotis*	8
Daubenton's bat	*Myotis daubentonii*	12
Birds		
Greater scaup	*Aythya marila*	2
Common goldeneye	*Bucephala clangula*	4

Common name	Species name (latin)	Record count
Red kite	*Milvus milvus*	2
Eurasian hobby	*Falco subbuteo*	2
Peregrine falcon	*Falco peregrinus*	14
Caspian gull	*Larus cachinnans*	2
Herring gull	*Larus argentatus*	12
Common kingfisher	*Alcedo atthis*	6
Sky lark	*Alauda arvensis*	2
Sand martin	*Riparia riparia*	6
Hedge accentor	*Prunella modularis*	26
Black redstart	*Phoenicurus ochruros*	22
Fieldfare	*Turdus pilaris*	38
Song thrush	*Turdus philomelos*	50
Redwing	*Turdus iliacus*	30
Common starling	*Sturnus vulgaris*	74
Spotted flycatcher	*Muscicapa striata*	4
House sparrow	*Passer domesticus*	66
Common linnet	*Carduelis cannabina*	38
Common toad	*Bufo bufo*	2
Amphibians		
Common frog	*Rana temporaria*	2
Invertebrates		
Stag beetle	*Lucanus cervus*	14
Plants		
Cornflower	*Centaurea cyanus*	2

Bat surveys

Bat triggering (remote recording) surveys

D.1.21 The bat triggering (remote recording) survey in the southern section of the site were undertaken over three nights between 1 and 3 May 2011. The battery on the recording device at location two failed after the first night of recording. This is likely to be due to the high numbers of bat passes recorded, which can sometimes drain the battery.

D.1.22 The survey in northern section of the site was undertaken over three nights between 14 and 16 September 2011. All surveys were undertaken in suitable weather conditions except for the final night of the surveys in the southern section, where temperatures dropped to around 6^{o}C (Vol 4 Table D.2).

D.1.23 The remote recording surveys recorded three species of bats using the site: common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pygmaeus)*, noctule (*Nyctalus noctula)* and Nathusius' pipistrelle *(Pipistrellus nathusii)*.

D.1.24 In the southern section of the site, a high number of bat passes were recorded for both common and soprano pipistrelle. At location two, the maximum number of bat passes recorded in one night for common pipistrelle was 187 and for soprano pipistrelle was 152 (both on 1 May 2011). A lower number of bat passes were recorded at location one although these were still high relative to the numbers recorded at other Thames Tideway Tunnel project sites. A maximum of 114 common pipistrelle and 77 soprano pipistrelle bat passes were recorded on 3 May 2011 at location one. At location one, a single noctule pass was also recorded on 1 May 2011.

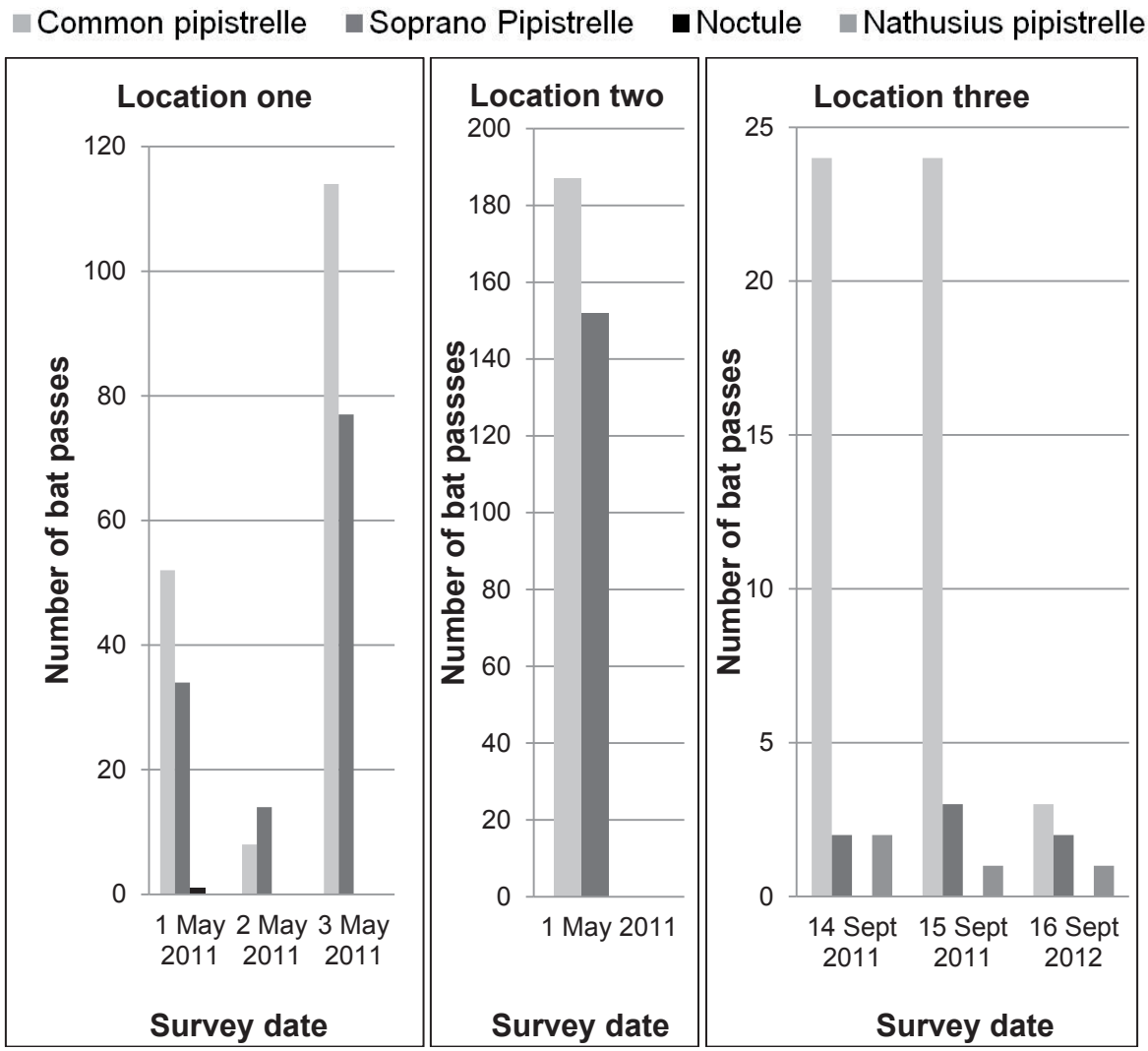
D.1.25 In the northern section of the site, lower numbers of common and soprano pipistrelle bats were recorded. A maximum of 24 common pipistrelle, three soprano pipistrelle and two Nathusius' pipistrelle bat passes were recorded in any one night. No noctule bat passes were recorded at this location.

D.1.26 Some of the bat passes were recorded close to sunset and sunrise.

Vol 4 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
1 May 2011	12^{o}C, gentle breeze, 75% cloud cover, dry
2 May 2011	11^{o}C, gentle breeze, 75% cloud cover, dry
3 May 2011	6^{o}C, gentle breeze, 100% cloud cover, dry
14 September 2011	11^{o}C, gentle breeze, 100% cloud cover, dry
15 September 2011	9^{o}C, gentle breeze, 100% cloud cover, dry
16 September 2011	10^{o}C, gentle breeze, 100% cloud cover, dry
30 July 2012	11^{o}C, calm, 75% cloud cover, dry
2 August 2012	15^{o}C, calm, 75% cloud cover, damp (light rain during the day)
3 August 2012	14^{o}C, calm, no cloud cover, dry

Vol 4 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at three locations at Greenwich Pumping Station



Bat activity (dawn) survey

D.1.27 As there were high numbers of bats recorded during the remote recording survey, this triggered the need for a bat activity (dawn) survey to be undertaken (based on bat triggering criteria in Vol 2 Section 5). The bat activity survey in the southern section of the site was undertaken on 14 June 2011 in suitable weather conditions (10^{o}C, gentle breeze, 100% cloud cover, dry). The bat activity survey in the northern section of the site was undertaken on 5 October 2011 in suitable weather conditions (15 ^{o}C, gentle breeze, 50% cloud cover, dry). The bat activity survey results are shown on Vol 24 Figure 6.4.3 (see separate volume of figures).

D.1.28 The activity survey in the southern section revealed high levels of activity across the site by common pipistrelle, with particularly high levels of foraging in the immediate vicinity of the main Greenwich Pumping Station building. Several individuals were recorded dispersing across the site and swarming around this building immediately before dawn. Two common pipistrelles were also recorded entering the building at dawn via the

northeast corner indicating that the building currently supports an active common pipistrelle roost. Several social calls were heard but no bats were seen, indicating that bats were present within the pumping station building at the time of the survey.

D.1.29 During the activity survey in the southern section, an individual noctule was recorded commuting along the eastern boundary of the pumping station site approximately an hour before dawn. No activity of any species was recorded along the Deptford Creek adjacent to the site.

D.1.30 During the activity survey in the northern section of the site, no bats were recorded on or adjacent to the site.

Bat surveys of Greenwich Pumping Station building

D.1.31 During the first dusk survey undertaken on 30 July 2012, common pipistrelle bats were recorded foraging around the pumping station building. The earliest record was at 20:37, approximately 15 minutes before sunset. This suggests that a roost is present close to the site although bats were not observed emerging from any features on or adjacent to the site such as trees and buildings. During the second dusk survey undertaken on 2 August 2012, the first bat appeared a little later at 21:28. Again, the activity was associated with foraging around the site. During the dawn survey undertaken on 3 August 2012, common pipistrelle bats were observed foraging along the tree line and commuting around the pumping station building but no bats were seen entering it. The last record was at 04:53, approximately half an hour before sunrise.

Breeding bird survey

D.1.32 Three survey visits were undertaken on 19 May, 9 and 14 June 2011 in suitable weather conditions (Vol 4 Table D.3) by an experienced ornithologist (bird specialist). The results of the breeding bird survey are shown on Vol 24 Figure 6.4.4 (see separate volume of figures) and in Vol 4 Table D.3.

Vol 4 Table D.3 Terrestrial ecology – breeding bird survey weather conditions

Survey visit	Weather conditions
19 May 2011	9°C, gentle westerly breeze, 100% cloud cover
9 June 2011	11°C, moderate south-westerly wind, dry, 50% cloud cover
14 June 2011	14°C, light south-westerly wind, dry, 100% cloud cover

D.1.33 Breeding bird territories were primarily recorded within established tree and shrub vegetation to the south of the pumping station building (both on and adjacent to the site) and associated with the mature treeline to the east of the site.

D.1.34 A total of 15 breeding bird species and 27 breeding territories (active nests and their surrounding territory) were recorded within the survey area. The breeding bird territory locations are indicated on Vol 24 Figure 6.4.4 (see

separate volume of figures). Species of conservation importance were recorded as follows:

c. Boundary vegetation adjacent to the site in the southeast provided breeding habitat for stock dove (*Columba oenas).*

d. The footbridge over Deptford Creek in the northwest of the survey area provides breeding habitat for a pair of grey wagtails *(Motacilla cinerea)*.

e. Two pairs of dunnock *(Prunella modularis)* were identified in the south of the survey area, associated with introduced shrub, scattered trees and amenity grassland.

Vol 4 Table D.4 Terrestrial ecology - breeding bird territories recorded within the survey area

Species name	Latin name	Conservation designation[i]	Estimated number of breeding territories
Feral pigeon	*Columba livia*	Green List	3
Stock dove	*Columba oenas*	Amber List	1
Wood pigeon	*Columba palumbus*	Green List	3
Great spotted woodpecker	*Dendrocopos major*	Green List	1
Grey wagtail	*Motacilla cinerea*	Amber List	1
Wren	*Troglodytes troglodytes*	Green List	2
Dunnock	*Prunella modularis*	Amber List UK BAP Priority List	2
Robin	*Erithacus rubecula*	Green List	2
Blackbird	*Turdus merula*	Green List	3
Great tit	*Parus major*	Green List	2
Blue tit	*Parus caeruleus*	Green List	1
Jay	*Garrulus glandarius*	Green List	1

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

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

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

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

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

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

Species name	Latin name	Conservation designation[i]	Estimated number of breeding territories
Chaffinch	*Fringilla coelebs*	Green List	2
Goldfinch	*Carduelis carduelis*	Green List	2
Greenfinch	*Carduelis chloris*	Green List	2

Wintering bird survey

D.1.35 A total of six survey visits were undertaken at monthly intervals between January 2011 and March 2011, and then October 2011and December 2011 by an experienced ornithologist (bird specialist). The survey visits were undertaken in suitable weather conditions Vol 4 Table D.5). The main foraging and resting areas for wintering birds are indicated on Vol 24 Figure 6.4.5 (see separate volume of figures). The numbers of individuals of each species recorded in each month are provided in Vol 4 Table D.5.

Vol 4 Table D.5 Terrestrial ecology – wintering bird survey weather conditions

Survey visit	Weather conditions
28 January 2011	1°C, gentle east north-easterly breeze, 100% cloud cover
28 February 2011	4°C, gentle northerly breeze, 50% cloud cover
15 March 2011	7°C, gentle easterly breeze, 100% cloud cover
20 October 2011	4°C, gentle north-westerly breeze, 100% cloud cover
16 November 2011	6°C, gentle south-easterly breeze, 100% cloud cover
15 December 2011	3°C, gentle south south-westerly breeze, 50% cloud cover

D.1.36 A total of ten waterbird[ii] species have been recorded within the intertidal Deptford Creek, which lies adjacent to the west of the proposed development site. Of the ten species recorded, seven are of conservation importance and are included on the Birds of Conservation Concern 3 (Royal Society for the Protection Birds, 2009)[1] Red or Amber List[iii] and/or UK and London BAP as priority species.

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

[iii] The conservation status of all regularly occurring British birds has been analysed in co-operation with the leading governmental and non-governmental conservation organisations, including the Royal Society for the Protection of Birds (RSPB), British Trust for Ornithology (BTO) and Birdlife International Birds of Conservation Concern 3 (RSPB, 2009). The basis of species ongoing population trends are assigned to one of three lists of Conservation Concern. These are the UK Red, Amber and Green lists. Although the lists confer no legal status in themselves, they are useful in evaluating the conservation significance of bird assemblages, and for assessing the potential significance of impacts and informing appropriate levels of mitigation with respect to bird populations.

D.1.37 The following species were observed in close proximity to the site:

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

b. Common kingfisher *(Alcedo atthis)* was recorded flying along Deptford Creek.

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

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

Species name	Latin name	Conservation designation[iv]	Monthly wintering bird counts					
			28 January 2011	28 February 2011	15 March 2011	20 October 2011	16 November 2011	15 December 2011
Grey heron	*Ardea cinerea*	None	-	1	-	-	1	-
Mallard	*Anas platyrhynchos*	Amber List	3	14	9	-	-	-
Moorhen	*Gallinula chloropus*	Green List	1	2	2	1	3	2
Coot	*Fulica atra*	Green List	-	2	-	-	-	-
Black-headed gull	*Chroicocephalus ridibundus*	Amber List	41	9	53	10	30	25
Common gull	*Larus canus*	Amber List	7	-	-	-	1	8
Lesser black-backed gull	*Larus fuscus*	Amber List	1	-	-	-	-	-
Herring gull	*Larus argentatus*	Red List UK BAP Priority List	2	2	-	2	2	1

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

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

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

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

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

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

Species name	Latin name	Conservation designation[iv]	Monthly wintering bird counts					
			28 January 2011	28 February 2011	15 March 2011	20 October 2011	16 November 2011	15 December 2011
Great black-backed gull	*Larus marinus*	Amber List	-	-	-	-	-	1
Kingfisher	*Alcedo atthis*	Amber List	-	-	-	1	-	-

Black redstart survey

D.1.38 A total of five back redstart survey visits were undertaken by an experienced ornithologist (bird specialist), between 19 May and 5 July 2011; following completion of black redstart surveys in the southern section, the proposed site boundary was extended to include the northern section of the site. The northern section was surveyed for black redstart between 27 April and 13 June 2012. The survey visits were undertaken for a minimum of three hours each during the early morning period and when weather conditions were suitable, as detailed below in Vol 4 Table D.7. The survey area for black redstart is indicated on Vol 24 Figure 6.4.6 (see separate volume of figures). No black redstarts were recorded within the boundaries of the survey area during any of the five surveys at either the southern or northern sections of the site.

Vol 4 Table D.7 Terrestrial ecology – black redstart survey weather conditions

Survey visit	Weather conditions
Southern section	
19 May 2011	9°C,light southerly breeze, no cloud cover, dry
09 June 2011	11°C, light south westerly breeze, 50% cloud cover, dry
14 June 2011	14°C, calm, 20% cloud cover, dry
28 June 2011	20°C, calm, no cloud cover, dry
05 July 2011	16°C, calm, 20% cloud cover, dry
Northern section	
27 April 2012	10°C, calm, 60% cloud cover, light rain then dry
09 May 2012	11°C, calm, 75% cloud cover, light rain
16 May 2012	14°C, calm, 5% cloud cover, dry
30 May 2012	18°C, calm, 20% cloud cover, dry
13 June 2012	15°C, calm, 5% cloud cover, dry

Invasive plant survey

D.1.39 The invasive plant survey was undertaken on the 2 September 2011 in the southern section and 21 September 2011 in the northern section of the site. The results of the survey are shown on Vol 24 Figure 6.4.7 (see separate volume of figures).

D.1.40 The invasive plant species (as listed on Schedule 9 of the Wildlife and Countryside Act, 1981), Japanese knotweed *(Fallopia japonica)* was recorded during the survey in two locations, as described in Vol 4 Table D.8.

D.1.41 Both stands of Japanese knotweed were located within the site boundary, on the southern side of the site near to the current pumping station facility. The stand furthest from the creek appeared to have been treated

previously but was showing signs of re-growth. The other stand nearest the creek had not been treated.

Vol 4 Table D.8 Terrestrial ecology - invasive plant species recorded at the site

Common and latin name	Location/description	National grid reference	Stand size
Japanese Knotweed *(Fallopia japonica)*	Several stands situated between a building (shed) and the river creek	TQ3766177187	10m x 5m
	Several semi-treated stands (viable) adjacent to a electrical sub-station	TQ37700 77257	5m x 5m

Interpretation

Bats

D.1.42 The remote recording survey identified a high number of bat passes for both common and soprano pipistrelle bats in the southern section of the site. A number of these passes were recorded close to sunset and sunrise, which indicated a possible roost on site. In the northern section of the site, lower numbers were recorded and no results indicated the presence of a roost.

D.1.43 The dawn survey confirmed the presence of a common pipistrelle roost within the pumping station building with two individuals seen entering the building via the southeast corner of the roof at dawn. Social calls were also heard that were coming from within the building. As bats were not seen entering or leaving the Greenwich Pumping Station building during the surveys undertaken in July and August 2012, the building is considered to be occasionally used by small numbers of common pipistrelle bats and the usage varies throughout the season. There is the potential for other parts of this building to be used by bats at different times of the year.

D.1.44 The data suggests that there may be other common and soprano pipistrelle roosts in close proximity to the site and bats from these roosts may forage on site. The majority of foraging activity is associated with the mature trees and introduced shrubs on and adjacent to the site.

D.1.45 The single record of noctule during both the remote recording survey and the dawn surveys at the site indicates that this species occasionally visits the site for foraging and commuting purposes.

D.1.46 Nathusius' pipistrelle bat was recorded during the remote recording surveys in the northern section of the site. The low numbers of bat passes and the lack of foraging resources in this area of the site indicates that this species occasionally passes through the site. Nathusius' pipistrelle may also forage along the Deptford Creek.

Breeding birds

D.1.47 Of the 15 bird species which occupied breeding territories within the survey area, none are listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended), although three are of nature conservation importance because they are included in the Birds of Conservation Concern Red or Amber List and/or UK BAP Priority Species: stock dove (one breeding territory), grey wagtail (one breeding territory) and dunnock (two breeding territories).

D.1.48 The majority of the site comprises buildings and hardstanding. There were a small number of nests associated with the buildings on site. However, the majority of breeding activity was associated with the mature trees to the south and east of Greenwich Pumping Station, and the DLR viaduct that passes through the site.

Wintering birds

D.1.49 Of the ten 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: mallard, black-headed gull, common gull, lesser black-backed gull, herring gull, great black-backed gull and kingfisher. The latter species is afforded special protection because it is listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended).

Black redstarts

D.1.50 The ten surveys detailed above (five in the southern section and five in the northern section) were undertaken at a time of year when back redstarts are most likely to be recorded if present. The lack of observations of this species throughout the course of the survey period strongly suggests they do not currently utilise the proposed development site for either foraging or breeding purposes. While there are many opportunities for black redstart to nest and forage in London, not all these locations are occupied by this species. This is mainly due to the rarity of black redstart in the UK and in London (Royal Society for the Protection Birds, 2012)[2].

Invasive plants

D.1.51 The invasive plant species Japanese knotweed was recorded on site in two locations. This species is listed on Schedule 9 of the Wildlife and Countryside Act 1981, which makes it illegal to cause these plants to spread or grow in the wild. Where works are to be undertaken within 10m of this species, control measures would be required to prevent its spread.

References

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

[2] Royal Society for the Protection Birds. *Black Redstart.* Last updated January 2012. Available online at: http://www.rspb.org.uk/wildlife/birdguide/name/b/blackredstart/index.aspx. Accessed 18 January 2012.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station appendices

Appendix E: Historic environment

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

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Environmental Statement

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Appendix E: Historic environment

E.1 Gazetteer of known heritage assets

E.1.1 Details of known heritage assets within the assessment area are provided in Vol 24 Table E.1 below, with the location shown on the historic environment features map (Vol 24 Figure 7.4.1, see separate volume of figures).

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

Vol 24 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	Pair of beam engine houses with linking boiler house at Deptford Sewage Pumping Station (also known as Greenwich Pumping Station). Grade II listed. Opened 1865 and designed by John Aird and Sons, architects and engineers; extended 1905. English bond grey brick with limestone dressings; shallow-pitched hipped Welsh slate roofs. Italianate style. Each 2-storey beam house is of 3 by 5 bays and is articulated by giant order of Tuscan pilasters rising to parapet with moulded stone cornice. Each main elevation has steps with cast iron railings which rise to panelled double doors set in classical architrave with cornice above over light. Square-headed stone-corniced windows to ground floor and semi-circular arched windows to upper floor, all with small panes to cast-iron casements. Louvred lantern finials to roofs. Beam engine house extended to south in matching style in 1905. One-storey boiler house has similar casements set in semi-circular arched window architraves to front and 8-bay arcade of semi-circular arches on moulded imposts to rear, whence coal was brought via the coal sheds; continuous strip clerestory light to roof. Interior: roofs of slate on wooden plank construction are supported by wrought-iron trusses. Part of Sir J W Bazalgette's drainage scheme for London, pumping sewage from the three main south London sewers up to the level of the southern outfall	1213334

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	sewer.	
1B	Coal shed immediately to the southwest of the beam engine houses with linking boiler house at Deptford Sewage Pumping Station. Grade II listed. Coal shed. 1865. Designed by Sir J W Bazalgette. Iron construction; M-shaped hipped Welsh slate roof. Of 2 by 5 bays. Slate on wooden plank roof construction, with wrought-iron roof trusses supported on cast-iron Tuscan columns, which are linked by segmental arches with openwork spandrels. One of 2 coal sheds which form an integral part of Bazalgette's work for Deptford Sewage Pumping Station.	1289021
1C	Southernmost of a pair of coal sheds to the southwest of a pair of beam engine houses with linking boiler house at Deptford Sewage Pumping Station. Grade II listed. Description as 1B.	1213549
1D	Concrete tanks or possible original cooling basin and associated features, situated below the present surface and to the north of the beam engine house. Also associated below ground pumping infrastructure consisting of pipework, penstock chamber, pumping chamber and well.	---
1E	Deptford Creek, Creekside Road, SE8, SE10. An archaeological foreshore survey by Museum of London Archaeology Service (MoLAS, now MOLA) in 2002. A survey of the drift geology and archaeology, a photographic record of the principal riverine structures of late 19th century or earlier date and a record of the physical attributes of the creek bed and associated structures were undertaken. Amongst the latter were stretches of timber river walls, constructed in the mid-19th century; timber revetments; a masonry riverbed lining of c. 1838; a dock or inlet of 1876–94; barge-bed revetments; masonry and timber splash aprons for the sewage pumping station; outfall pipe of 1868; a masonry and timber drain of c. 1868; and a line of timber uprights which may be remnants of the river wall line predating the 18th century. The first bridge of the London and Greenwich railway, recorded in the Greater London Historic environment Record (GLHER), was built over Deptford Creek in 1836, closed in 1869, replaced in 1884 and replaced again by the current bridge in 1963. The Halfpenny	FLS02 MLO2120 070263

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	Hatch footbridge ran along its south side until it was demolished at the beginning of the 20th century.	
1F	Railway viaduct extending across the site from the platforms of Greenwich railway station *c* 150m east of the site, to the modern bridge over Deptford Creek on the west side of the site. Grade II listed. The section to the west of Deptford Creek is the subject of a separate listing (HEA 42). The viaduct for the London and Greenwich Railway: construction was authorised by Act of Parliament in 1833 and the railway opened from Greenwich to London in 1838. Grey brick; eighteen arches, each 20 feet wide from centre to centre and 22 feet high. The 28 feet-wide railbed is enclosed by parapets roughly four and a half feet high.	1253722
1G	Museum of London Archaeology was commissioned by Thames Water Utilities Ltd to investigate and record the two coal sheds and the northeastern of two beam engine houses, all listed buildings, at Greenwich Pumping Station. The survey was conducted in January 2012.	TWG12
1H	Line of the Bazalgette Southern Low Level Sewer.	---
1I	Line of the Bazalgette High Level Sewer.	---
1J	Line of a Bazalgette sewer.	---
1K	Line of the Bazalgette East Greenwich Branch Sewer.	---
2	173–185 Greenwich High Street, MoLAS watching brief in 2001. In two trenches natural gravels were overlaid by subsoil which, in one, contained 17th century material. A number of pits of 18th or 19th-century date were also found in what would have been open ground. In another trench the cellar of a house was revealed; this was formerly No.175, possibly dating to the early 19th century and destroyed by bombing in 1944. Also recorded were brick foundations associated with the Greenwich Railway Terminus of 1840 and a late-19th century pit that may have been associated with a nearby public house.	GWH01
3	Nos.136 and 138 Greenwich High Road. Grade II listed.	1078996
4	No.98 Greenwich High Road. Grade II listed. Early 18th century house of 3 storeys, 5 windows. High pitched roof, renewed in machine tile, partly concealed behind parapet. Brown brick with upper part renewed in	1358974

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	pinkish brick after war damage. Gauged, shallow segmental brick arches to renewed sash windows, some of early 19th century, in near-flush box frames. Nos.100–104 Greenwich High Road. Grade II listed. Early 18th century terrace. Each house 2 storeys, attic and basement, 3 windows. Renewed, tiled mansard roof with one square dormer. Brown brick fronts. Upper parts and tall parapet renewed in unsuitable pale brick after war damage. Bands at cornice, 1st floor cills and 1st floor level. Gauged, very slightly cambered brick arches to 1st floor renewed sash windows in near-flush box frames.	1220783
5	Harold Wharf, 6 Creekside, Deptford, SE8. An archaeological watching brief by Chris Philpotts in 2001. Above the natural gravels 19th–20th century dumps and the boundary walls and outbuildings of a 19th century chemical works were recorded.	CEP01
6	MoLAS carried out an archaeological watching brief in 1997 on the Deptford Creek Viaduct Pier Bases in advance of the proposed Docklands Light Railway route. A series of timber stakes thought to date from the medieval to post-medieval period were recorded within the silt which extended to the base of the underlying peat. The stakes were probably the base of a wattle revetment on the eastern edge of the Ravensbourne of parallel water course such as a mill leat.	DXK96 MLO77153
7	A Roman road as recorded on the GLHER. A more likely route may have been on the line of modern New Cross Road and Deptford Bridge, c. 500m to the southwest of the site.	MLO11490 70557
8	84 Norman Road, SE10. An archaeological evaluation by MoLAS in 1998. In one of two trenches, a compacted layer of crushed chalk - a yard surface or thoroughfare - was recorded above the natural gravel, sealed by a deposit of ashy waste containing a dense concentration of 19th century potsherds. The second trench had been subject to heavy disturbance in modern times, with the surviving deposits interpreted as ground-raising dumps, probably associated with 19th century industrial activity.	NRM98
9	The site of a gravel pit shown on Rocque's map of 1746. Recorded on the GLHER.	MLO72934 071818

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
10	Bronze Street, Deptford. The GLHER includes archaeological fieldwork in 1983 which recorded late 17th or early 18th century brick walls and mortar floors, and a pit lined with wedge-shaped bricks. A piece of medieval earthenware pottery was found in a wall composed of concrete and other pottery fragments, and assemblages of 18th century possibly industrial tiles and chimney pots were recovered (Richardson)[1]. Also the site of late 19th century cottages and late 19th/20th century pottery, flowerpots, drain pipes and tiles.	MLO11370 070061 MLO24486 070274
11	River Wall, Creekside, SE8. An archaeological survey by MoLAS in 2001. A topographic survey of the revetment on the west side of Deptford Creek was undertaken, as well as a plan of a crane base rail.	CEK01
12	53 Norman Road, SE10. An archaeological watching brief by MoLAS in 1996. Natural gravels were overlaid by river silt, interpreted as a floodplain deposit from Deptford Creek. Above this was a reclamation dump, followed by thick agricultural soil. The agricultural use of the site is documented from the 18th century and it continued until engineering works were constructed some time in the 1860s; these were demolished recently. Also the site of a post-medieval gas works. Recorded on the GLHER.	NRG96 MLO67320 071369
13	No.165 Greenwich High Road. Grade II listed. No.167 Greenwich High Road. Grade II listed.	1078993 1078994
14	K2 telephone kiosk outside No.171 Greenwich High Road. Grade II listed.	1289165
15	The GLHER includes the site of a tannery shown on the Greenwich Tithe Map of 1844 on the east side of Deptford Creek. The complex is shown as four long and narrow buildings identified as stabling sheds. The tannery buildings appear to have been still standing in 1870, but by 1875 the site seems to have changed hands to become the Merryweather and Sons' Tram Locomotive Works and a Fire Fighting Equipment Factory. Under these hands the site had a factory of three floors, an erecting shop, pattern makers and carpenters' offices, smithy buildings, a foundry, saw mills, wheelwright's shop and painter's buildings.	MLO98648

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	Portions of the site were redeveloped as housing. Much of the site was damaged in the destruction caused by a V1 flying bomb in June 1944, to be redeveloped as further industrial units. Other buildings included a mid-20th century 'Engine House' building which replaced a building damaged in wartime, the 'Station House', 'Pump House', 'Brigade House', 'Siren and Bell House' and toilets. The 'Engine House' building was an industrial building constructed in English Bond brickwork, with concrete sills and lintels. Most of the original Crittal windows survived of this building, with steel support trusses and roofed with corrugated asbestos sheeting. The 'Station House' was of brick laid in stretcher bond of yellow stock brick. The 'Pump House' was of 1920s–1930s date of alternating colour brickwork, concrete coping and internal beams.	
16	The Miller General Hospital Royal Kent Dispensary. Grade II listed.	1078995
17	The projected extent of the Saxon and medieval settlement of Deptford. Recorded on the GLHER. The place name Deptford is derived from the Anglo Saxon for "deep ford", indicating the crossing of the Ravensbourne in this period. It was for a time known as West Greenwich and before that as Depeford. The Deptford Bridge area may have been the focus of settlement in the early to mid Saxon period and the St Nicholas church area, to the north, a focus in the mid to late Saxon period.	MLO83376 MLO71960
18	The Miller General Hospital Miller General Wing (Rehabilitation Department). Grade II listed.	1220749
19	A congregational chapel and burial ground noted by Mrs Basil Holmes in 1896 (Holmes, 1896)[2].	Holmes ID 248
20	No.2 Burgos Grove. Grade II listed.	1358933
21	23 Greenwich High Street (East Mill). This appears to be the earliest surviving component of the Mumford's Mill complex. It was possibly constructed around 1817 and is the earlier of the two mill buildings on this site. Brick, with segmental-headed windows punctuating the English bond brickwork. An entranceway is set in an architraved entrance. The presumed location of the granary block is the site of the 1897 silo, and it is possible that the original mill may have extended as far north as the creek edge. There is some elaboration of	MLO98653

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	the building with the string and dentil courses. The fourth floor may be an addition to the whole of the building, though this is uncertain. The interior of the mill was probably reached through the double doors set below the bow window of the manager's office or by doors in the now water tower block. The interior includes non-fireproof timber floors formed from timber beams, now largely changed to steel-framed floors of the later 19th century. The ground floor rests on the river bank - there is no basement. The steel girders also include ones with the legends of the makers. The fourth floor contains what was probably the original kingpost roof, possibly re-sited from the earlier roofline. A cast iron sprinkler system is present along the roof. Recorded on the GLHER.	
22	A late 19th century grain silo and flour mill. Recorded on the GLHER.	397897
23	Nos.1–40a, 40, 44–61, 65–74 Ashburnham Grove. Locally listed buildings. Built of yellow stock brick, with pitched slate roofs and stone window surrounds. Mostly two storey with basements, some three storey with parapet roofs.	---
24	Nos.10, 11, 13–27 Ashburnham Place. Locally listed buildings. Two storey with basements, mostly with plastered parapet roofs, stone window surrounds and bracketed cornices to the front doors.	---
25	Nos.4 and 6, 8-24 (evens) Burgos Grove. Locally listed buildings. Built in yellow stock brick with tiled and slated roofs, two storeys with basements. Stone window surrounds and conrniced parapets to the roofline.	---
26	Deptford Creek, c. 250m to the north of the site. The remains of a timber river wall.	FLS02 A101
27	Devonshire Drive Baptist Church. Locally listed building. Rebuilt in 1955 in yellow stock brick, with decorative iron railings to front. Incorporates date stone from an earlier church building.	---

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
28	St Paul's Holy Trinity Church, Devonshire Drive. Locally listed building. Gothic church, built of Kentish ragstone with pantilled roof. Open belfry with weather vane. Designed by Teulon, but not completed.	---
29	Deptford Creek, c. 100m to the northwest of the site. The remains of a timber river wall, similar to HEA 26 above.	FLS02 A102
30	Deptford Creek, c. 80m to the west/southwest of the site. The location of a timber revetment formed of at least 26 upright round timbers which extend for c. 7m at a maximum surviving height of c. 0.2m.	FLS02 A105
31	No.135 Greenwich High Road. Locally listed building. Two bay three storey house, built in London stock brick with a parapet to the roofline. Wooden doorcase with reeded pilasters.	---
32	London Electric Supply Corporation electricity sub station, built in the early–mid 20th century.	---
33	A medieval book fitting reported as found to the northwest of the site as part of the Portable Antiquities Scheme (PAS).	PAS-2E8D10
34	Late 19th century chimney, on Thames Water land to the south the site and of Bazalgette's pumping station.	---
35	Deptford Creek frontages Package project. An archaeological watching brief by MOLA in 2009. Natural Thames terrace gravels were observed at between –1.0m OD and +1.0m Ordnance Datum (OD), equivalent to 99.0–101.0 ATD (above Tunnel Datum). The existing timber river walls were dismantled by machine and recorded photographically, and deposits in the foreshore were also observed. No structures or deposits earlier than the mid 19th century were definitively identified, although it is possible that some of the disturbed alluvial silts and gravels at the base were a century or so earlier. A timber revetment was observed at the upstream end of Hilton's Wharf, marking an earlier inland return prior to the construction of the existing Hilton's Wharf frontage. This structure could have been 19th century or earlier.	HTV09
36	Laban Centre, Creekside, Deptford, SE14. An	LGR00

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	archaeological evaluation by MoLAS in 2000. Above fluvial clays there was evidence of land reclamation, consisting of two unlined 18th century drainage channels. The earliest structural features on site were the foundations of an early 19th century brick boiler house, interpreted as part of the soap works that used to occupy the site. Part of the north wall of an infilled 20th century barge dock was also located.	
37	Deptford Creek, to the west of the site: the Halfpenny Hatch Bridge, a footbridge over the Ravensbourne beside the railway bridge.	FGW29 A102
38	Deptford Creek, to the west of the site: a masonry riverbed lining, probably related to the construction of the railway bridge or Halfpenny Hatch Bridge (HEA 37).	FGW29 A103
39	Deptford Creek, to the west of the site: a barge bed revetment is located here, consisting of a series of stout timber posts, retaining a wall of planks laid horizontally, forming a platform extending alongside the cast iron river wall of a former pumping station.	FGW29 A104
40	Deptford Creek, to the west of the site: a masonry and timber splash apron for the sewage pumping station.	FGW29 A105
41	Deptford Creek, to the west of the site: a masonry and timber drain. Deptford Creek: the remains of a timber barge bed revetment. Deptford Creek: masonry and timber splash apron for the sewage pumping station. Deptford Creek: the remains of a flood defence, consisting of upright timbers in the centre of the present channel which may once have formed a revetment or timber wall.	FGW29 A106 FGW29 A107 FGW29 A108 FGW29 A109
42	Railway viaduct to the west of the site between Deptford Creek and North Kent Junction. Grade II listed. Railway viaduct for the London and Greenwich Railway. Construction was authorised by Act of Parliament in 1833; the section from North Kent Junction (Bermondsey) to Deptford was opened in February 1836, that east to Deptford Creek in December 1836. The total length is 5,150 metres. Grey brick; each arch is 20 feet from centre to centre and 22 feet high. The 28 feet-wide railbed is enclosed by parapets roughly four and a half feet high.	1253151

E.2 Site location, topography and geology

Site location

E.2.1 The site lies at the mouth of the Ravensbourne valley, c. 600m to the south of the River Thames. This lower stretch of the Ravensbourne River, which flows north past the site towards the Thames, is known as Deptford Creek. The site lay within the parish of Deptford, formerly in the county of Kent.

Topography

E.2.2 The topography of the site varies. The foreshore of Deptford Creek along the western edge of the site lies at c. 101.7m ATD (above Tunnel Datum; equivalent to 1.7m OD); above this the northern part of the site lies at c. 105.0m ATD in the northwest corner, sloping down to 103.2m ATD at the eastern edge. To the south, the site slopes up from c. 103.5m ATD in the southwest corner to c. 105.7m ATD in the southeast corner.

Geology

E.2.3 The southeast corner of the site overlies the Kempton Park Gravel Formation, which forms the river terrace, with the remainder of the site being on the floodplain, where alluvium overlies Shepperton Gravel. The underlying bedrock geology is Thanet Sand.

E.2.4 The site straddles the floodplain and river terrace within the valley of the River Ravensbourne. The modern confluence of the Ravensbourne and the Thames lies 600m north of the site. The site is situated on the eastern side of the floodplain and extends onto the river terrace, which forms the lowest part of the valley side. Beyond the eastern boundary of the site, the river terrace is overlain by soliflucted silt and gravel Head deposits (solifluction is the sludging of soil down a slope during periods of freeze and thaw in periglacial environments). Such material can seal and protect earlier landsurfaces and archaeological deposits which might otherwise not survive later erosion. Further up the valley side a series of different geological formations outcrop, comprising the Woolwich and Reading Beds, the Thanet sands and the Harwich formation (British Geological Survey solid and drift geology map sheet 270). The soils formed in these deposits are typically permeable to depth and well-drained, a combination of properties that makes them easy to cultivate.

E.2.5 Borehole records are sparse for the area, with only sixteen historic and modern logs within 300m of the site. The borehole logs are modern and detailed, however, although in some cases limited in depth. Eleven boreholes were dug within the site, mostly recording made ground directly over gravels, but some with alluvium sandwiched between. The borehole logs show variable depths of made ground, typically 3–5m, but in places just 1.2m.

E.2.6 The surface of Shepperton Gravel lies at around 97m to 98.5m ATD in the borehole logs towards the western side of the site, but is probably deeper in incised channel areas. In one monitored borehole (SR4087) the Shepperton Gravel below alluvial deposits to the south west of site was

recorded at 99.16m ATD. The surface of the Kempton Park Gravel of the river terrace in the east (and also existing as isolated outcrops at the edge of the floodplain) lies at around 103.5m ATD. In the central part of the site the gravel surface is likely to be irregular as it will slope and slump between the river terrace and the floodplain.

E.2.7 The alluvium is likely to blanket both the Shepperton Gravel of the floodplain and the Kempton Park Gravel of the river terrace. Although the full extent of the alluvium within the site is uncertain, it is likely to become thicker from east to west, into the floodplain. Where alluvium survives in the floodplain part of the site it provides evidence of flowing water within the prehistoric or historic river (1–2m of sands with organic remains), below about 98.5m ATD. The Holocene sands are sealed by deposits representing channel marginal, backwater and marshy environments (1–2m of clay with peaty pockets and sand lenses). In SR4087 the marshy deposits were recorded from 99.84m ATD and in a historic borehole (TQ37NE153) peat is recorded from 103.03m ATD within the south of the site. This indicates that the river channels will have migrated or become abandoned over time, leaving the site marshy and full of reeds and subject to fluctuating water levels. The clays would have built up through flood events, some of which were high energy and distributed sand across the floodplain. The uppermost part of the alluvium (recorded from 99.34m ATD in SR4087) is likely to be increasingly weathered alluvial clay to the top, with occasional finds and gravel, representing accretionary floodplain soils, mostly dry but probably flooded in the winter months.

E.2.8 The alluvium on the site provides a link between the past environment of the Thames and that of the Ravensbourne. It is likely to record events caused by human activity and environment changes upstream, as well as the influence of the tidal Thames on the freshwater environment of the tributary. As the alluvium provides a good medium for organic survival a wide range of environmental indicators, such as seeds, pollen, ostracods, insects and snails are likely to be preserved, which could provide evidence of changes in water salinity and flow, past vegetation, as well as indirect evidence for human activity and catchment disturbance, with the potential for establishing a timeframe through radiocarbon dating.

E.3 Past archaeological investigations within the assessment area

E.3.1 A number of archaeological investigations have been carried out within the 350m radius assessment area around the site. All have recorded historic assets dating to the post-medieval period, mostly of the 18th to 20th centuries. The only possibly earlier remains were at the southwestern edge of the assessment area (**HEA 6**), where a series of timber stakes thought to date from the medieval to post-medieval period were found within the silt of Deptford Creek. The stakes were probably the base of a wattle revetment.

E.3.2 In 2002, MOLA carried out an archaeological foreshore survey along Deptford Creek (**HEA 1E**), in the northern part of the site. The investigation included a record of the physical attributes of the creek bed,

and a photographic record of the late 19th century or earlier structures along the creek. These included stretches of timber river walls, constructed in the mid-19th century; timber revetments; a masonry riverbed lining of c. 1838; a dock or inlet of 1876–94; barge-bed revetments; masonry and timber splash aprons for the sewage pumping station outfall pipe of 1868; a masonry and timber drain of c. 1868; Halfpenny Hatch rail bridge of 1870; and a line of timber uprights which may be remnants of the river wall line predating the 18th century.

E.3.3 The results of these investigations, along with other known sites and finds within the assessment area, are discussed by period, below.

E.4 Archaeological and historical background of the site

E.4.1 The following section provides a detailed archaeological and historical background for the site. It should be read alongside the research framework presented in Appendix C to Vol 2 Appendix E2, which sets the overall Thames Tideway Tunnel project, and the individual site-specific assessments, within a broader historic environment context (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 Thames and its tributaries were subject to rising water levels throughout prehistory due to sea level changes following the last glacial period. The Ravensbourne would have been an important feature in the prehistoric landscape as, like other rivers, it served as a route through the forested landscape and was a source of rich natural resources. In the Colne and the Lee Rivers for example, Mesolithic flint knapping and butchery assemblages were found within the early Holocene floodplain soils and on low sandy islands within the river, which later became sealed by expanding wetland deposits. Later in the prehistoric, the nearby high ground of the river terrace in this location could have made it a focal point for settlement or occupation. If the site area was not subject to later river scour there is some potential to recover evidence of Mesolithic and later remains across the floodplain.

E.4.3 Although much of the site may have been dry land in the Mesolithic, marshy wetland environments are likely to have expanded across it during the prehistoric period, particularly as a result of changing landuse (especially deforestation) upstream, impeded drainage and the encroachment of tidal water. As a result the preservation of organic remains, and in particular structures and artefacts is likely to be good where waterlogged deposits are present. There is background potential for riverside structures, such as prehistoric timber trackways, revetments, jetties and platforms of all periods, although these are rare finds and there are none known from the site or vicinity. There is also potential for palaeoenvironmental evidence, sealed within the alluvium.

E.4.4 There are no recorded features or finds dating to the prehistoric period within the assessment area. However, the location of the site at the interface of the river terrace and the floodplain, as well as near the confluence of the Ravensbourne and the Thames would have made it an attractive area for exploitation by hunting and fishing in prehistory, with easy access to intertidal freshwater and dryland resources.

E.4.5 Outside the assessment area, a Palaeolithic flint axe was recovered from the Ravensbourne River at the Century Works, Conington Road, c. 770m to the south of the site. Bronze Age artefacts have also been recovered from the Ravensbourne and its floodplain in Lewisham, c. 750m to the south of the site.

Roman period (AD 43–410)

E.4.6 The Roman settlement of Londinium lay c. 5.4km to the northwest of the site, and was the hub of the Roman road system in Britain. Although the GLHER includes an entry for a Roman road (**HEA 7**) c. 40m to the north of the site, this is likely to be incorrectly located. The hills of New Cross, Blackheath and Greenwich would have provided a dry route for a major road from Southwark to the east Kent coast (later known as Watling Street), but its precise alignment is uncertain. A possible projection of the road through this area is likely to be further south, just outside the assessment area along the line of the modern New Cross Road, c. 400m to the south of the site (Margary, 1967)[3]. The point at which the road crosses Deptford Creek, the present Deptford Broadway c. 450m to the southwest, would have attracted settlement, and evidence was uncovered in 1866 c. 570m southwest of the site, when a portion of tessellated pavement and brickwork was excavated below Deptford High Street during the construction of a sewer. Archaeological investigations nearby in 1988 and 1992 (site code OCDB-88) recovered fragments of Roman pottery (Steele, 1993)[4].

E.4.7 No evidence of Roman occupation has been recorded within the assessment area, and during this period the site lay within or on the eastern bank of the Deptford Creek. As such it would probably have been seasonally flooded, particularly with rising sea levels at the end of and after the Roman period. Grazing of animals or marshland activities, such as fishing, harvesting reeds or salt making, could conceivably have taken place near the site, as seen elsewhere in the lower Thames Estuary.

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

E.4.8 During its early history, the area of Deptford within which the site lies was a small island of solid ground, surrounded by a bog swamp, and was known as ‘Meretun’ meaning ‘town in the marshes’ (Steele, 1993)[5]. The place name of Deptford itself is of Anglo-Saxon in origin, referring to a deep ford crossing the river Ravensbourne (Gaimster, 2005)[6]. The old Roman road is likely to have continued in use as a route to Canterbury. A ford, and later a bridge, provided access across the river at the point just before it becomes tidal and widens into Deptford Creek, at the site of modern Deptford Bridge, c. 450m to the southwest of the site.

E.4.9 Two Saxon settlement centres have been suggested, both outside the assessment area. One, Deptford Strand, is likely to have been close to the Thames in the area of St Nicholas's Church at Deptford Green, c. 550m to the northwest of the site. The church may be a Saxon foundation, as early-to-middle Saxon pottery was found nearby during excavations in 1996. The other may have been to the south, in the vicinity of Deptford Bridge and Deptford Broadway c. 570m to the southwest of the site. Two 7th century burials were found during excavations in 1992 and 2003 on the northeast side of the junction of Deptford High Street and New Cross Road, c. 325m to the southwest of the site. One included grave goods of jewellery and other personal items (Gaimster, 2005)[7].

E.4.10 During this period the site was located outside the main areas of occupation. Parts or all of the site were seasonally flooded and the site was probably used for rough pasture and the grazing of livestock.

Later medieval period (AD 1066–1485)

E.4.11 Domesday Book (1086) records that after the Norman Conquest (1066) West Greenwich (Deptford) was owned by Odo, Bishop of Bayeux and the brother of King William I, and held by Gilbert de Magminot, the Bishop of Lisieux. Deptford included arable land, meadow, pasture, woodland and four mills (Williams and Martin, 1992)[8]. Just outside the southwestern edge of the assessment area the GLHER includes the location of a tide mill at Deptford Creek, established by the 14th century (GLHER ref. 070074, MLO1910). This would have operated either by the flow of the tide, or by storing water at high tide, which could be released to drive the mill as the tide dropped. The gradual containment of the river would have had the added benefit of increasing the speed of its flow, and the location had the advantage of easy bulk transport of goods along Deptford Creek to the Thames.

E.4.12 The settlement beside the river crossing to the southwest of the site continued to develop, and there was a wooden bridge by 1359. It lay on the route from London to Canterbury, and in the late 14th century was mentioned in Chaucer's Canterbury Tales (Gaimster, 2005)[9]. It is possible that the settlement shifted or expanded northwards, although the exact extent is uncertain. The GLHER (**HEA 17**) suggests that it stretched north from Deptford Bridge along the western bank of the Deptford Creek, within c. 60m of the western edge of the site, although a 17th century map by John Evelyn (not reproduced) shows settlement further to the north and west, and some distance from the site.

E.4.13 Numerous references attest to the flourishing fishing village of Greenwich to the northeast of the site in the medieval period. It was almost certainly centred on the Thames riverside but tapered southwards to and beyond the parish church, c. 640m to the northeast of the site. There is also archaeological evidence for continued settlement at Deptford Broadway, on the west side of the Ravensbourne (site codes DCPD-89, DGDL-92).

E.4.14 Closer to the site, within the assessment area, archaeological evidence for this period is sparse. The GLHER records a series of timber stakes (**HEA 6**) c. 350m to the west of the site, found within the silt along the Deptford

Creek and thought to date from the medieval to post-medieval period. The stakes were probably the base of a wattle revetment on the eastern edge of the Creek. A fragment of medieval earthenware was recovered during archaeological investigations c. 190m to the northwest of the site (**HEA 10**), and a medieval book fitting was found by chance 500m to the north of the site on the edge of the creek (**HEA 33**).

E.4.15 The site probably remained within seasonally flooded land, possibly used as pasture: some attempts may have been made at reclamation.

Post-medieval period (AD 1485–present)

E.4.16 Rocque's map of 1768 (Vol 24 Plate E.1) shows the general topography, settlements and roads, with development alongside the main roads and the southern part of Deptford Creek. The northern part of the site probably comprised reclaimed marshland, while the southern part comprised market gardens and properties fronting onto the road to Greenwich which runs along the southeastern edge of the site. Morris's map of 1832 (Vol 24 Plate E.2) is more detailed but shows little change, although some small new buildings are shown within the site.

E.4.17 Chapel Place **(HEA1L)** was a short street which has now become the access on to the site from its southeastern corner. It may have acquired its name from an earlier chapel in the area where John Wesley preached a funeral sermon for George Whitfield in 1770. The chapel originated as a wooden barn 'on the north side of Greenwich Road, now Greenwich High Road' in around 1750 (Cheffins, 2009)[10]. The exact location of this early chapel is uncertain but it probably lay just outside of the site to the east of Chapel Place. It was short-lived: the foundation stone of the new Congregational Chapel which replaced it was laid in 1799 and the building was completed in 1801. This is the building shown as a chapel on Morris's map of 1832 (Vol 24 Plate E.2) on the south side of Greenwich Road **(HEA19).** The reluctance of the Anglican Church to conduct burial funerary services over non-conformers led to the growth of burial grounds attached to nonconformist meeting houses during the 18th century (City of London, 1999)[11]. No historic maps show a burial ground on the site but it is conceivable that burials took place within or around the early chapel. Mrs Basil Holmes's survey of 1896 does not record a burial ground on the site but refers to the burial-ground next to the Congregational Chapel on the other side of Greenwich High Road as operating from *c* 1800 (Holmes, 1896)[12].

E.4.18 Sims's map of 1838 (Vol 24 Plate E.3) shows the site in more detail and highlights each individual terraced house along the southern part of the site where it fronts Greenwich Road. Running roughly parallel to Deptford Creek, within the western edge of the site is a drainage ditch, and at its southern end is a small building of unknown use.

E.4.19 Construction of the London and Greenwich Railway was authorised by Act of Parliament in 1833 and the railway opened from Greenwich to London in 1838. To cross the Ravensbourne valley a viaduct (**HEA 1F and HEA 42**) was built from Greenwich railway station c. 150m east of the site, with a drawbridge spanning Deptford Creek to the west of the site to allow

masted ships to pass. The viaduct (Vol 24 Plate E.14) is now Grade II listed.

E.4.20 By the mid 19th century, urban and industrial development was more extensive as shown on Stanford's map of 1862 (Vol 24 Plate E.4). The map shows the Deptford Sewage Pumping Station (also known as Greenwich Pumping Station) in the site, constructed between 1859 and 1862 by Sir Joseph Bazalgette, and opened in 1865 (Cherry and Pevsner, 1983)[13]. The beam engine building (**HEA 1A**) to the northeast is Grade II listed, with two beam engine houses either side of a central boiler house (Vol 24 Plate E.9); two coal sheds (**HEA 1B** and **HEA 1C**) in the southwestern part of the site are also Grade II listed (Vol 24 Plate E.10). The southern part of the site is crossed by Bazalgette's Southern Low Level Sewer (**HEA 1H**), the High Level Sewer (**HEA 1I**) and the East Greenwich Branch Sewer (**HEA 1K**).

E.4.21 Stanford's map (Vol 24 Plate E.4) shows the northern part of the site crossed by the London and Greenwich Railway viaduct, with Railway Wharf on its western edge and buildings alongside Railway Place in the northeastern part of the site.

E.4.22 The Ordnance Survey 1st edition 25": mile map of 1862–95 (Vol 24 Plate E.5) shows no change to the layout of buildings within the site, but shows them in more detail. Terraced houses front Greenwich Road in the southeastern edge of the site, with gardens to the rear. Trees surround the pumping station buildings to the south of the railway viaduct, and the railway drawbridge and foot bridge (**HEA 37**) are marked. To the north of the viaduct is Railway Wharf, with sheds or warehouses on the eastern and western edges of the site. The Ordnance Survey 2nd edition 25": mile map of 1896–8 (Vol 24 Plate E.6) shows no change within the site.

E.4.23 In 1905, the beam engine house (**HEA 1A**) in the site was extended and is shown on the Ordnance Survey 3rd edition 25": mile map of 1909–20 (Vol 24 Plate E.7). Immediately south of the railway viaduct are large cooling tanks. This map also shows that the terraced houses which were previously in the southeastern edge of the site fronting Greenwich Road had been demolished.

E.4.24 The London County Council's bomb damage map (not reproduced) records that during World War II the two coal sheds (**HEA 1B** and **1C**) suffered serious but repairable damage (London County Council, 2005)[14]. The Ordnance Survey 1:2500 scale map of 1947–72 (Vol 24 Plate E.8) shows three small tanks built in the southern part of the site; one at the eastern edge, one in the middle and the third next to the coal shed. An electricity sub-station (**HEA 32**) was also constructed, probably in the early 1920s (Cheffins, 2007)[15] in the early–mid 20th century by the London Electric Supply Corporation (LESC) just outside the southern end of the site fronting onto Greenwich High Road (Vol 24 Plate E.13).

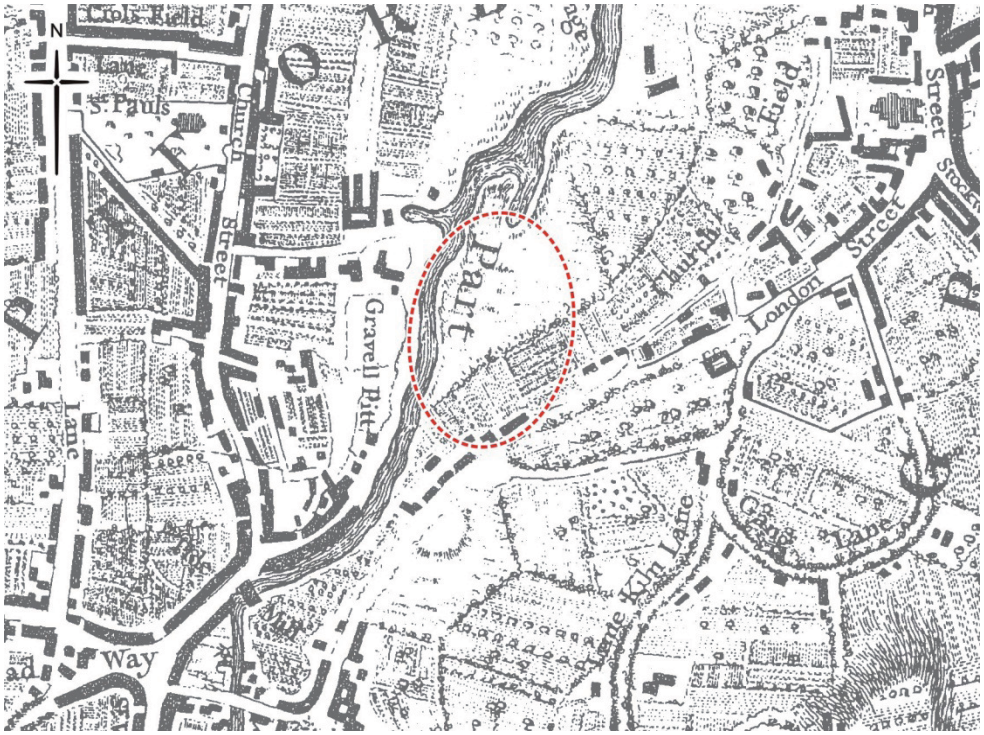
Current area of the site

E.4.25 Phoenix/Harts Wharf which comprises the northern section of the site, north of the railway line, is bounded by a vehicle repair garage and offices to the north, Norman Road and the Greenwich Centre Business Park to

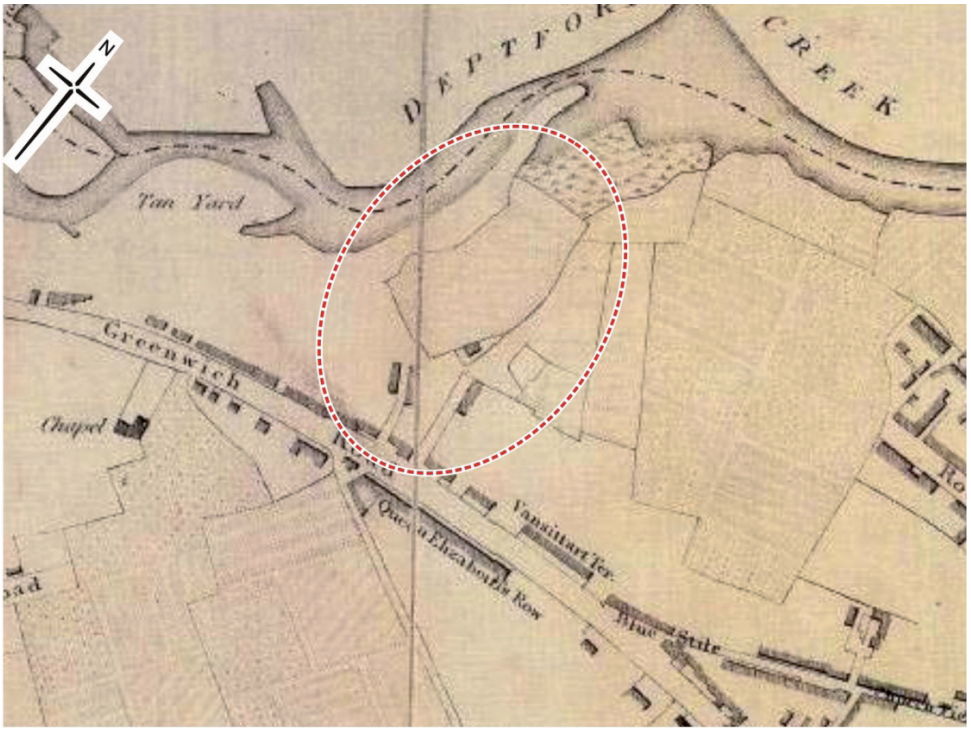
the east and Deptford Creek to the west. The Docklands Light Railway (DLR) was constructed in the late 1990s, on a viaduct which runs across the central part of the site, to the south of the Grade II listed railway viaduct (**HEA 1F**). The southern part of the site contains the main Grade II listed Greenwich Pumping Station buildings (**HEA 1A**) surrounded by access routes and low level landscaping. The two Grade II listed coal sheds (**HEA 1B** and **1C**) are, or have recently been, used for storage and the southernmost of the two has modern structures within it built using cement blocks.

E.5 Plates

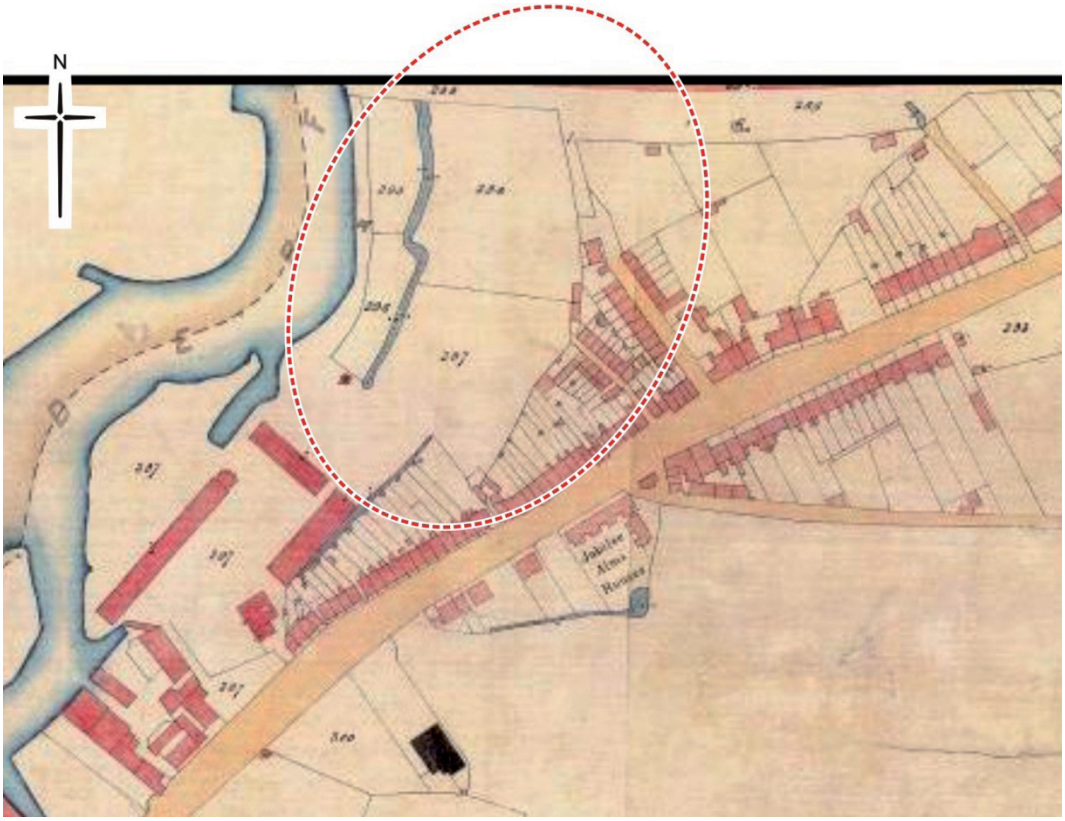
Vol 24 Plate E.1 Historic environment – Rocque's map of 1746



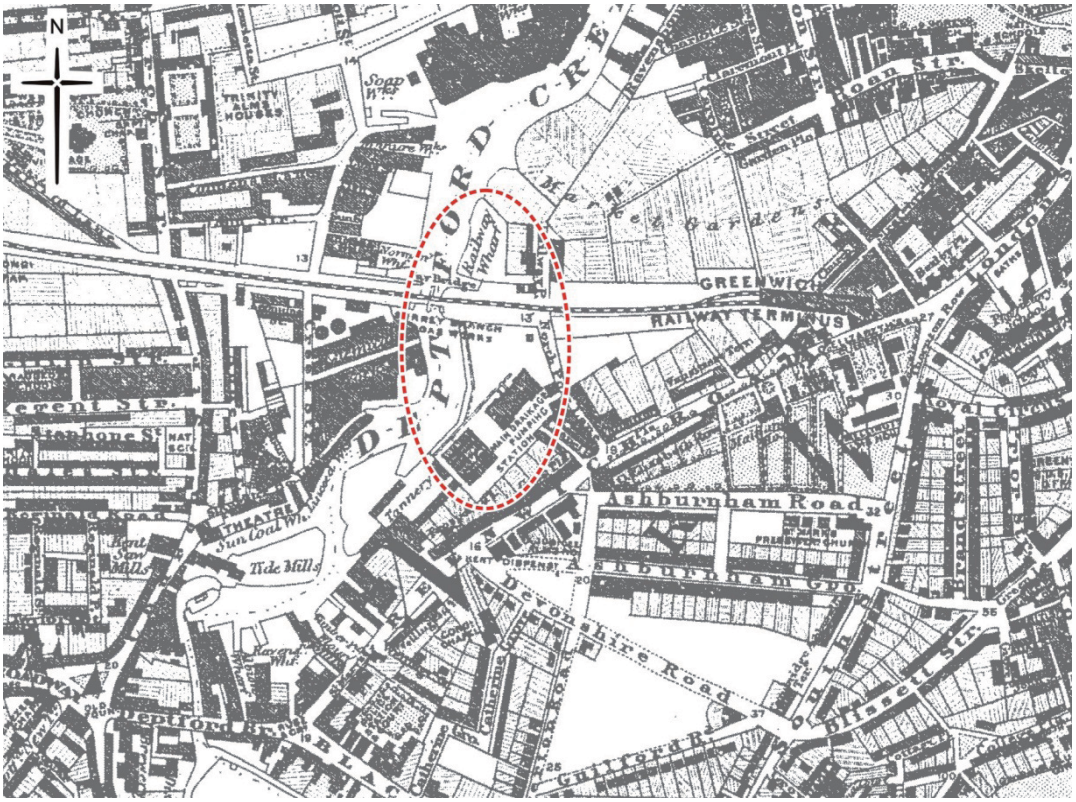
Vol 24 Plate E.2 Historic environment – Morris's map of 1832



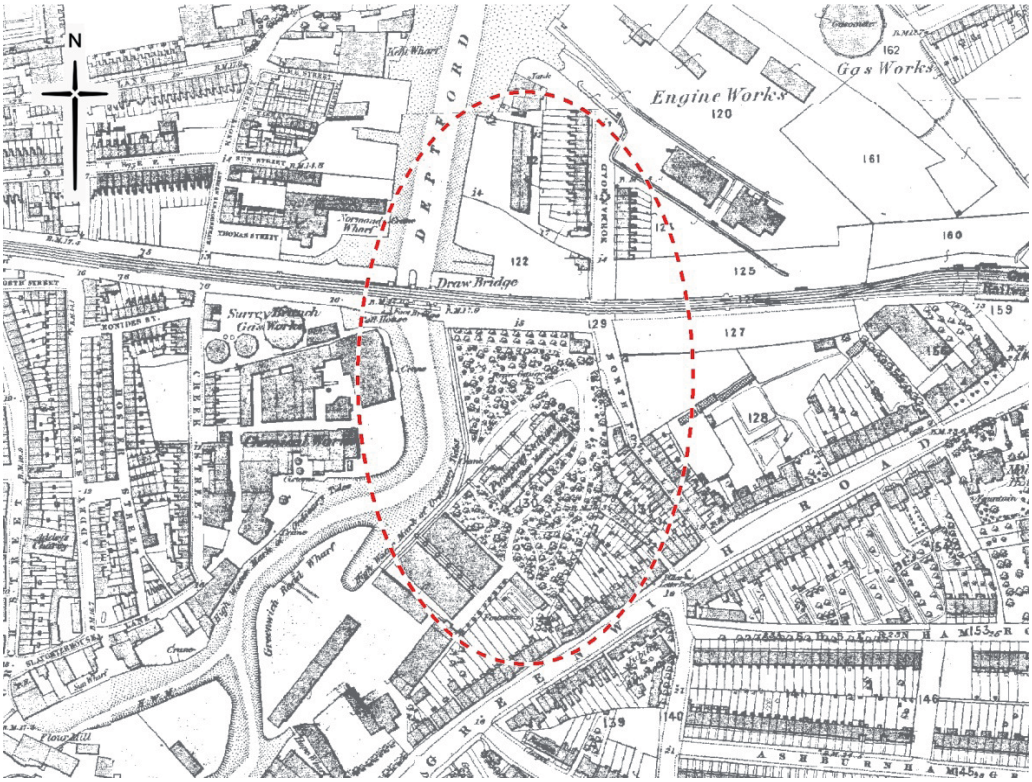
Vol 24 Plate E.3 Historic environment – Sims's map of 1838



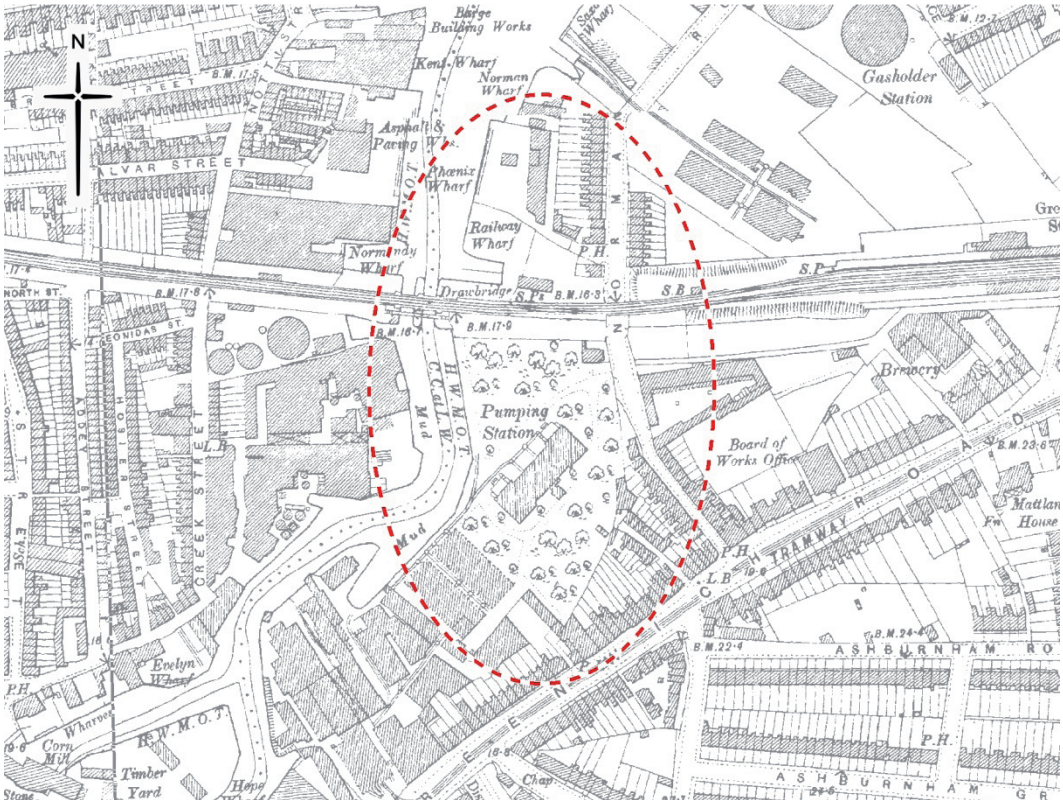
Vol 24 Plate E.4 Historic environment – Stanford's map of 1862



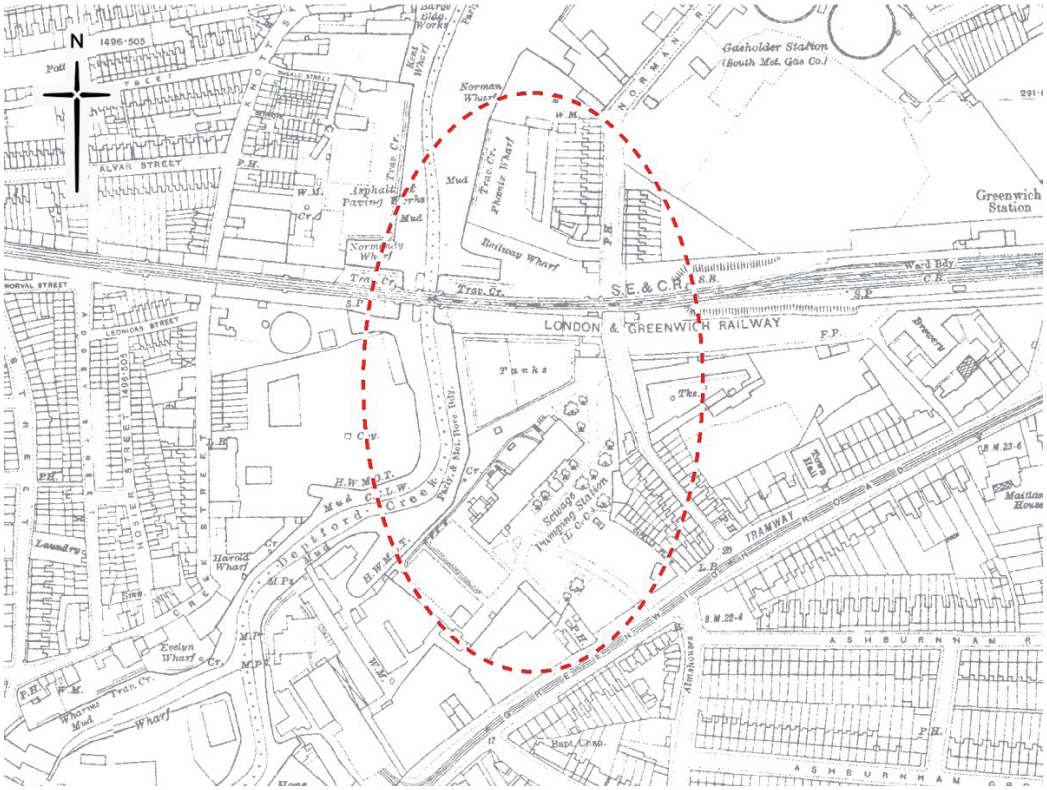
Vol 24 Plate E.5 Historic environment – Ordnance Survey 1st edition 25”:mile map of 1862–95 (not to scale)



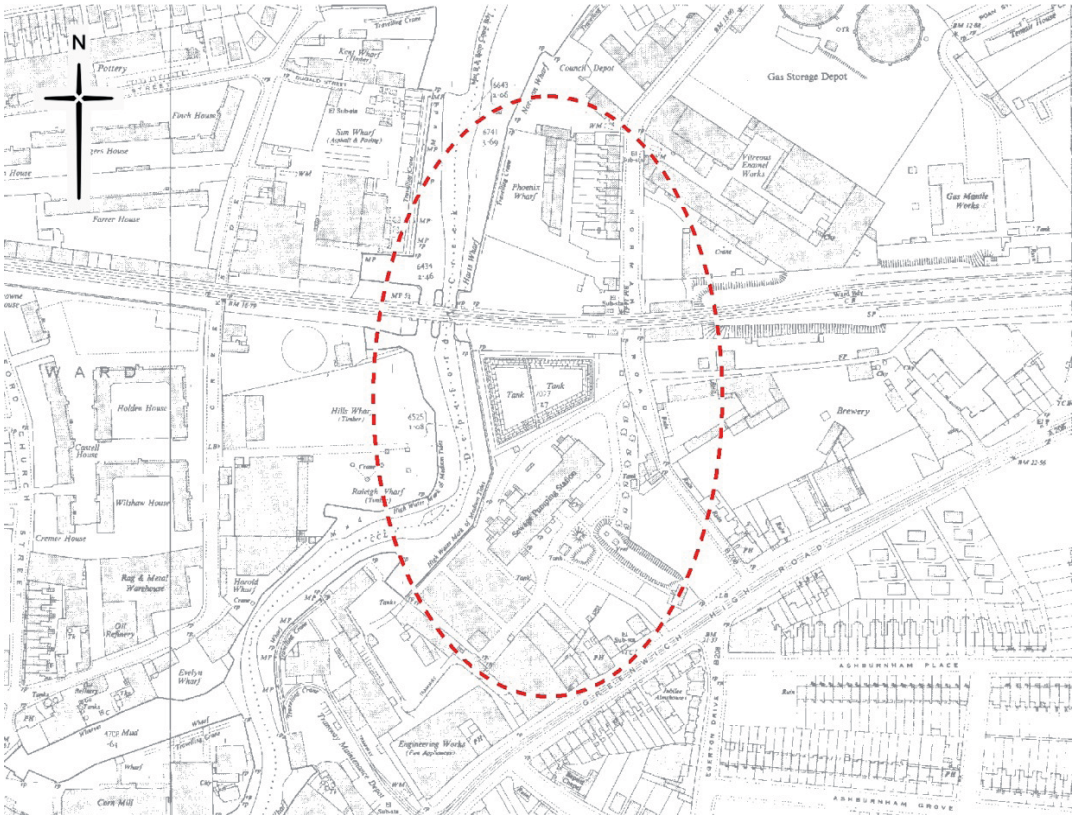
Vol 24 Plate E.6 Historic environment – Ordnance Survey 2nd edition 25”:mile map of 1896–8 (not to scale)



Vol 24 Plate E.7 Historic environment – Ordnance Survey 3rd edition 25”:mile map of 1909–20 (not to scale)



Vol 24 Plate E.8 Historic environment – Ordnance Survey 25”:mile map of 1947–72 (not to scale)



Vol 24 Plate E.9 Historic environment – Bazalgette's Grade II listed Greenwich Pumping Station (HEA 1A) within the site, with the beam engine houses either side of the boiler house. The 1905 extension is behind the trees on the right, whilst the cooling basin is under the surface in the foreground; standard lens, looking south

Vol 24 Plate E.10 Historic environment – The northernmost of the two Grade II listed coal sheds (HEA 1B and 1C) in the southwestern part of the site. The cast iron columns are hollow and function as drainpipes; standard lens, looking southeast

Vol 24 Plate E.11 Historic environment – Interior of the north beam engine house (HEA 1A); standard lens with flash, looking south

Vol 24 Plate E.12 Historic environment – Stone steps and entrance platform of the north beam engine house (HEA 1A) also showing the earlier iron posts alongside modern railings; standard lens, looking east

Vol 24 Plate E.13 Historic environment – LESC substation (HEA 32) immediately outside the southern edge of the site boundary; standard lens, looking west

Vol 24 Plate E.14 Historic environment – Grade II listed viaduct to the west of the site (HEA 42) built by the London to Greenwich railway in 1838; standard lens, looking northwest

Vol 24 Plate E.15 Historic environment – 19th century brick built chimney, south of the pumping station outside of the site; standard lens, looking south from the small car park area

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station appendices

Appendix F: Land quality

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

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Thames Tideway Tunnel

Environmental Statement

Volume 24 appendices: Greenwich Pumping Station site assessment

Appendix F: Land quality

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Appendix F: Land quality

F.1 Baseline report

F.1.1 Baseline data is sourced from:

a. walkover survey

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

c. stakeholder consultation

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

Site walkover

F.1.2 A site walkover was undertaken on the 18th November 2010, access was available across the entirety of Greenwich Pumping Station site (and within site buildings).

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 A large area of Japanese Knotweed was observed located adjacent to/partially covering the central part of the site.

F.1.5 Part of the existing Thames Water sewage pumping station is located on-site. Ancillary pump buildings are located centrally.

F.1.6 The sewage pumping building immediately to the south contains four diesel engines, and two large (25,000 litre) diesel fuel tanks contained within a brick built bund.

F.1.7 Waste oil drums were observed stored on concrete hardstanding adjacent to the building. No spillage or leakage was observed during the site walkover.

F.1.8 The Docklands Light Rail (DLR) crosses the site on a concrete viaduct and the mainline rail track crosses on a brick built viaduct.

F.1.9 The northern part of the site beyond the brick viaduct comprises operational builders' merchants. No access was gained to the merchants at the time of the survey.

F.1.10 Detailed site walkover notes are provided in Vol 24 Table F.1 below.

Vol 24 Table F.1 Land quality – site walkover report

Item (Site ref: PGH4X, Greenwich Pumping Station)	Details
Date of walkover	18th November 2010
Site location and access	Thames Water operated Greenwich Pumping Station, situated along Greenwich High Road.

Item (Site ref: PGH4X, Greenwich Pumping Station)		Details
	Access was available across the entirety of the pump station site (and within site buildings). Surroundings viewed from publicly accessible areas.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	Site is flat and in keeping with the level of the surrounding area.
Neighbouring site use (in particular note any potentially contaminative activities or sensitive receptors)	North	The site is bordered to the north by industrial commercial units forming part of the Brockmarsh Industrial Estate. The estate comprises a number of warehouse style buildings with associated hardstanding and access road.
	South	The site is bordered to the southeast by Greenwich High Road and to the southwest by a large commercial building, the use of which is unknown. Residential properties located to the southeast of the site.
	East	An unoccupied industrial estate is located to the east on Norman Road with further operational units further to the north along Norman Road. The operational Greenwich Pumping station is adjacent to southern part of the eastern boundary.
	West	The majority of the site is bordered directly to the west by the tidal Deptford Creek. Industrial and commercial units exist beyond the creek. In the southernmost part new apartments and hotel are under construction.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	Part of existing Thames Water sewage pumping station is on-site. Ancillary pump buildings are located centrally. The southeastern part of the site is formed form listed covered storage area. The Docklands Light Rail cross the site on a concrete

Item (Site ref: PGH4X, Greenwich Pumping Station)		Details
		viaduct and the mainline rail track crosses on a brick built viaduct. The northern part of the site beyond the brick viaduct comprises operational builders' merchants.
Surfacing	Record type and condition	Mixture – within pump station site the ground is generally loose surfaced.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	A large area of Japanese Knotweed was observed located adjacent to/partially covering the central part of the site.
Services	Evidence of buried services?	None observed
Fuels or chemicals on-site	Types/ quantities?	None on-site – The sewage pumping building immediately to the south contains four diesel engines, and two large (25,000 litre) diesel fuel tanks contained within a brick built bund. Waste oil drums were observed stored on concrete hardstanding adjacent to the building. No spillage or leakage was observed.
	Tanks (above ground or below ground)	See above
	Containment systems (eg, bund, drainage interceptors). Record condition and standing liquids	See above
	Refill points located inside bunds or on impermeable surfaces etc?	None observed
Vehicle servicing or refuelling onsite	Record locations, tanks and inspection pits etc.	None observed
Waste generated/stored onsite	Adequate storage and security? Fly tipping?	Some localised storage of empty oil containers and pipework on hard surfacing within pump station site. No fly tipping.

Item (Site ref: PGH4X, Greenwich Pumping Station)		Details
Surface water	Record on-site or nearby standing water	Deptford Creek (tidal) is situated on the western boundary of the Greenwich Pumping Station site.
Site drainage	Is the site drained, if so to where? Evidence of flooding?	None observed
Evidence of previous site investigations	Eg trial pits, borehole covers.	None observed
Evidence of land contamination	Evidence of discoloured ground, seepage of liquids, strong odours?	No obvious evidence
Summary of potential contamination sources		Presence of Japanese Knotweed. Builders' Merchants on northern part of site. Diesel fuel tanks and waste oil drums adjacent to the site
Any other comments	Eg access restrictions/ limitations	Access was available across the site area with the exception of the builders' merchants. Surroundings viewed from publicly accessible areas.

Review of historical contamination sources

F.1.11 Historical mapping (dated between 1870 and 1995) has been reviewed in order to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.12 Vol 24 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.1.13 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.1.14 Items listed in the table below are also shown on Vol 24 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 24 Appendix E.

Vol 24 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			
1	Sewage pumping station	c1860s-present	Heavy metals, arsenic, free cyanide, nitrates, ammonium, phosphates, sulphates, sulphides, asbestos, oil/fuel hydrocarbons, chlorinated aliphatic hydrocarbons, chlorinated aromatic hydrocarbons, polychlorinated biphenyls (PCBs), pathogens
2	Tanks	c1916-recent	Content unknown
14	Railway	c1870-present	Polyaromatic hydrocarbons (PAHs), heavy metals, phenols, sulphates, fuel oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons, herbicides, semi volatile organic compounds (SVOCs)
41	Builders yard	c1987	Oil/fuel hydrocarbons, volatile organic compounds (VOCs), solvents, oil and greases, heavy metals, particulates
Off-site			

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
3	Electrical substation	c1951-c1952	Oils, PCBs
4	Kent Wharf (60m northwest)	c1870-recent	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
5	Sun Wharf (40m west)	c1870	
6	Hills Wharf (40m west)	c1870	
7	Harold Wharf (85m southwest)	c1870	
8	Evelyn wharf (110m southwest)	c1870	
9	Hope Wharf (120m southwest)	c1870	
10	(a) Chemical works (60m west)	c1870-c1896	Heavy metals, arsenic, boron, selenium, nitrates, sulphates, sulphides, asbestos, PAHs, phenols, acetones, aromatic hydrocarbons, PCBs, dioxins, furans
	(b) Engineering works (60m west)	c1970-c1981	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
11	Surrey Gas Works and associated gasometer (55m west)	c1870	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, cyanides, ammoniacal liquors, phenols, heavy metal, asbestos, sulphates, sulphides

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
12	(a) Engine works (85m northeast)	c1870-c1882	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
	(b) Gas storage depot (85m northeast)	c1951-c1955	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds. cyanides, ammonia, phenols, heavy metals and asbestos
13	(a) Gas works (140m northeast)	c1870	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, cyanides, ammoniacal liquors, phenols, heavy metal, asbestos, sulphates, sulphides
	(b) Gas holders (140m northeast)	c1896-c1955	
15	(a) Colour works and associated tanks (140m northwest)	c1870-c1882	Heavy metals, arsenic, selenium, free cyanide, nitrates, sulphates, sulphides, asbestos, PAHs, phenols, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, organotin compounds
	(b) Depot (140m northwest)	c1987	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
16	(a) Pitch tar, varnish and naphtha works (90m northwest)	c1870	Monoaromatic hydrocarbons, PAHs, n-alkanes (C5-C20), methyl tert-butyl ether (MTBE), lead, solvents incl. acetone
	(b) Council depot (90m northwest)	c1916-present	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
17	Tank (40m north)	c1870	Content unknown
18	Tramway (5m south)	c1896-c1952	PAHs, heavy metals, phenols, sulphates, fuel oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons
19	Timber yard (160m southeast)	c1896	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs, cresols
20	Timber yard (120m southeast)	c1896	
21	Asphalt and paving works (45m west)	c1896-c1971	Heavy metals, arsenic, sulphides, asbestos, acetone, oil/fuel hydrocarbons, PAHs, PCBs
22	(a) Brewery (10m east)	c1896-c1959	VOCs, total petroleum hydrocarbons (TPHs), heavy metals, ethanol/methanol, ammonia, chlorinated
	(b) Bottling works (10m east)	c1970-c1974	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
			alkalis, benzene, toluene, ethylbenzene and xylenes
	(c) Greenwich industrial estate (10m east)	c1987-recent	TPHs, metals, paints, solvents
23	Soap works (100m north)	c1896	Phenols, PAHs, aromatic hydrocarbons
24	Laundrette (180m west)	c1916	Heavy metals, arsenic, VOCs such as chloroform and tetrachloroethane; various solvents; fluorocarbon 113; PCBs; aromatic hydrocarbons; chlorinated aliphatic hydrocarbons
25	Dock (45m northwest)	c1916	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PCBs, PAHs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
26	Hospital (100m south)	c1916-c1974	Pathogens, radioactive substances, heavy metals, oil/fuel hydrocarbons
27	Oil refinery (150m west)	c1951-c1971	Monoaromatic hydrocarbons, PAHs, n-alkanes (C5-C20), MTBE, lead
28	Rag and metal warehouse (120m west)	c1951-c1971	Metals, solvents, hydrocarbons

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
29	Timber yard (Raleigh Wharf) (30m west)	c1951-c1967	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs, cresols
30	Tramway maintenance depot and associated tanks (adjacent south)	c1951-c1952	PAHs, heavy metals, phenols, sulphates, fuel oil, lubricating oil, greases, PCBs, solvents, asbestos, chlorinated aliphatic hydrocarbons
31	(a) Vitreous enamel works (40m east)	c1951-c1959	Metal oxides, coal ash, asbestos
	(b) Engineering works (40m east)	c1970-c1995	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
32	Gas mantle works including associated tank (140m east)	c1951-c1967	Heavy metals, arsenic, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, radioactive isotopes
33	Engineering works (10m south)	c1951-c1981	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
34	Oil refinery (175m southwest)	c1951-c1971	Monoaromatic hydrocarbons, PAHs, n-alkanes (C5-C20), MTBE, lead
35	Works (60m south)	c1959	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons
36	Works (45m east)	c1959	
37	(a) Depot (10m east)	c1959-c1995	Oil/fuel hydrocarbons, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
	(b) Waste paper depot (10m east)	c1970-c1995	Ink, dyes, adhesives
38	Foundry (75m east)	c1970-c1987	Heavy metals, PCBs, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons
39	Brockmarsh Industrial Estate (adjacent north)	c1987-recent	Aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
40	Faircharm Trading Estate (95m west)	c1987-recent	
42	Depot (195m east)	c1987-present	Oil/fuel hydrocarbons, aromatic
43	Depot (50m northeast)	c1987-present	

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
			hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organolead compounds, heavy metals and asbestos
44	Electrical substation (120m east)	c1970-present	Oils, PCBs
45	Electrical substation (125m east)	c1970-present	
46	Electrical substation (120m west)	c1970-present	
47	Electrical substation (135m west)	c1970-present	
48	Electrical substation (230m west)	c1959-present	
49	Electrical substation (80m northeast)	c1951-c1952	
50	Tank (185m west)	c1970	Contents unknown
51	Tanks x2 (160m and 180m northwest)	c1869-c1873	
52	Timber yard (175m northwest)	c1951-c1952	Heavy metals, arsenic, boron, sulphate, phenol, acetone, aromatic hydrocarbons, PAHs, cresols
53	Wharf (110m northeast)	c1869-c1970	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
54	(a) Manure works (120m north)	c1869	Organic matter

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
	(b) Asphalt works (120m north)	c1916	Heavy metals, arsenic, sulphides, asbestos, acetone, oil/fuel hydrocarbons, PAHs, PCBs
	(c) Wharf (120m north)	c1952	Heavy metals, arsenic, asbestos, phenols, oil/fuels, hydrocarbons, PAHs, PCBs, sulphide, sulphate, chlorinated aromatic hydrocarbons, chlorinated aliphatic hydrocarbons
55	Wharf (180m northeast)	c1869-c1970	

On-site

F.1.15 With the exception of the unidentified tanks first shown on the 1916 map, the historical map review has identified no on-site potentially contaminating land-uses additional to the existing pumping station and builders' merchants.

F.1.16 The presence of the railways (on brick or concrete viaducts) is the only other current land-use on-site and is not judged to be a significant source of contamination.

Off-site

F.1.17 Within the 250m assessment area, the historical mapping shows that the area surrounding the Greenwich Pumping Station site was (and partially remains) predominantly industrial in nature. Specific previous indusitrres of note include a gas works and oil refinery, tar and naphtha works and chemical works, all located on the opposite (western) side of Deptford Creek.

Geology

F.1.18 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 24 Table F.3 below.

Vol 24 Table F.3 Land quality – anticipated site geology

Geological Unit/ Strata	Description	Approximate depth below ground level (m)
Made Ground	Largely comprises sandy gravelly silt with local gravels of brick, concrete and flint.	0.0 – 2.10
Alluvium	Soft and firm sandy slightly gravelly clay with occasional shell fragments	2.10-3.40
River Terrace Deposits	Medium dense to dense to dense sand and gravel (predominantly quartz sand and flint gravel).	3.40-10.4
Lambeth Group (Upnor Formation)	The Upnor Formation consists of dense, silty sand with some rounded flint gravel.	10.4 – 15.4
Thanet Sand Formation	Generally dense glauconitic silty fine sand with occasional rounded flint gravel.	15.4 – 25.8
Chalk Group	Fine grained limestone with nodular and tabular flints.	25.8 – unproven

Unexploded ordnance

F.1.19 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.1.20 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited at the Greenwich Pumping Station site (see Vol 24 Appendix F.2). The report reviews information sources such as the Ministry of Defence, Public Records Office and the Port of London Authority (PLA).

F.1.21 The report advises that no high explosive bomb strikes occurred within the site, however two occurred within the buffered site boundary and a further eight were recorded within 100m of the buffered site boundary. In addition, seven V1 bomb strikes have been recorded as occurring within 150m of the site and one within the site boundary itself.

F.1.22 The report also advises that a large proportion of the site has been redeveloped since WWII with the possibility that any buried UXO would have been removed during this time.

F.1.23 Taking into account the findings of this study and the known extent of the proposed works, it was considered that there is an overall low/medium threat from UXO at the Greenwich Pumping Station site.

Thames Tideway Tunnel ground investigation data

F.1.24 This section summarises the ground investigation undertaken by the Thames Tideway Tunnel project.

F.1.25 Boreholes were drilled on-site (borehole reference SR1024 and SR1018D) and immediately adjacent to the boundary of the Greenwich Pumping Station site (PR1023). Vol 24 Figure F.1.2 (see separate volume of figures) identifies the location of the boreholes in relation to the site.

F.1.26 Vol 24 Figure F.1.2 also identifies a number of other boreholes excavated in vicinity of the site, these are not considered relevant to the contamination status of the site, either due to their distance from the proposed drop shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination data

F.1.27 Ten soil samples comprising seven samples of Made Ground, one sample of Alluvium, one sample of River Terrace Deposits and one sample of Thanet Sand retrieved from the boreholes were sent for laboratory analysis.

F.1.28 No obvious visual or olfactory evidence of contamination was recorded on the borehole logs, although ash and clinker was recorded locally within the Made Ground in all boreholes: this is commonly a source of PAHs.

F.1.29 The laboratory analysis comprised a suite of common contaminants that may be associated with the current and former industrial setting of the site and surrounding area.

F.1.30 The testing suite included the following contaminants: heavy metals and metalloids, PAHs, TPH, VOCs, phenols, cyanide, ammoniacal nitrogen, pH, soil organic matter content.

F.1.31 The results of the analyses have been compared against human health screening values (for light industrial / commercial land use[3,4]). No contaminants above these human health screening values were found in the samples tested.

F.1.32 These values consider risks to workers in the long term assuming that some open amenity space is provided.

F.1.33 See Volume 2 Environmental assessment methodology for full guidance on the benchmarks used.

Soil gas data

F.1.34 Gas monitoring installations in borehole PR1023 were screened below the groundwater level. No soil gas testing results were available for wells screened above or across the water level.

F.1.35 No soil gas testing results were available for boreholes SR1018D or SR1024.

Groundwater contamination data

F.1.36 Samples of groundwater were taken from from borehole SR1024, SR1018D and PR1023.

F.1.37 The groundwater data for SR1024 showed low levels of contamination with respect to aluminium, arsenic, chloride, chromium, cypermethrin, dichlorprop and sodium.

F.1.38 Samples of groundwater from borehole SR1018D showed a low level of contamination in relation to aromatics and within borehole PR1023, low levels of contamination with respect to benzene, phenol, total aromatics and PAHs.

F.1.39 Refer to Section 13 Water resources – groundwater of this volume for further information.

Sediment quality analysis

F.1.40 An investigation into the sediment quality at the Greenwich Pumping Station (Deptford Creek foreshore) site was undertaken by the Port of London Authority (PLA) hydrographic department in December 2011[5] . A report on the findings is presented in Mott MacDonald Limited *Thames Tunnel Foreshore Sediment Quality Interpretative Report*[6] .

F.1.41 Five samples of sediment were taken from the foreshore of the Deptford Creek and sent for laboratory analysis.

F.1.42 The testing showed relatively low levels of PAHs and metals within the foreshore sediments which are typical of the sediments along the tidal Deptford Creek. These contaminants reflect the former industrial nature of the area and are present as they tend to bind with soils. The results are not elevated in terms of risk to human health3,4 but elevated over PLA approved sediment quality guidelines, with the exception of one sample which recorded levels of various individual PAH compounds above the residential assessment criteria.

F.1.43 No samples were recorded to exceed the less stringent commercial land use values. Refer to Vol 2 for full guidance on the benchmarks used.

Third party ground investigation data

F.1.44 No third party ground investigation data was available for review at the Greenwich Pumping Station site.

Other environmental records

F.1.45 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 24 Table F.4. Pertinent records are discussed in further detail below.

F.1.46 The location of these records is shown on Vol 24 Figure F.1.3 (see separate volume of figures).

Vol 24 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	4
Licensed waste management facility	0	3
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	An area of past potential contaminated industrial use is present on-site, in addition to areas within 250m.	
Pollution incident to controlled water*	1	0
Registered waste transfer site	0	4
Registered waste treatment or disposal site	0	1

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

F.1.47 Inspection of the data has identified one on-site record of a pollution incident to controlled water. This is located in the northern part of the site within the existing builders' merchants and is classified as a minor incident involving oils (which took place in 1990). Localised residual contamination of the soils (and shallow groundwater) beneath the site may be associated within this incident.

F.1.48 However, with the possible exception of the entry on the opposite side of Norman Road, none of these waste facilities or operations is considered to pose a significant risk to soils beneath the subject site.

F.1.49 There are areas identified both on-site and within the 250m assessment area as being of past potential contaminated industrial use. These are detailed by the land-use entries identified in Vol 24 Vol 24 Table F.2 and shown on Vol 24 Figure F.1.1 (see separate volume of figures).

F.1.50 Common contaminants associated with these types of previous land-use are identified in Vol 24 Table F.2.

F.1.51 Within 250m of the Greenwich Pumping Station site, there are four local authority pollution prevention and control sites recorded. Two of these are located close to the northern and eastern site boundaries on Norman Road (on Greenwich Business Park and Brockmarsh Industrial Estate), these records relate to respraying of road vehicles and mobile screening and crushing processes.

F.1.52 The third is located approximately 200m to the southwest on Greenwich High Road and relates to a petrol filling station and the fourth is located approximately 240m to the north on Cooperas Street. This control relates to activities associated with the quarrying process such as roadstone plants and the size reduction of bricks, tiles and concrete.

F.1.53 There are three licensed waste management facilities within 250m, these are located some 40m to the east of the site on Norman Road; 135m to the northwest on Creekside; and 220m to the northwest by Cooperas Street. In addition to four waste transfer sites and a single waste treatment or disposal site.

F.1.54 Two of the waste transfer sites are located approximately 150m to the north in the industrial complex along Cooperas Street, with a further site located 130m to the west within Faircharm Industrial Estate on the opposite side of Deptford Creek. The final site is situated in the same place as the previously mentioned licensed waste management facility on Norman Road.

F.1.55 The single waste treatment or disposal site is recorded as being located 230m to the north on Cooperas Street.

Thames water operational records

F.1.56 Thames Water records of contaminating substance storage at the Greenwich Pumping Station site within the last five years were reviewed.

F.1.57 The storage of 56,000 litres of fuel oil is currently taking place within the wider Greenwich Pumping Station site. In addition to the storage of 20-100, 20 litre drums of lubrication oil for engines and pumps. This does not account for potential storage of contaminating substances at the trunk sewer depot within the wider Greenwich Pumping Station site.

F.1.58 No spillages of any potentially contaminating substances to ground were recorded.

Land quality data from local authority

F.1.59 The Royal Borough (RB) of Greenwich was consulted with respect to land quality information they may held for the site and designated search area.

F.1.60 RB Greenwich provided site investigation reports relating to two sites within close proximity to Greenwich Pumping Station. The first site is located adjacent to the Greenwich Pumping Station site (Numbers 43-81 Greenwich High Road) and the second approximately 250m north, at Haddo Estate (Tarves Way).

F.1.61 These reports provided by the council confirmed the industrial history of the area around Greenwich Pumping Station. A brief summary of the investigation undertaken adjacent to the site is as follows:

i The assessment concluded that there were soil contamination hotspots with lead, copper, zinc and mercury, hydrocarbons and benzo(a)pyrene located in the northern and northwestern section of the site.

e. Analysis of the groundwater showed elevated concentrations of TPH (320µg/l) in the southwest of the site and slightly elevated concentrations of selenium were recorded (17µg/l in comparison with the EC Drinking water value of 10µg/l) elsewhere.

f. Leachate results indicated that heavy metals were only slightly leachable whilst TPH and PAH contamination was found to be mobile.

g. Gas screening values fall within Characteristic Situation 2 (typical of natural soils with a high peat / organic content and typical 'Made Ground').

Summary of contamination sources

F.1.62 Following the review of the baseline data, the following sources of on-site contamination which may impact on the construction of the proposed development have been identified:

a. The southern part of the site (shaft location and associated construction compound) has formed part of the Greenwich Pumping Station since the mid 19th Century with associated coal fired boilers, fuel tanks, engines, electrical switchgear. The northern part of the site contained buildings associated with the railway from the late 19th century, which subsequently formed the Phoenix Wharf during the early 20th century and was used as a builder's merchant from the 1980s. The main potential contaminants of concern are likely to be, but not limited to: fuels, oils, PCBs, PAHs, VOCs, pathogens. It is however noted that two phases of intrusive ground investigations undertaken in order to provide site specific data on soil and groundwater conditions. No evidence to suggest the presence of widespread contamination was recorded by the borehole logs. Laboratory testing of soils for a wide range of contamination has also recordedat the site have recorded no elevated soil contamination in comparison with human health risk assessment screening values for commercial/industrial land-use 3,4 (where available). Some contamination of the groundwater with metals and organic contaminants has however been recorded.

b. Japanese Knotweed

c. Potential UXO.

F.1.63 Off-site sources of contamination arise from a residual groundwater contamination associated with adjacent and nearby former potentially contaminative activities. Notably, the presence of former gas works located approximately 60m west of the site, chemical works (later engineering works) 50m west and numerous wharf areas located along Deptford Creek – the main potential contaminants of concern are likely to be, but not limited to: hydrocarbons, benzene, toluene, ethylbenzene and xylene, cyanides, phenols, PAHs, metals, ammoniacal liquors and VOCs.

F.1.64 Ground investigations on the adjacent land to the south (a former engineering works) recorded locally elevated metals and PAHs in soils with some relatively minor TPH in groundwater.

F.2 Detailed Unexploded Ordnance (UXO) risk assessment

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6 Alpha Associates Limited
Quatro House, Frimley Road
Camberley, Surrey
GU16 7ER

T: +44(0) 203 371 3904
F: +44(0) 1276 804 676
W: www.6alpha.com

Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PGH4X – Greenwich Pumping Station
Document Number: 336-RG-TPI-PGH4X-000001
Client Name: Thames Water
6 Alpha Project Number: P2853_R8_V2.0
Date: 23rd May 2012

Originator: Max Chainey (21st May 2012)
Quality Review: Lisa Askham (22nd May 2012)
Released by: Lee Gooderham (23rd May 2012)

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Contents

Figures

EXECUTIVE SUMMARY

Study Site	The Client has specified the Study Site as Work Area PGH4X, located at National Grid Reference "537707, 177261".
Key Findings	In light of the research for this report, 6 Alpha has assessed the threat on this Site based on these pertinent facts: • The Work Area is situated on what was predominantly developed land during World War Two (WWII), and is situated adjacent to *Deptford Creek*. • Several WWII bombing targets have been identified within the Work Area identified as a "pumping" station" and "wharves", as well as a "gasholder station" located immediately adjacent to the buffered Site boundary. Numerous other primary and "opportunistic" bombing targets were found within 1km of the Work Area. • The Site is located between *Deptford Metropolitan Borough* and *Greenwich Metropolitan Borough*, which experienced a bombing density of 453 High Explosive (HE) bombs and 216 HE bombs per 1,000 acres respectively. The former is a high bombing density for *London*, whilst the latter is considered a medium bombing density. • No HE bomb strikes occurred within the Work Area, however two strikes occurred within the buffered Site boundary. A further eight HE bomb strikes were recorded within 100m of the buffered Site boundary. Seven V1 bomb strikes occurred within 150m of the Work Area, with one V1 rocket striking within the Site boundary. Given the industrial development of the Site, it is likely that UXO would have been witnessed and reported across much of the Site. • Significant bomb damage was recorded within the Work Area including "total destruction", and extensive but varied bomb damage occurred throughout the buffered Site boundary ranging from "general blast damage; minor in nature" to "total destruction". The damage recorded is concomitant with the V1 strikes identified within and around the Work Area. • The Work Area has been mostly redeveloped since WWII, most notably the "wharf" that has been reclaimed for land use, and thus there is a possibility that buried UXO items may have been removed. 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	**LOW/MEDIUM**
Recommended Risk Mitigation	**The following actions are recommended before undertaking any activity on the Study Site:** 1. **Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site in the event of a suspected or real UXO discovery. 2. **UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. 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.

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 PGH4X. The Site is located at National Grid Reference 537707, 177261. For the purposes of this study, a 50m assessment radius will be applied to the work area to provide flexibility should it need to be relocated. See *Figures 1* and *2* for the Site location.
Location Description ***(Figure 3)***	The Work Area is situated to the southeast of the *City of London*, and lies between *Deptford Metropolitan Borough* and *Greenwich Metropolitan Borough*. Current aerial photography has identified the Work Area as land adjacent to *Deptford Creek* with structural developments, railway infrastructure and a "wharf" on site.
Proposed Engineering Works	*Thames Water* have specified a summary of the proposed engineering works, including working draft plans with drawing no. 100-DA-CNS-PGH4X-273105_AI; 100-DA-CNS-PGH4X-273106_AI; 100-DA-CNS-PGH4X-273107_AG; and 100-DA-CVL-PGH4X-373020_AI. The proposed works may not represent the full scheme but rather those that may present an UXO risk: • A 17m internal diameter shaft 43m deep. The shaft is anticipated to be constructed with diaphragm walls. • An interception chamber adjacent to the existing penstock chamber. • A culvert from the interception chamber to the drop shaft, including a valve chamber will be constructed on the culvert near the drop shaft. • An odour control building, including a 15m vent column. • A control kiosk containing equipment to operate a penstock. • Hardstanding access to the site from Norman Road, which will involve widening of the existing gated access. • Construction of the 5.0m diameter connection tunnel to Chambers Wharf. Within the construction compound there will be offices/welfare facilities, a storage area for construction materials and a storage and handling area for excavated material including slurry separation units. During tunnel driving there will be a slurry handling area and a TBM workshop and maintenance area.
Ground Conditions	*Thames Water* have indicated the following ground conditions for the Work Areas as:

Site Geology	Depth Below Ground Level (m)	Thickness (m)
Made Ground	0.00	2.10
Alluvium	2.10	1.30
River Terrace Deposits	3.40	7.00
Lambeth Group UF	10.40	5.00
Thanet Sand	15.40	10.40
Seaford Chalk	25.80	Not Proven

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

STAGE TWO – REVIEW OF HISTORICAL DATASETS	
Sources of Information Consulted	The following primary information sources have been used in order to establish the background UXO threat: 1. Home Office WWII Bomb Census Maps; 2. WWII & post-WWII Aerial Photography; 3. Official Abandoned Bomb Register; 4. National Archives in Kew; 5. Internet based research; 6. Historic UXO information provided by 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.
Site History and Use	According to the County Series (CS) & Ordnance Survey (OS) historical mapping, the following site history can be recorded immediately prior to and post-WWII: **1938 CS mapping** – The Work Area is situated on developed land and contains a "railway line" and a "wharf". **1949 OS mapping** – No significant or noticeable structural developments have occurred within the Site.
1945 Aerial Photography ***(Figure 4)***	The 1945 aerial photography confirms structural development on Site, and despite the lack of clarity in the aerial photography, we can infer that much of the Site is intact, given the buildings present on the photograph are concomitant with mapping from 1938. To the north of the Site, there is one "L-shaped" building present on the 1938 mapping that is no longer clearly visible on the 1945 aerial photography.
WWII Luftwaffe Bombing Targets ***(Figure 5)***	Primary targets have been identified as a "pumping station" within the Site and a "gasholder station" located within 10m of the buffered Site boundary, as well as *South Metropolitan Gas Works* located 300m to the north of the Site and *Deptford Power Station* located 260m to the north. "Opportunistic" targets include numerous scattered wharves, some of which are situated within the Work Area boundary, as well as a railway station and railway infrastructure, "depots", "works", a "shipbuilding factory" and a "reservoir" all located within 1km of the Site.
WWII HE Bomb Strikes ***(Figure 6)***	Air Raid Precaution (ARP) reports indicate that no bomb strikes occurred within the Work Area. However, two bomb strikes occurred within the buffered Site boundary and eight strikes occurred within 100m of the buffered Site boundary. Additionally, one V1 strike occurred within the east of the Site, three V1 strikes occurred within the buffered Site boundary to the south and north, and three V1 strikes were recorded within 150m of the Site.
WWII Bomb Damage ***(Figure 7)***	*London County Council* (LCC) bomb damage maps indicates bomb damage throughout the Site and buffered Site boundary, ranging from "general blast damage; minor in nature" to "total destruction". It should be noted that whilst two coal sheds located on the southwest corner of the Site are recorded as "damaged beyond repair", these structures are still standing today and appear to be in good condition for their age. This discrepancy is assumed to be based upon an initial overestimation of the damage sustained by local ARP wardens.
WWII HE Bomb Density ***(Figure 8)***	The Study Site is located between the *Greenwich Metropolitan Borough* and *Deptford Metropolitan Borough,* which recorded 216 HE bombs and 453 HE bombs per 1,000 acres respectively. This figure does not include incendiary devices, as they were often released in such large numbers that they were seldom recorded.
Abandoned Bombs	The Official Abandoned Bomb Register recorded no abandoned bombs on or within 1,000m of the Work Area.

STAGE THREE – DATA ANALYSIS	
Was the ground undeveloped during WWII?	No; the Work Area was fully developed with industrial structures and "wharves".
Is there a reason to suspect that the immediate area was a bombing target during WWII?	Yes; the Work Area is located directly at the site of a "pumping station" and in close proximity to other primary and "opportunistic" bombing targets.
Is there firm evidence that ordnance landed on Site?	Yes; whilst no HE bomb strikes were recorded within the Work Area, a V1 rocket struck within the east of the Site. The bomb damage recorded within the Site correlates with other V1 strikes around, but not within, the Site boundary.
Is there evidence of damage sustained on Site?	Yes; "general blast damage" and "damage beyond repair" were recorded to structures within the south of the Site, and "total destruction" was recorded to structures within the east of the Site. Additionally, extensive bomb damage has occurred to structures throughout the buffered Site boundary from "blast damage; minor in nature" to "total destruction".
Is there any reason to suspect that military training may have occurred at this location?	No; there is no evidence to suggest that military training occurred within any of the areas.
Would an UXB entry hole have been observed and reported during WWII?	Likely; the Work Area was industrially developed and located adjacent to a major road (*Greenwich High Road*) and the *Greenwich Railway Station*, indicating a high volume of footfall. Therefore, it is likely that any UXB entry hole may have been witnessed and investigated. However, the LCC maps show significant bomb damage to many buildings within the Work Area and debris from bomb-damaged buildings may have masked potential UXB entry holes. Additionally, a small portion of the Site was at one time a "wharf", and therefore UXBs falling within this area are unlikely to have been observed and reported.
What is the expected UXO contamination?	The most likely source of UXO contamination is from *German* aerial delivered ordnance, which ranges from small incendiary bombs through to large HE bombs (of which the latter forms the principal threat).
Would previous earthworks have removed the potential for UXO to be present?	Unlikely; the "wharf" has been reclaimed for land use and so has not reduced the potential for UXO to be present at this specific location. The remaining areas of the Site are a mix of post-WWII redevelopment and demolition of structures, and in some places no changes at all. However, the capacity for UXO to remain on site and undiscovered largely depends on the scale and depth of the post-WWII development, and this cannot be readily established.

STAGE FOUR – RISK ASSESSMENT		
Explanation For Non-Division Of Site	During WWII, the Site contained a "wharf" that presents very different ground conditions to the rest of the Site. However the "wharf" has since been filled in and reclaimed for land use, and *Thames Tunnel* have specified they will use this area for excavated materials and a concrete batching plant. Given that no major works of excavation, shaft installation or tunnelling are occurring at this particular location, it is felt that the Site does not warrant division.	
Threat Items	The threat is predominately posed by WWII *German* HE bombs and incendiary bombs. Additionally, *British* Anti Aircraft Artillery (AAA) projectiles may also be present. However, AAA does not have the potential for deep burial, and thus is unlikely to be encountered at depths greater than 1m bgl.	
Maximum Penetration	The general ground conditions (highlighted in Stage 1) of the Work Area that are relevant consist of Made Ground, Alluvium and River Terrace Deposits, and thus the most likely Bomb Penetration Depth (BPD) for a 250kg bomb is assessed to be a maximum of 7m bgl, dependant on the depth of any rock sediment. Whilst the *Luftwaffe* used larger bombs, their deployment was so few and only used against notable targets, to use them within this risk assessment would not be justified. Additionally, smaller items such as *German* incendiary bombs and *British* AAA projectiles would have a significantly reduced penetration capability and would not be expected to be encountered at depths greater than 1m.	
Risk Pathway	Intrusive engineering activities are likely to be in the form of excavations. Although for the purposes of this report 6 Alpha will use a range of generic construction activities for the risk assessment.	
Consequence	**Potential consequences of UXO initiation**	1. Kill and/or critically injure personnel 2. Severe damage to plant and equipment 3. Blast damage to nearby buildings 4. Rupture and damage underground services
	Potential consequences of UXO discovery	1. Delay the project 2. Disruption to local community/infrastructure 3. Incurring of additional costs
Site Activities	A number of construction methodologies have been identified for analysis on this Site. There is a large amount of variation in the probability of encountering, or initiating items of UXO when conducting different activities on Site. Additionally the consequences of initiating UXO vary greatly depending on how the item of UXO was initiated on Site.	

STAGE FOUR – RISK ASSESSMENT (…continued)

UXO RISK CALCULATION TABLE

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

Activity	**WORK AREA**		
	Probability (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	1x1=1	3x3=9	1x9=9
Tunnelling	1x2=2	1x3=3	2x3=6
Shaft Installation	1x2=2	1x3=3	2x3=6
Open Excavations	1x2=2	2x3=6	2x6=12

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 (2.10m at this Site) as any magnetometer results are highly likely to be affected by ferro-magnetic contamination due to previous construction activities within the Study Site location. **Intrusive Methods of Mitigation** – Intrusive magnetometry is expected to be possible (although limited) on this Site. It should be noted that ferro-contamination of any made ground/fill material, particularly at the fill layer, is likely to adversely affect detection capability of the equipment.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'		
Activity	**Risk Mitigation Measures**	**Final Risk Rating**
ALL ACTIVITIES	**The following actions are recommended before undertaking any activity on the Study Site:** 1. **Operational UXO Risk Management Plan;** appropriate site management documentation should be held on site to plan for and guide upon the actions to be carried out in the event of a suspected or real UXO discovery. 2. **UXO Safety & Awareness Briefings;** the briefings are essential when there is a possibility of explosive ordnance encounter and are a vital part of the general safety requirement. All personnel working on the site should receive a general briefing on the identification of UXB, what actions they should take to keep people and equipment away from the hazard and to alert site management. Posters and information of the general nature of the UXB threat should be held in the site office for reference and as a reminder.	ALARP
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 PGH4X
Site Location

Figure 1

British National Grid

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BOMB SEARCH

6 Alpha Associates Ltd.
Quatro House
Frimley Road
Camberley
Surrey GU16 7ER
United Kingdom
www.6alpha.com
0203 371 3900

0 100 200 400 600 800 1,000 Meters

N

Project Number: P2853_PGH4X
Drawn By: Dominique René
Checked by: Lee Gooderham
Date: 9th May 2012

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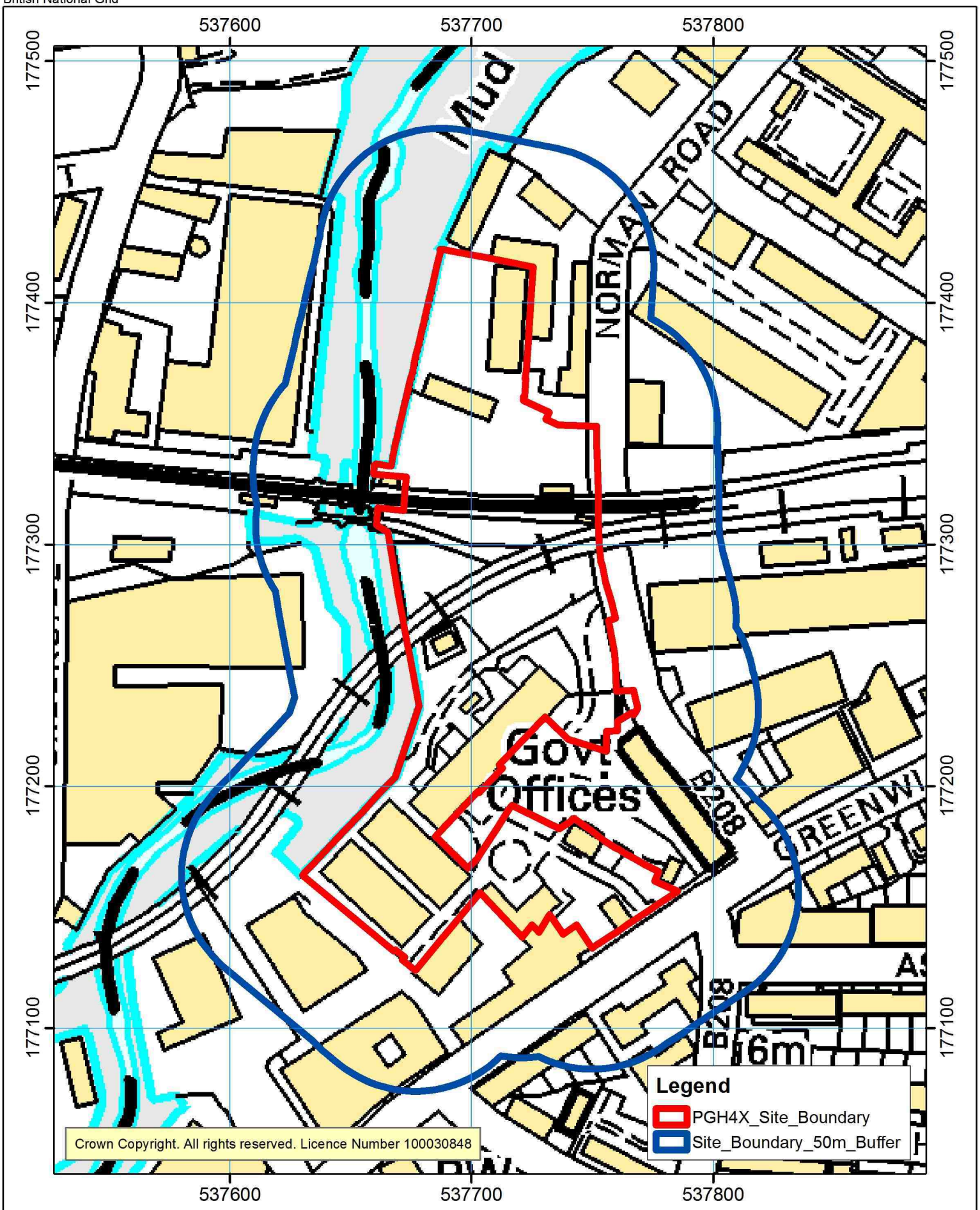
Figure Two

Site Plan

Thames Tideway Tunnel - Work Area PGH4X Site Boundary

Figure 2

British National Grid



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Camberley
Surrey GU16 7ER
United Kingdom
www.6alpha.com
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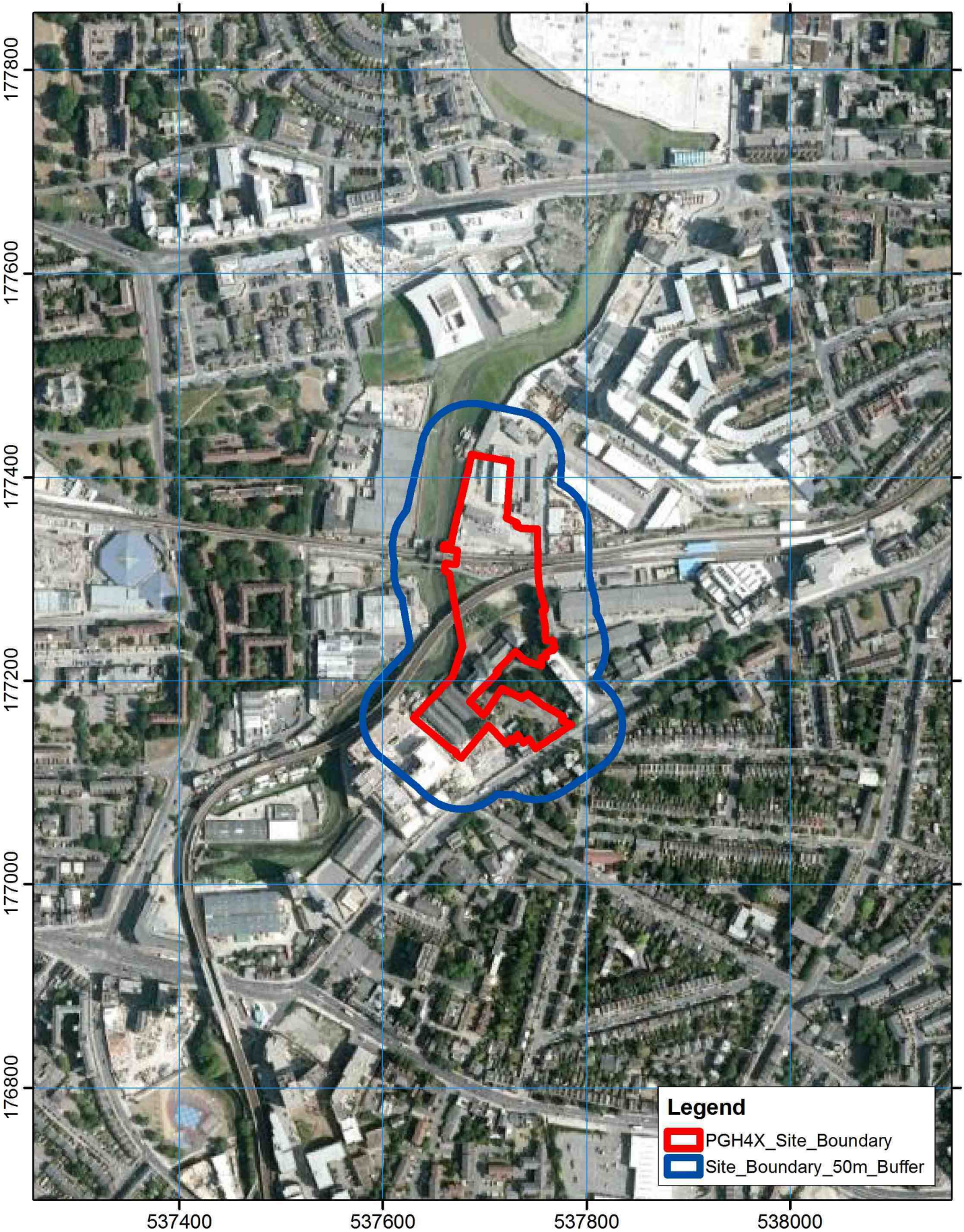
Figure Three

Current Aerial Photography

Thames Tideway Tunnel - Work Area PGH4X
Current Aerial Photography

Figure 3

British National Grid



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Frimley Road
Camberley
Surrey GU16 7ER
United Kingdom
www.6alpha.com
0203 371 3900

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Figure Four

1945 Aerial Photography

Thames Tideway Tunnel - Work Area PGH4X
1945 Aerial Photography

Figure 4

British National Grid

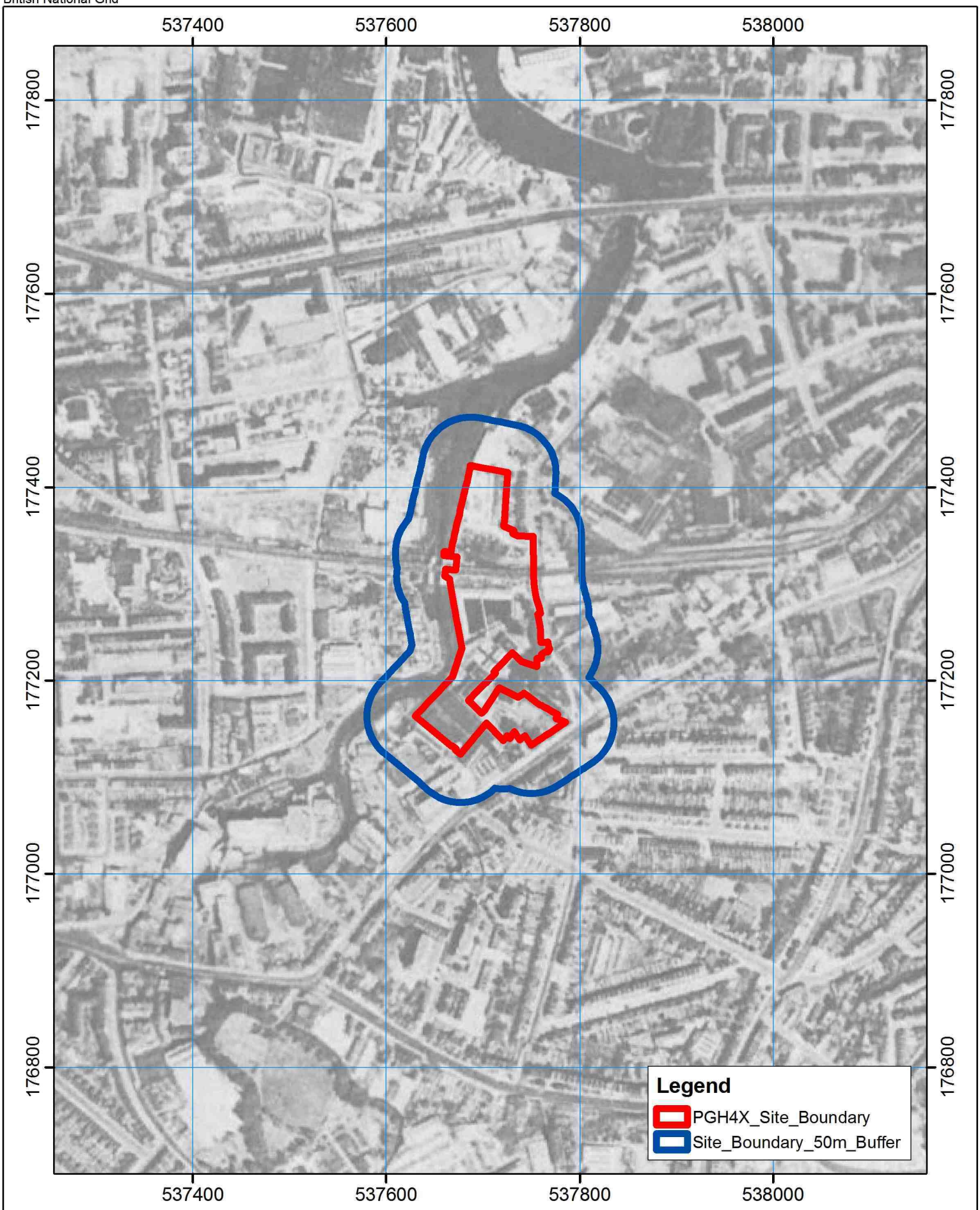

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Figure Five

WWII Luftwaffe Bombing Targets

Thames Tideway Tunnel - Work Area PGH4X
WWII Luftwaffe Bombing Targets

Figure 5

British National Grid

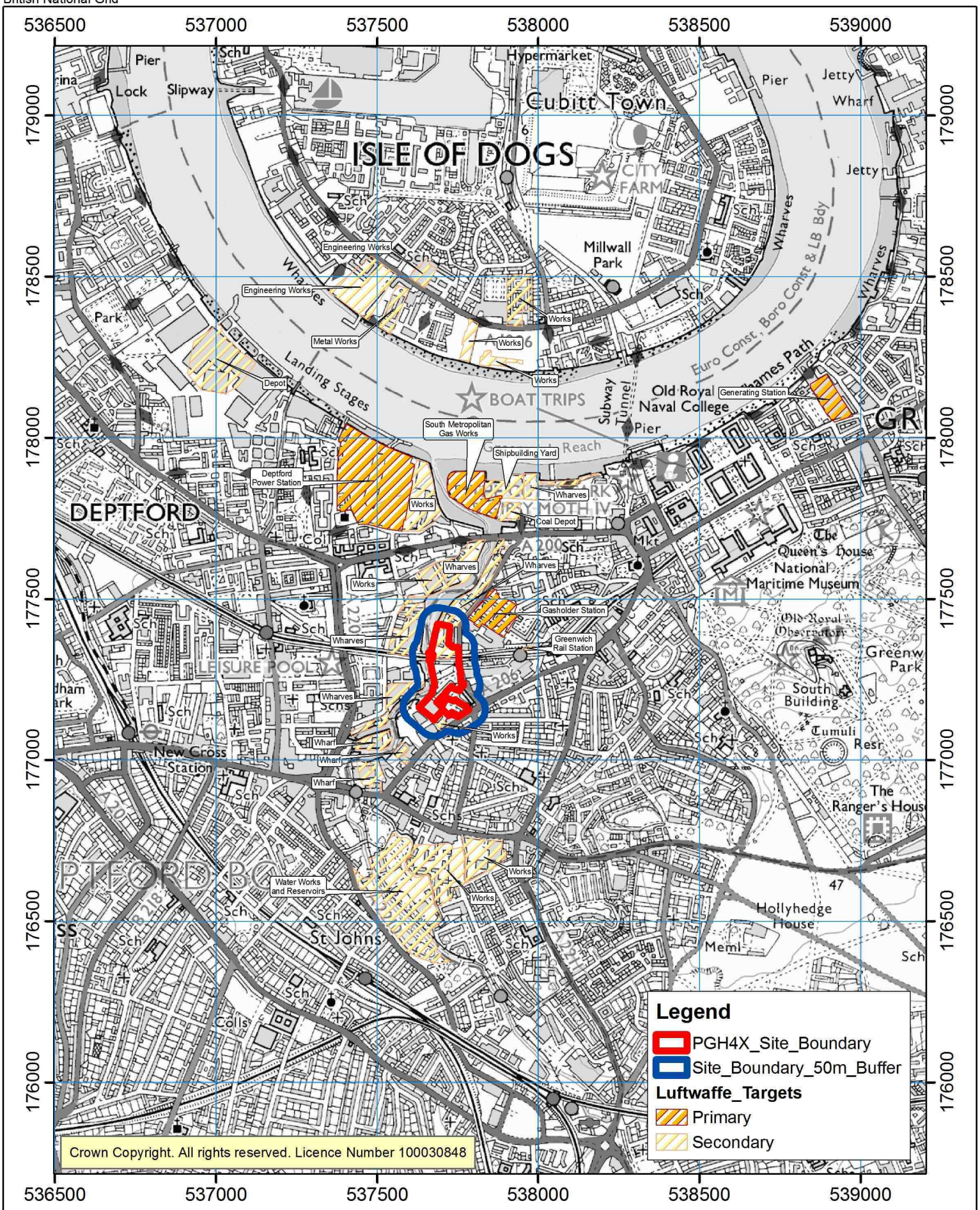

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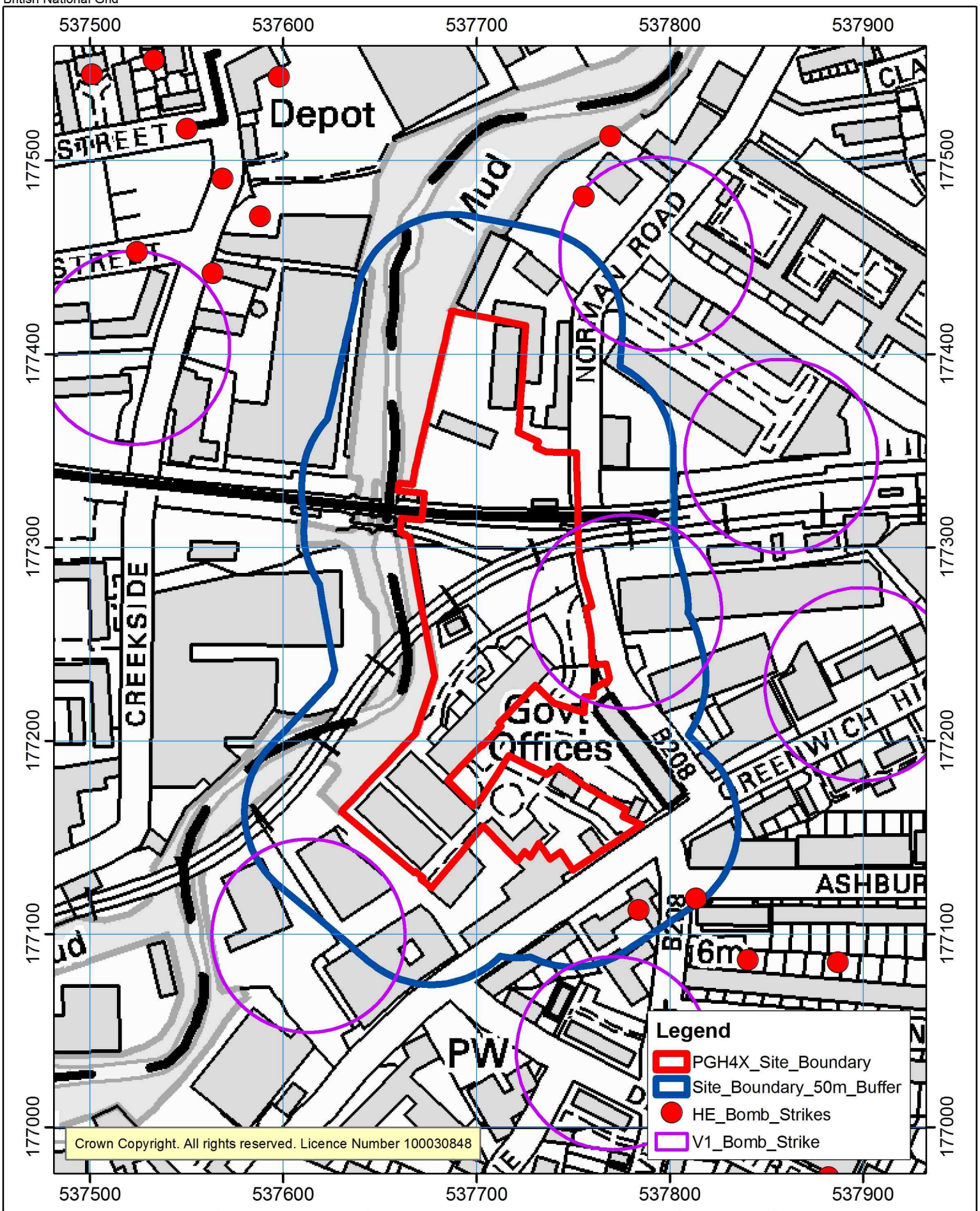
Figure Six

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PGH4X
WWII High Explosive Bomb Strikes

Figure 6

British National Grid



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Surrey GU16 7ER
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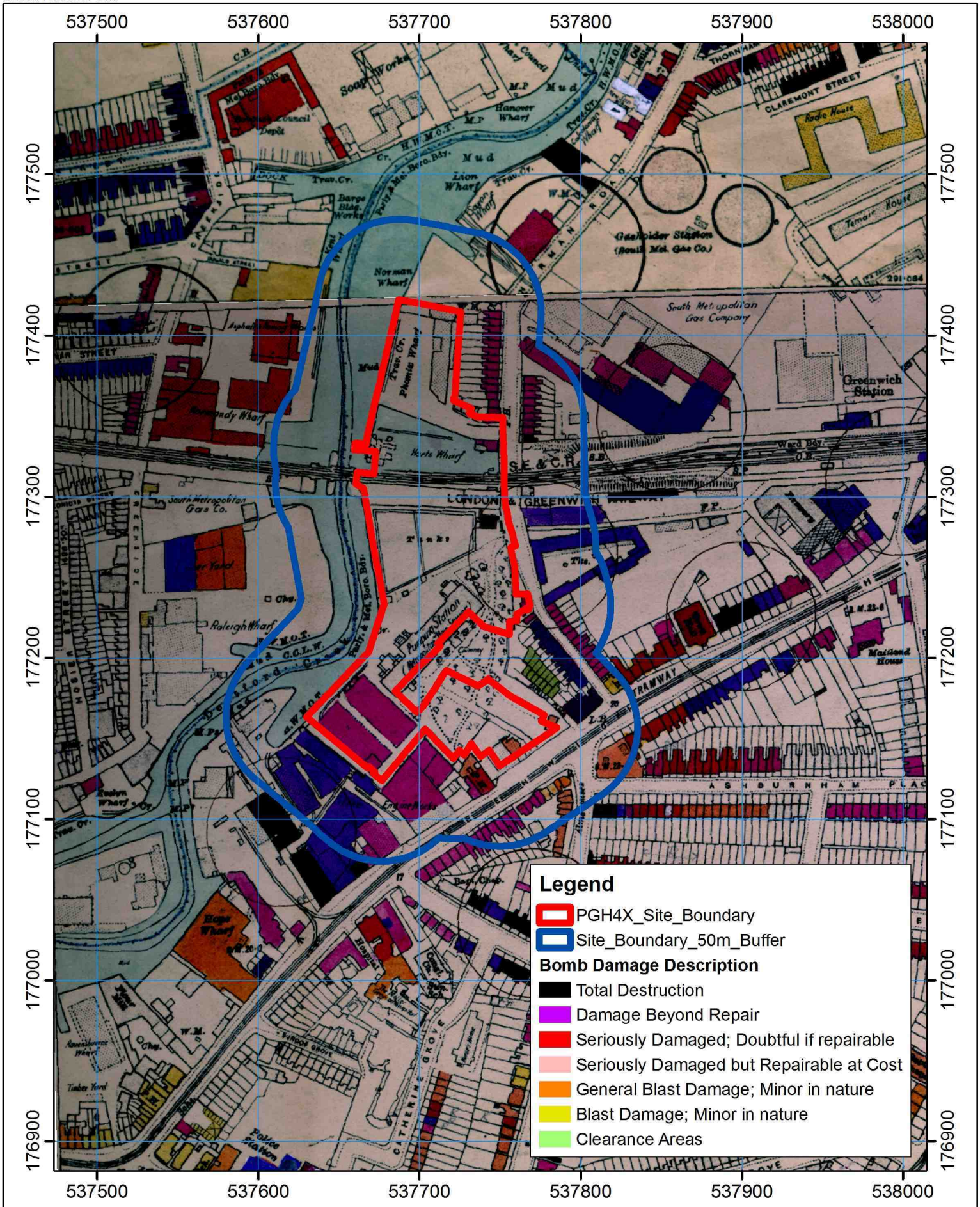
Figure Seven

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PGH4X
London County Council Bomb Damage Map

Figure 7

British National Grid



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Quatro House
Frimley Road
Camberley
Surrey GU16 7ER
United Kingdom
www.6alpha.com
0203 371 3900

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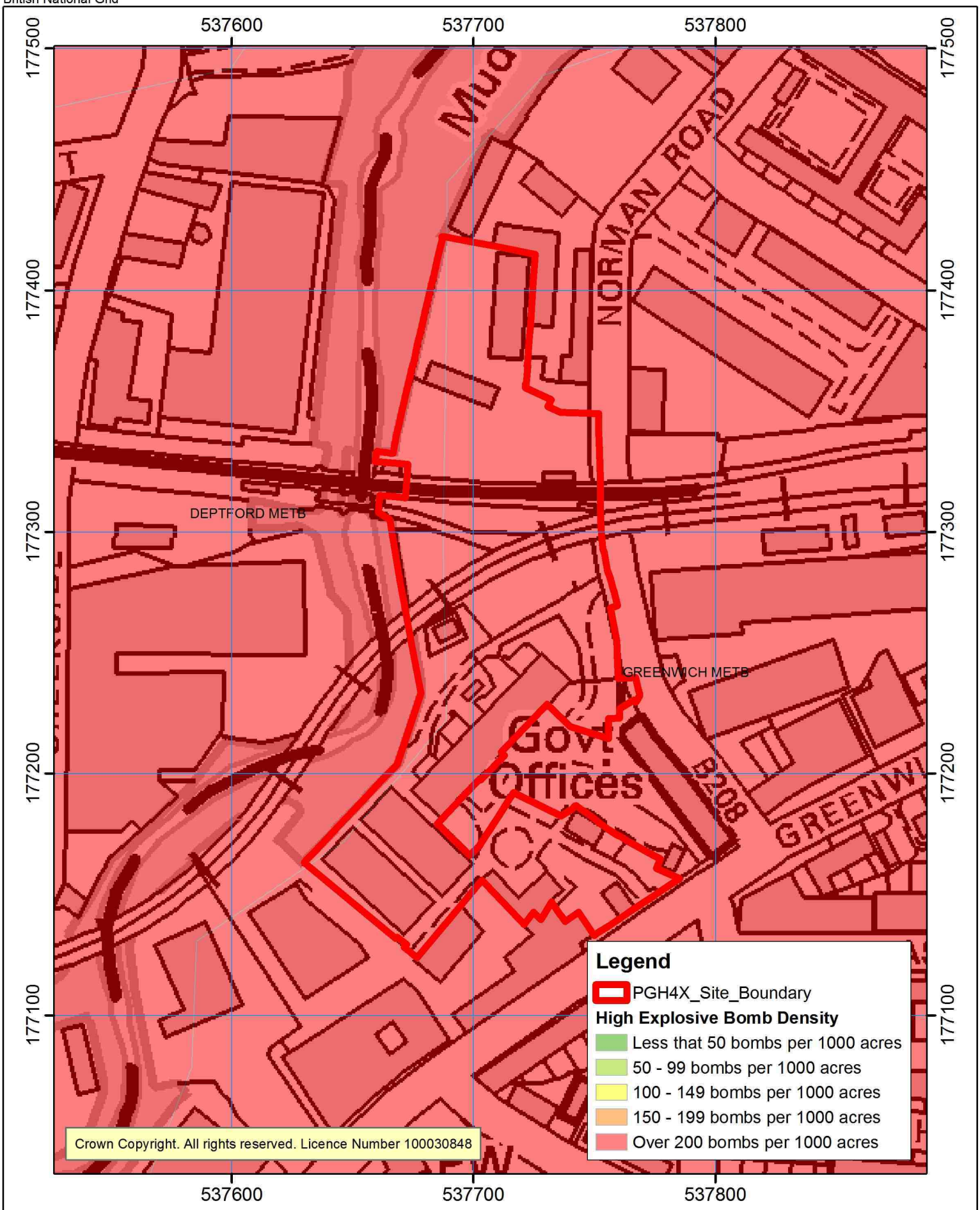
Figure Eight

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PGH4X
WWII High Explosive Bomb Density

Figure 8

British National Grid



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References

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station appendices

Appendix G: Noise and vibration

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

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Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 24 Greenwich Pumping Station 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 Greenwich Pumping Station are the residential dwellings close to the site, the future mixed-use development to the east of the site known as 'The Movement', which is likely to be complete by the first year of construction and one commercial office building, Norman House that fall within the assessment area for this site.

Survey methodology

G.1.3 The Royal Borough of Greenwich and London Borough of Lewisham have been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys.

G.1.4 An initial baseline noise survey was completed on 28th to 29th June, 2011 and additional data was collected on 15th to 17th October, 2011. The baseline surveys comprised continuous unattended monitoring at three locations.

G.1.5 For the initial baseline, survey data was collected for a typical weekday only. For the additional baseline survey, data was also collected for a typical weekend, in accordance with the survey methodology and proposed construction working hours for this site.

G.1.6 Vol 24 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 24 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date
Initial Baseline Survey: 28th - 29th June, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2659069 2435919 2506362	11/03/2011* 25/05/2011* 25/05/2011*
½ " Microphone(s)	4189	Brüel & Kjær	2650595 2519772 2643144	10/03/2011* 12/05/2011* 13/05/2011*
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2445811	14/10/2010*
Additional baseline survey: 15th to 17th October, 2011				
Hand-Held Analyzer(s)	2250	Brüel & Kjær	2626232 2626233 2659069	15/02/2010** 15/02/2010** 11/03/2011*
½ " Microphone(s)	4189 4952 4189	Brüel & Kjær	2621211 2550901 2650595	15/02/2010** 25/05/2011** 10/03/2011*
B&K Sound Calibrator(s)	4231	Brüel & Kjær	2619375	12/01/2011**

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

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

G.1.8 The environmental cases used for the continuous data logging were locked to avoid any potential tampering. The microphones were tripod-mounted approximately 1.3m above ground level. Windshields with bird spikes were fitted over the microphones at all times during the survey period to minimise the effects of any wind induced noise and to prevent birds from perching on the equipment.

G.1.9 Contemporary weather data recorded at Heathrow Airport (EGLL) has been summarised in Vol 24 Table G.2. This is deemed to be

representative of the prevailing weather conditions for the continuous unattended monitoring kit.

Vol 24 Table G.2 Noise – contemporary weather data for Heathrow Airport

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Tuesday 28th June, 2011 (09:00 onwards) [a]				
2-4.1	Variable (Predominantly NNW and NW)	15-19	Yes (between 12:30 and 16:00, 8.0mm)	Mostly cloudy
Wednesday 29th June, 2011 (until 11:00) [b]				
2-5.1	Variable (Predominantly NW, W and WNW)	10-18	No	Clear
Saturday 15th October, 2011 (23:00 onwards) [c]				
0-1	Variable	8-9	No	Clear
Sunday 16th October, 2011 [d]				
0.5-5.7	Variable (Predominantly West)	5-18	No	Fog, then cloudy
Monday 17th October (until 23:00) [e]				
1.6-9.8	Variable (Predominantly West)	6-17	No	Clear AM then cloudy PM

a. *http://www.wunderground.com/history/airport/EGLL/2011/6/28/DailyHistory.html*
b. *http://www.wunderground.com/history/airport/EGLL/2011/6/29/DailyHistory.html*
c. *http://www.wunderground.com/history/airport/EGLL/2011/10/15/DailyHistory.html*
d. *http://www.wunderground.com/history/airport/EGLL/2011/10/16/DailyHistory.html*
e. *http://www.wunderground.com/history/airport/EGLL/2011/10/17/DailyHistory.html*

Measurement locations

G.1.10 Vol 24 Table G.3 details the measurement locations which are also presented in Vol 24 Figure G.1 Noise – measurement locations (see separate volume of figures), and shown in Vol 24 Plate G.1 to Vol 24 Plate G.3.

Vol 24 Table G.3 Noise – measurement locations

Measurement Location Number	Description	Co-ordinates	
		X	Y
GPS01	Within private grounds of Greenwich Pumping Station, near to Greenwich High Road	537752	177141
GPS02	Within private grounds of Greenwich Pumping Station, near to Norman Road	537755	177228
GPS03	Within private grounds of Faircharm Trading Estate, near to Deptford Creek	537636	177272

Results

G.1.11 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 24 Table G.4 to Vol 24 Table G.6.

Vol 24 Table G.4 Noise – continuously logged noise survey results - GPS01

Location Detail: GPS01, within the southern corner of Greenwich Pumping Station grounds, adjacent to Greenwich High Road							
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	79	49	57	82	52	60
	08.00-18.00	93	51	58	96	54	61
	18.00-19.00	77	50	56	80	53	59
	19.00-22.00	82	50	55	85	53	58
	22.00-07.00	77	45	53	80	48	56
Saturday	22.00-07.00*	67	42	51	70	45	54
Sunday	07.00-21.00	83	46	55	86	49	58
	21.00-07.00	72	41	52	75	44	55

**The data presented in this row is deemed to be representative of the reference period. Data was collected from 11pm to 7am.*

Vol 24 Table G.5 Noise – continuously logged noise survey results - GPS02

Location Detail: GPS02, alongside the eastern boundary of Greenwich Pumping Station grounds, adjacent to Norman Road							
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	78	49	58	81	52	61
	08.00-18.00	97	50	60	100	53	63
	18.00-19.00	76	51	59	79	54	62
	19.00-22.00	75	51	57	78	54	60
	22.00-07.00	76	42	53	79	45	56
Saturday	22.00-07.00*	75	41	49	78	44	52
Sunday	07.00-21.00	85	43	55	88	46	58

**The data presented in this row is deemed to be representative of the reference period. Data was collected from 11pm to 7am.*

Vol 24 Table G.6 Noise – continuously logged noise survey results - GPS03

Location Detail: GPS03, alongside the eastern boundary Faircharm Trading Estate, near to Deptford Creek							
Day	**Period**	**Period noise level (dB(A) free-field)**			**Period noise level (dB(A) façade)**		
		L_{AFmax}	**L_{A90}**	**L_{Aeq}**	**L_{AFmax}**	**L_{A90}**	**L_{Aeq}**
Weekday	07.00-08.00	75	43	57	78	46	60
	08.00-18.00	105	46	61	108	49	64
	18.00-19.00	109	45	64	112	48	67
	19.00-22.00	87	44	58	90	47	61
	22.00-07.00	77	38	52	80	41	55
Saturday	22.00-07.00*	83	37	48	86	40	51
Sunday	07.00-21.00	79	39	55	82	42	58

**The data presented in this row is deemed to be representative of the reference period. Data was collected from 11pm to 7am.*

Baseline survey photographs

G.1.12 The following plates (Vol 24 Plate G.1 to Vol 24 Plate G.3) illustrate the noise measurement locations.

Vol 24 Plate G.1 Noise – measurement location GPS03

Note: Within private grounds of Greenwich Pumping Station, looking south towards Greenwich High Road

Vol 24 Plate G.2 Noise – measurement location GPS02

Note: Within private grounds of Greenwich Pumping Station, looking east towards Norman Road

Vol 24 Plate G.3 Noise – measurement location GPS03

Note: Within private grounds of Faircharm Trading Estate, looking north

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 24 Table G.7.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Vol 24 Plate G.4 to Vol 24 Plate G.11.

Vol 24 Table G.7 Noise – typical construction plant schedule

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
Hoarding General site equipment NOT applicable during this phase	Excavator digging post holes for hoarding	1	105	30	BS5228-1[1]: Table C.2, Item 2	Tracked excavator, 71 t
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Nail guns for erection of hoarding	2	101	10	BS5228-1: Table C.4, Item 95	Handheld cordless nail gun, 15 to 50 mm nails
	Circular saw cutting timber	1	107	10	BS5228-1: Table D.7, Item 72	Hand-held electric circular saw,
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Compressor 250cfm	1	93	30	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker,
	Hand-held percussive breaker	1	111	10	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	15	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)	2	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,
	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	91	20	BS5228-1: Table C.3, Item 13	Water jet pump,
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Dewatering Pump	1	96	100	BS5228-1: Table C.4, Item 88	Water pump,
	Generator - 200 kVA	1	100	100	Measured data	Generator, 800kVA
	Water settling/treatment	1	104	100	Measured data	Dirty water plant ,
	Well drilling Rig	1	107	50	Manufacturer	Bauer BBA well drilling rig,
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	116	15	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	Site dumper	1	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Pneumatic breaker	1	111	20	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Concrete crusher	1	93	80	BS5228-1: Table C.1, Item 15	Tracked crusher,
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Diaphragm wall construction General site equipment also applicable during this phase	Diaphragm wall rig (grab)	1	114	20	BS5228-1: Table D.4, Item 10	D wall rig,
	Diaphragm wall rig (hydrofraise)	2	110	50	Measured	Hydrofraise D wall rig,
	Diaphragm wall slurry treatment plant	1	100	100	Measured	Slurry treatment plant
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	1	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
	Compressor 400cfm	1	93	90	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,
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Waste water treatment plant	1	104	100	Measured	Dirty water plant
	100t crawler crane	2	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
Shaft excavation General site equipment also applicable during this phase	Ventilation fans	1	100	90	Measured	Ventilation fans,
	Long reach excavator	1	106	80	BS5228-1: Table C.7, Item 1	Long reach tracked excavator, 21 m arm / 39 t
	20t excavator with breaker	1	116	10	BS5228-1: Table C.5, Item 1	Backhoe mounted hydraulic breaker,
	25t excavator	1	105	80	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	80t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	100t crawler crane	2	103	25	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
Long	250t mobile (TBM assembly	1	106	25	BS5228 Table C 4,	Wheeled mobile

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
connection tunnel drive (TBM assembly)	only)				Item 38	telescopic crane, 400 t
	500t mobile (TBM assembly only)	1	106	25	BS5228 Table C 4, Item 38	Wheeled mobile telescopic crane, 400 t
Long connection tunnel drive General site equipment also applicable during this phase	150t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	Air compressor 600cfm	2	93	100	BS5228-1: Table D.5, Item 5	Compressor for hand-held pneumatic breaker
	Grout mixer including silos and feeders	1	108	50	BS5228-1: Table D.6, Item 13	Grout and mixer,
	Tunnel slurry treatment plant	1	100	100	Measured	Slurry treatment plant,
	25T loading shovel	2	114	30	BS5228-1: Table C.9, Item 8	Wheeled loader, 50 t
	Flatbed trucks for materials haulage	1	105	20	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Flatbed trucks for segment haulage	1	105	20	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Dumper	1	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Telehandler 5t	1	99	80	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Gantry cranes 30t, 25m span with cantilever one end	2	105	80	Measured	Gantry crane,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Waste water treatment plant	1	96	100	BS5228-1: Table C.4, Item 88	Water pump,
	Ventilation fans - set	4	90	100	Measured	Ventilation fans,
	Mains substation	2	95	100	Measured	Batching,
	Handling / Stockpile conveyor	1	90	100	Measured	Conveyor,
	Stockpiler conveyor	1	90	100	Measured	Conveyor,
	Land conveyor to stockpile	1	90	100	Measured	Conveyor,
Long connection tunnel secondary lining	Air compressor 600cfm	2	98	50	BS5228-1: Table D.6, Item 41	Compressor,
	Concrete batching plant 40m3/hr	1	95	100	Measured	Batching,
	Concrete pump	1	106	20	BS5228-1: Table C.3, Item 25	Concrete pump
	Gantry cranes 30t, 25m span with cantilever one end	2	105	80	Measured	Gantry crane,
	25T loading shovel	1	114	50	BS5228-1: Table C.9, Item 8	Wheeled loader, 50 t
	Mains substation	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Sump pumps 150mm	4	96	100	BS5228-1: Table C.4,	Water pump (diesel),

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 88	100 kg
	Waste water treatment plant	1	104	100	Measured	Dirty water plant
Shaft secondary lining General site equipment also applicable during this phase	150t 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
	Fixed and portable concrete vibrators	4	102	20	BS5228-1: Table D.6, Item 20	Poker vibrator,
Culvert and chamber works General site equipment also applicable during this phase	Service crane - 100T mobile crane	1	99	50	BS5228-1: Table C.4, Item 41	Mobile telescopic crane, 100 t
	25t excavator	1	97	50	BS5228-1: Table C.2, Item 25	Tracked excavator, 14 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),

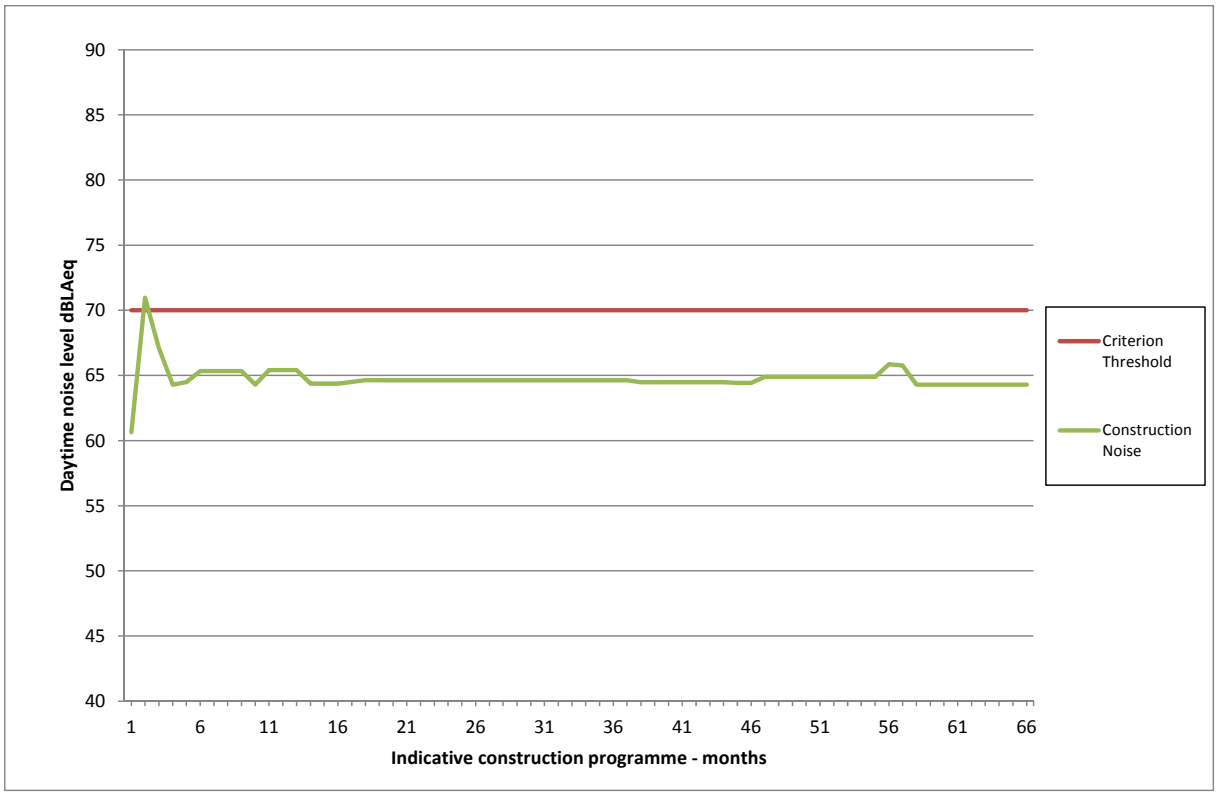
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
	Concrete boom pump	1	108	20	BS5228-1: Table C.4, Item 29	Truck mounted concrete pump + boom arm, 26 t
	Fixed and portable concrete vibrators	4	102	20	BS5228-1: Table D.6, Item 20	Poker vibrator,
	Hand tools (e.g. drills and wrenches)	4	95	80	Estimated	Impact wrench and compressor,
Piling for culvert support	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25 tonne mobile crane	1	98	50	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Small secant piling rig	1	107	80	BS5228-1: Table C.3, Item 16	Crane mounted auger
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	102	10	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar
	Hand-held percussive breaker	1	111	10	BS5228-1: Table C.1,	Hand-held pneumatic

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
					Item 6	breaker,
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol),
	Vibrating rollers	1	101	20	BS5228-1: Table C.2, Item 38	Roller, 18 t

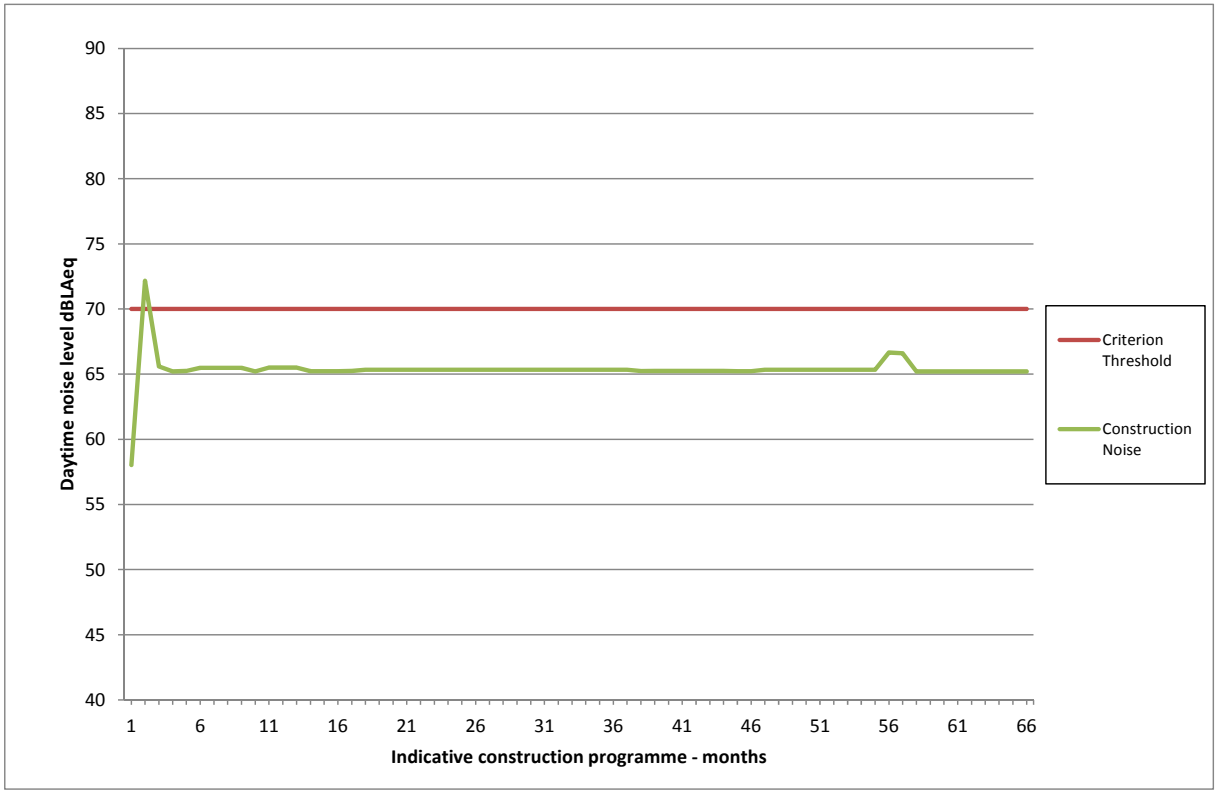
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable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

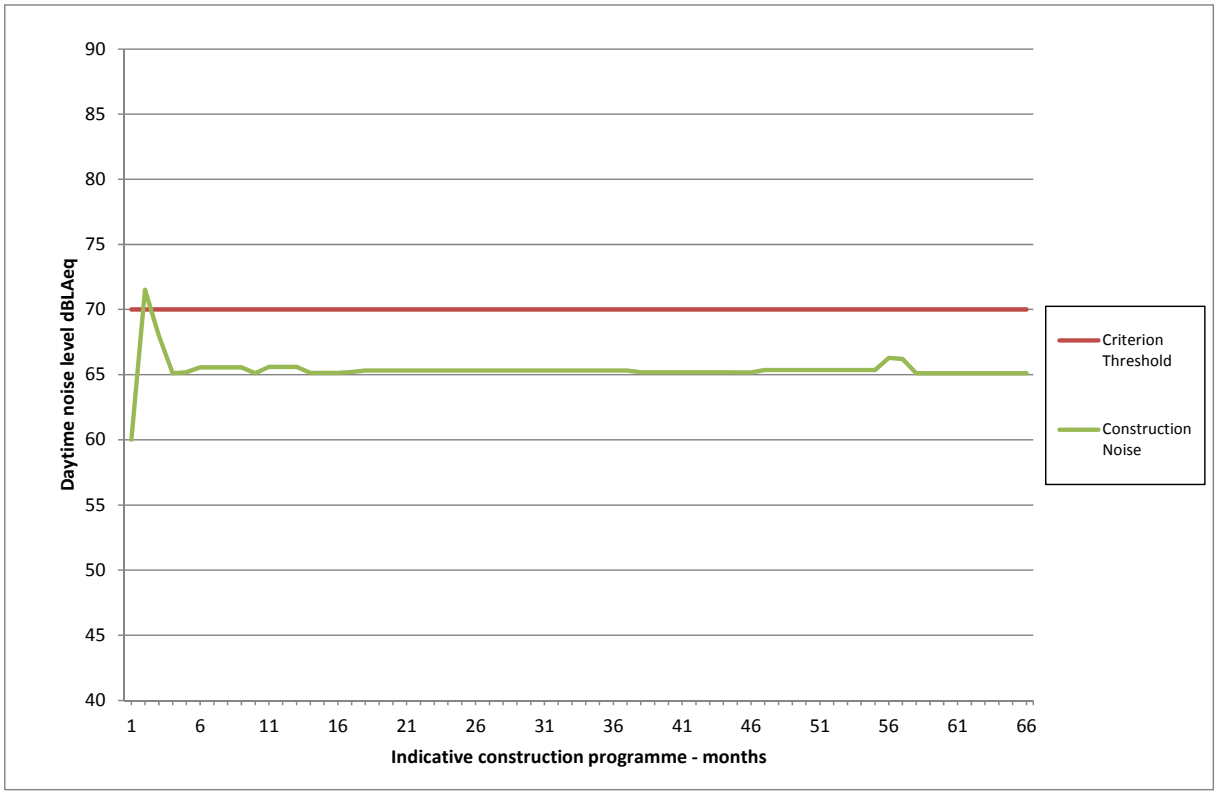
Vol 24 Plate G.4 Noise – Average monthly daytime noise level over duration of construction – Hatfield House – 43-81 Greenwich High Road (GP1)



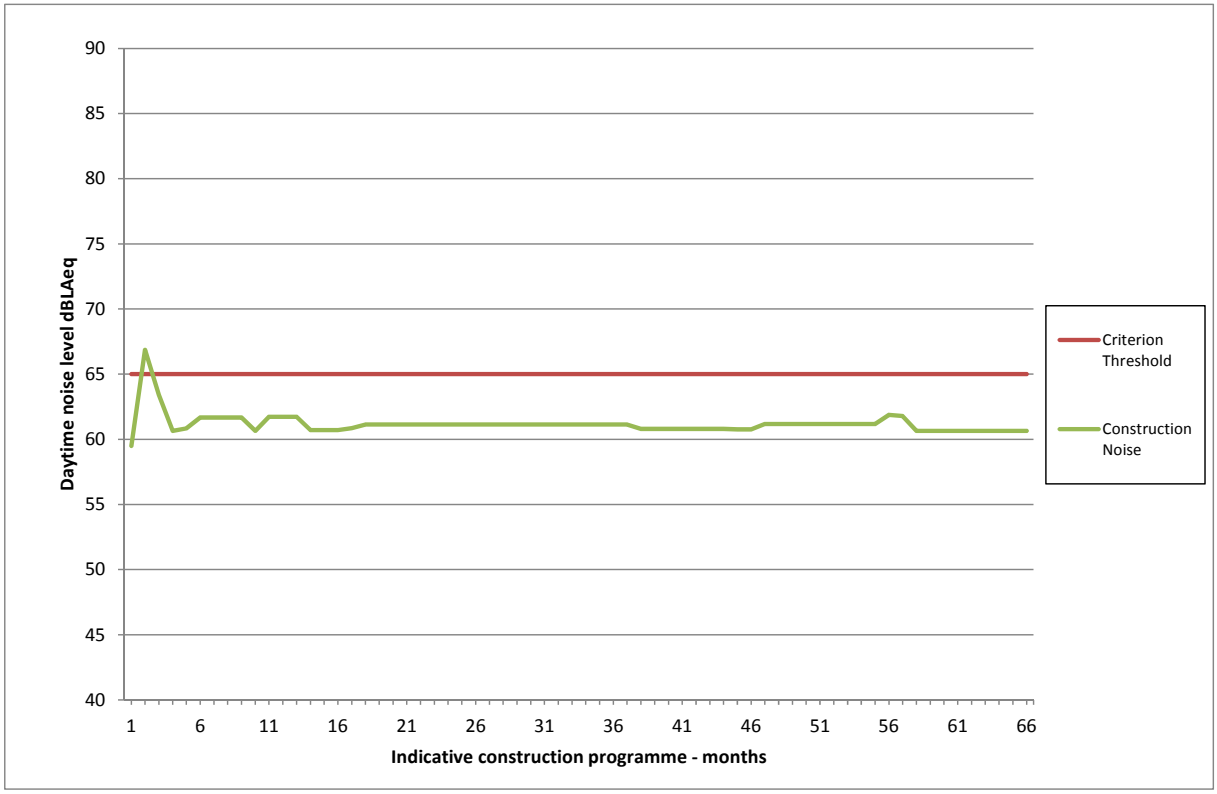
Vol 24 Plate G.5 Noise – Average monthly daytime noise level over duration of construction – Torrent Lodge – 43-81 Greenwich High Road (GP2)



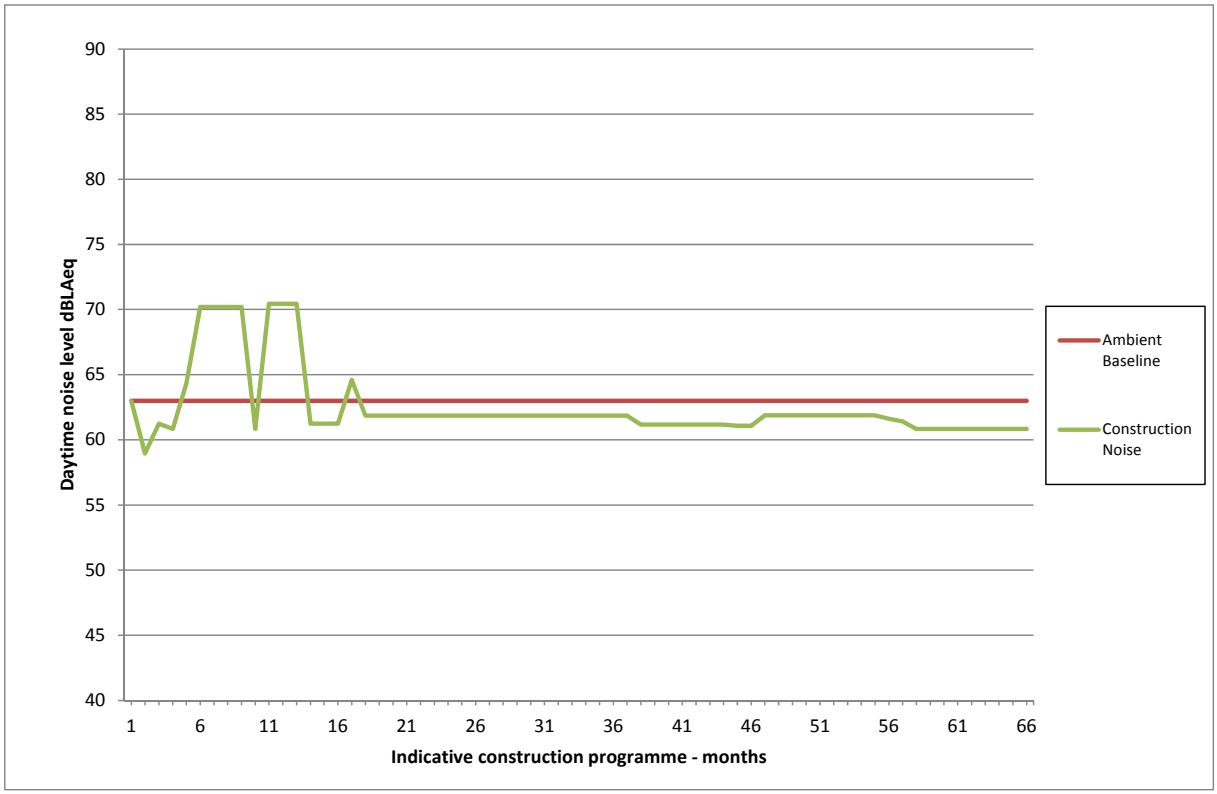
Vol 24 Plate G.6 Noise – Average monthly daytime noise level over duration of construction – Block E – 43-81 Greenwich High Road (GP3)



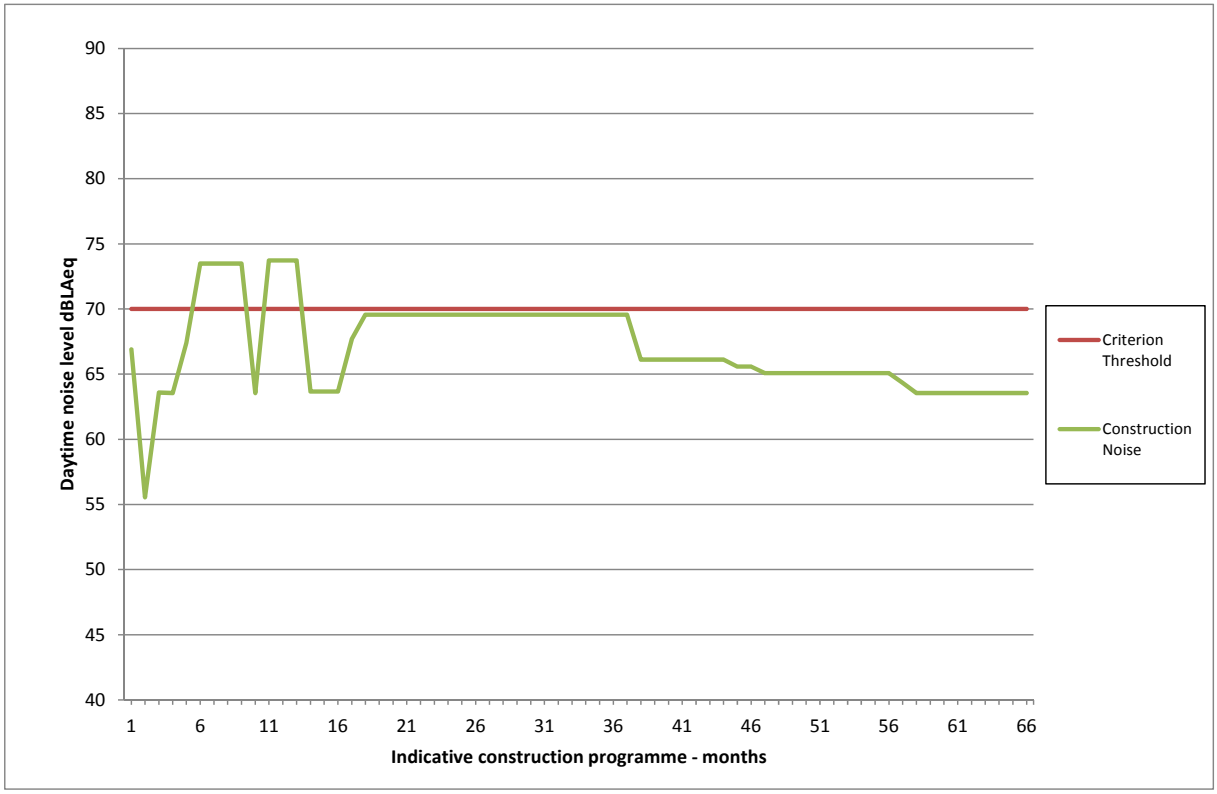
Vol 24 Plate G.7 Noise – Average monthly daytime noise level over duration of construction – 83-87 Greenwich High Road (GP4)



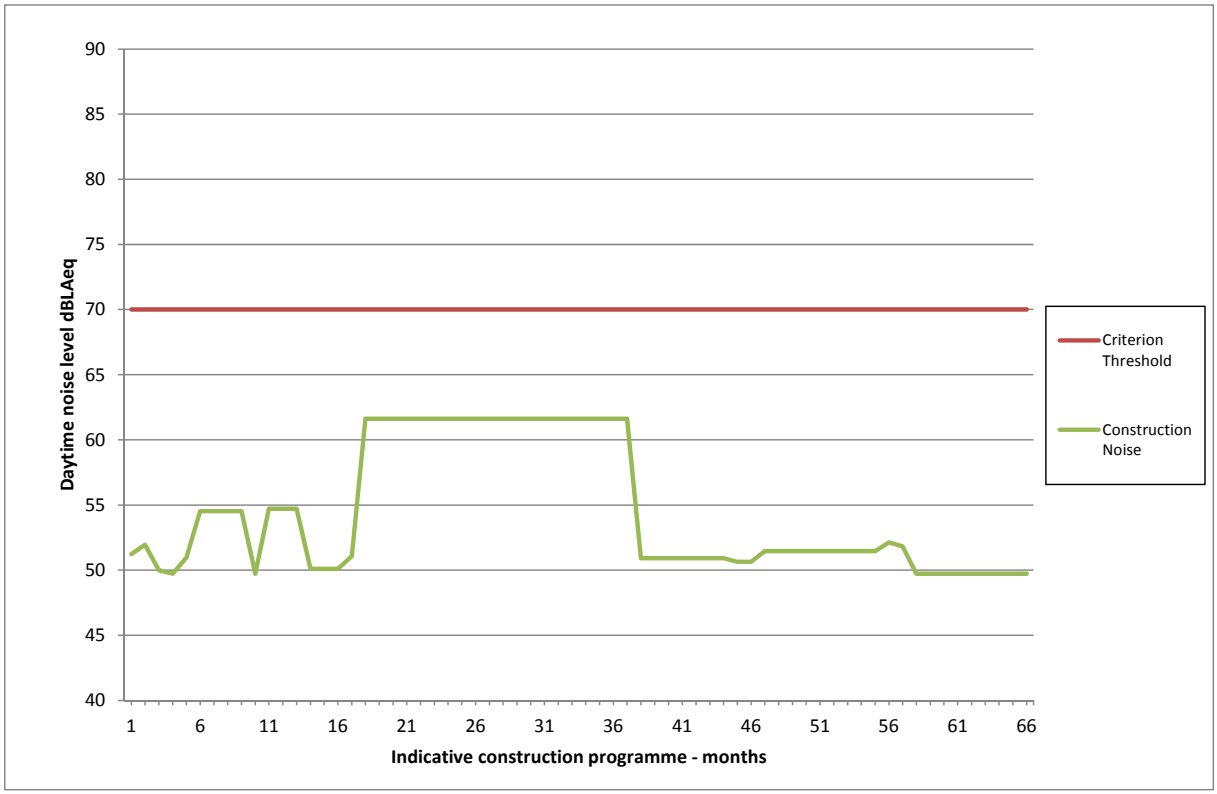
Vol 24 Plate G.8 Noise – Average monthly daytime noise level over duration of construction – Norman House (GP5)



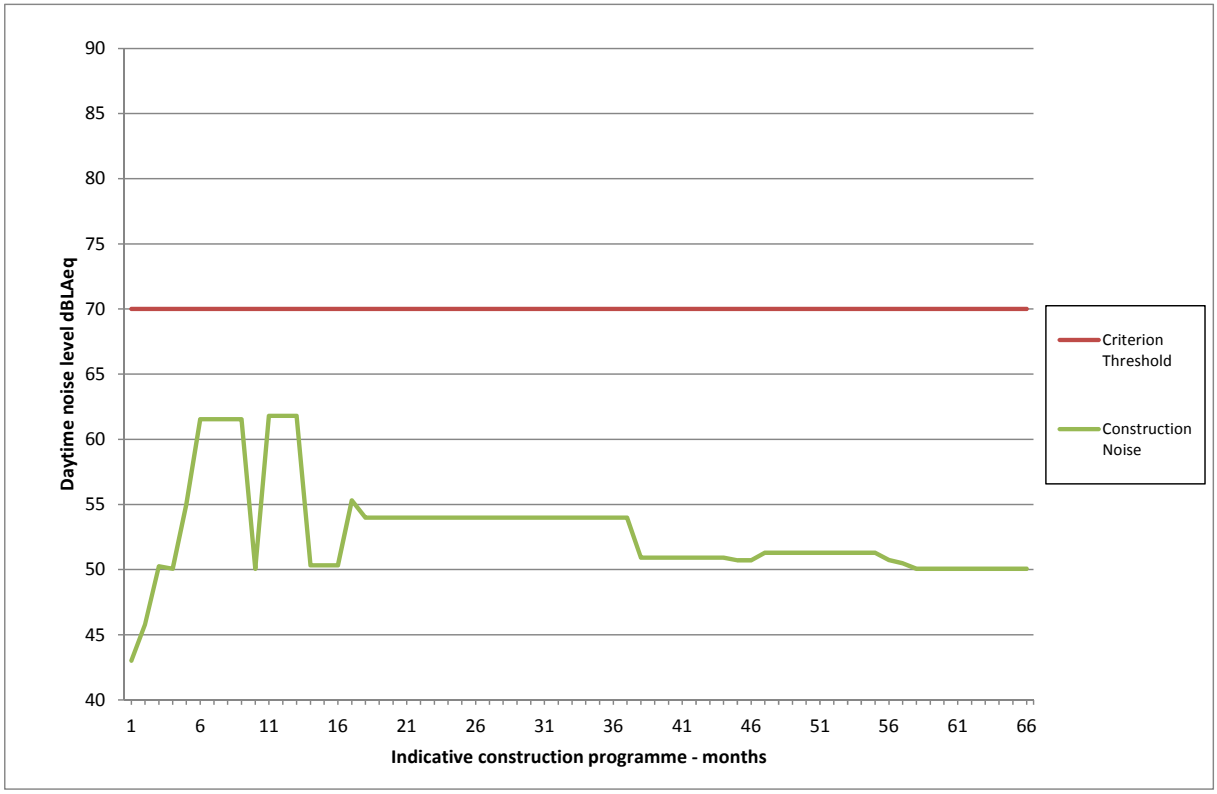
Vol 24 Plate G.9 Noise – Average monthly daytime noise level over duration of construction - The Movement (GP6)



Vol 24 Plate G.10 Noise – Average monthly daytime noise level over duration of construction - Rubicon (GP7)



Vol 24 Plate G.11 Noise – Average monthly daytime noise level over duration of construction - Paxton Point – 43-81 Greenwich High Road (GP8)



References

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 24: Greenwich Pumping Station appendices

Appendix H: Socio-economics

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Appendix H: Socio-economics

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Appendix H: Socio-economics

H.1 Baseline community profile

H.1.1 The community profile is based on both Output Area (OA) and local authority level data from the Office of National Statistics (ONS). The data have been obtained from four sources: Census 2001[1] (the last census for which data are available[i]), Department of Communities and Local Government Deprivation Indices 2010[2], London Public Health Observatory 2012[3], and the Network of Public Health Observatories 2011[4] (see Volume 2 Methodology). Data is grouped according to those 'protected characteristics'[ii] or groups which are relevant for consideration in relation to this socio-economic impact assessment. This baseline community profile provides context for this socio-economic assessment.

H.1.2 On the basis of likely impacts on receptors identified in this socio-economic assessment, the community profile examines the 'immediate area' surrounding the construction site (ie, within an assessment area of 250m) and the overall borough level (which in this case is the Royal Borough [RB] of Greenwich).

H.1.3 The main protected characteristic group concentrated[iii] within 250m of the construction site are persons belonging to Black and 'Other' ethnic groups.

Resident population

H.1.4 The resident population was approximately 2,075 within 250m of the site at the time of the last census.

Gender and age

H.1.5 Of the total population within 250m of the site 50.7% residents are female, slightly lower than the proportion at a borough wide level (52.1%) and within Greater London (51.6%) both of which also have a slight predominance of female residents.

H.1.6 Vol 24 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (19.3%) is broadly in line with the Greater London level (20.2%) and slightly lower than the proportion of under 16 year olds within the RB of Greenwich (21.8%).

H.1.7 Within 250m, the proportion of over 65 year olds (11.2%) is broadly in line with the Greater London level (12.4%) and slightly lower than the borough wide proportion (13.0%).

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

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

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

Vol 24 Table H.1 Socio-economics – age breakdown by assessment area

Age group	Assessment area		
	Immediate area (250m)	Borough wide (RB of Greenwich)	Greater London
Under 16 years old	19.3%	21.8%	20.2%
Over 65 years old	11.2%	13.0%	12.4%

Ethnicity

H.1.8 Vol 24 Table H.2 outlines ethnicity by assessment area, showing that within 250m of the site, White residents comprise approximately 70% of the population (69.1%). This is slightly lower than the proportion recorded for the RB of Greenwich (77.1%) and broadly in line with the Greater London proportion (71.2%).

H.1.9 Within 250m, the proportion of Asian residents (3.7%) is moderately lower than the RB of Greenwich (6.8%), and considerably lower than the Greater London level (12.1%). The proportion Black residents within 250m of the site (20.5%) is approximately twice as high as the RB of Greenwich (11.1%) and Greater London averages (10.9%).

H.1.10 Within 250m, the proportion of residents of 'Other' ethnicity (4.0%) is somewhat higher than within the RB of Greenwich (2.3%) and Greater London levels (2.7%).

Vol 24 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area		
	Immediate area (250m)	Borough wide (RB of Greenwich)	Greater London
White	69.1%	77.1%	71.2%
BME	30.9%	22.9%	28.8%
Asian	3.7%	6.8%	12.1%
Black	20.5%	11.1%	10.9%
Other	4.0%	2.3%	2.7%
Mixed	2.7%	2.7%	3.2%

Note: The figure for Black and Minority Ethnic (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 The proportion of Christians within 250m of the site (56.1%) is broadly in line with Greater London levels (58.2%) and slightly lower than the RB of Greenwich average (61.5%). Muslims are the second most predominant religious group within 250m (3.8%) and the borough (4.3%), however

these levels are considerably lower than the proportion of Muslims recorded across Greater London as a whole (8.5%).

H.1.12 Within 250m, 36.0% of residents do not follow or state a religion, moderately higher than the Greater London average (24.3%).

Health indicators

H.1.13 Vol 24 Table H.3 outlines health indicators by assessment area, noting that within 250m of the site, the proportion of residents with a long term or limiting illness (14.7%) is broadly in line with the Greater London level (15.5%), and slightly lower than the RB of Greenwich proportion (17.4%).

H.1.14 The proportion of residents who claim disability living allowance within 250m (5.5%) is slightly lower than the RB of Greenwich (5.9%) and somewhat higher than within Greater London (4.5%).

Vol 24 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area		
	Immediate area (250m)	Borough wide (RB of Greenwich)	Greater London
Long term limiting sick	14.7%	17.4%	15.5%
Disability living allowance	5.5%	5.9%	4.5%

H.1.15 In the Middle Layer Super Output Area (MSOA)[iv5] in which the site falls, levels of adult obesity fall within the second lowest quintile (ie, the lowest being the best) relative to Greater London.

H.1.16 Deaths caused by circulatory disease fall within the second lowest quintile (ie, the lowest being the best) within the borough. Strokes, heart disease and respiratory disease are more prevalent and fall within the middle quintile. Deaths by cancer fall within the second highest quintile.

H.1.17 Male life expectancy within the MSOA in which the site falls is in the second lowest quintile within the borough (ie, the lowest being the worst) and female life expectancy within the middle quintile. Average life expectancy for male residents is 80.3 to 81.9 years and for female residents of 81.9 to 83.2 years old.

Lifestyle and deprivation indicators

H.1.18 Vol 24 Table H.4 outlines lifestyle and income deprivation indicators by assessment area, showing that within 250m of the site, over half of households do not own cars (52.4%), moderately higher than the Greater London level (37.5%) and borough wide levels (40.8%).

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

H.1.19 The incidence of income deprivation[v] within 250m (38.4%) is slightly lower than the incidence recorded for the RB of Greenwich (43.2%), however it is somewhat higher than for Greater London (30.8%). The incidence of overall deprivation within 250m of the site (38.4%) is broadly in line with the RB of Greenwich (41.1%), and considerably higher than the Greater London average (24.5%).

Vol 24 Table H.4 Socio-economics – lifestyle and income deprivation levels by assessment area

Indicator	Assessment area		
	Immediate area (250m)	Borough wide (RB of Greenwich)	Greater London
No car households	52.4%	40.8%	37.5%
Income	38.4%	43.2%	30.8%
Overall	38.4%	41.1%	24.5%

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

H.2 Baseline economic profile

H.2.1 This section presents a profile of the economy local to the proposed construction site at the Greenwich Pumping Station site.

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 Royal Borough [RB] of Greenwich) 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[vi].

Employment and businesses

H.2.4 Within approximately 250m of the site there are approximately 2,200 jobs.[vii] Vol 24 Table H.5[viii] 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 7% of total employment within 250m. It can be seen that:

a. Professional, Scientific and Technical Activities account for 14% of employment within 250m; double that within the RB of Greenwich (7%) and considerably more than within Greater London (11%).

b. Accommodation and Food Service Activities account for 12% of employment within 250m of the site, double that within the RB of Greenwich (6%) and considerably more than within Greater London (8%).

c. Other Service Activities account for 10% of employment within 250m, more than double that within both the RB of Greenwich (4%) and Greater London (4%).

d. Administrative and Support Service Activities account for 7% to 9% of employment at all three geographical levels.

e. Human Health and Social Work Activities account for 8% to 9% of employment at all three geographical levels.

f. Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles accounts for 7% of employment within 250m, less than half that recorded within both the RB of Greenwich (17%) and Greater London (16%).

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

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

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

Vol 24 Table H.5 Socio-economics – employment by top six sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (RB of Greenwich)**	**Greater London**
Professional, Scientific and Technical Activities	14%	7%	11%
Accommodation and Food Service Activities	12%	6%	8%
Other Service Activities	10%	4%	4%
Administrative and Support Service Activities	9%	7%	8%
Human Health and Social Work Activities	9%	9%	8%
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	7%	17%	16%
Other (Including unclassified)	37%	50%	53%

H.2.5 Within approximately 250m of the site there are approximately 350 businesses (defined here as business locations[ix]). The split of businesses by sector within 250m generally reflects the breakdown of employment by sector set out in Vol 24 Table H.5 with a relatively high proportion of businesses engaged in Professional, Scientific and Technical Activities (13%), Other Service Activities (9%), Administrative and Support Service Activities (9%), Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles (9%) and Information and Communication (9%). However, Accommodation and Food Service Activities account for 4% of businesses, despite generating 12% of employment.

H.2.6 Vol 24 Table H.6 illustrates the size of businesses in terms of the number of employees at each business location / unit. Businesses within the smallest size band (one to nine employees) account for the greatest proportion across all three geographical levels. Within approximately 250m, 87% of businesses have one to nine employees, which is comparable to both the RB of Greenwich (91%) and Greater London (88%). However within 250m of the site the number of businesses employing ten to 24 employees is somewhat greater (9%) than within the RB of Greenwich (6%) and similar to Greater London (8%).

H.2.7 For the sectors accounting for the greatest proportions of jobs and businesses within approximately 250m, their size banding follows a broadly similar pattern. Units employing one to nine employees account for 94% of Administrative and Support Service Activities compared to an average across all sectors of 87%; whereas 85% of Professional,

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

Scientific and Technical Activities are of this size. Within the Other Service Activities sector, the proportion of businesses of this size is slightly lower at 82%, with the remaining 18% of firms employing ten to 24 employees.

H.2.8 However, within the Accommodation and Food Service Activities sector there is a greater variance in regard to the size banding of businesses with 54% of business units employing one to nine employees, 23% employing ten to 24 employees and 8% employing 100 to 249.

Vol 24 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)	87%	9%	3%	1%	1%	0%
Professional, Scientific and Technical Activities	85%	11%	2%	2%	0%	0%
Administrative and Support Service Activities	94%	3%	0%	0%	3%	0%
- *Other Service Activities*	82%	18%	0%	0%	0%	0%
- *Accommodation and Food Service Activities*	54%	23%	15%	0%	8%	0%
Borough wide (RB of Greenwich)	91%	6%	2%	1%	0%	0%
Greater London	88%	8%	2%	1%	1%	0%

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[1] ONS. *Neighbourhood Statistics* (2001). Available at: http://neighbourhood.statistics.gov.uk/dissemination/

[2] Department for Communities and Local Government. Index of Multiple Deprivation 2010 (2010). Available at: http://www.communities.gov.uk/communities/research/indicesdeprivation/deprivation10/

[3] London Public Health Observatory. Fair Society, Healthy Lives: The Marmot Review (2012). Available from: http://www.lho.org.uk/LHO_TOPICS/NATIONAL_LEAD_AREAS/MARMOT/MARMOTINDICATORS.ASPX. Accessed 30 August 2012

[4] Network of Public Health Observatories. Health Profiles: London (2011-2012) Available at: http://www.apho.org.uk/resource/view.aspx?QN=HP_REGION_H. Accessed February 2012.

[5] Office of National Statistics. *Super Output Areas: Introduction* (2012). Accessed 29 May 2012. Accessed from: http://www.neighbourhood.statistics.gov.uk/dissemination/Info.do;jessionid=vtvdPZRWZ3yhT9ShjB6TcwQ00WNTZcPQgyVpGLvZjTzh7nYnBhqL!1624269762!1327075798387?m=0&s=1327075798387&enc=1&page=aboutneighbourhood/geography/superoutputareas/soa-intro.htm&nsjs=true&nsck=true&nssvg=false&nswid=1225.

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

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Appendix I: Townscape and visual

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Appendix I: Townscape and visual

I.1 Introduction

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

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Appendix J: Transport

J.1 Introduction

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

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Appendix K: Water resources - groundwater

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Appendix K – Water resources – Groundwater

K.1 Geology

K.1.1 A summary of the anticipated geological succession at the Greenwich Pumping Station site is shown in Vol 24 Table K.1.

Vol 24 Table K.1 Groundwater - anticipated geological succession

Period	Series	Group	Formation
Quaternary	Holocene	Superficial deposits	Made ground
			Alluvium
	Pleistocene		River Terrace Deposits
Palaeogene	Palaeocene	Lambeth	Upnor
		No group	Thanet Sand
Cretaceous	Upper Cretaceous	White Chalk Subgroup	Seaford Chalk**

** Not a Formation but an important depositional feature*

*** Subdivided into the Haven Brow, Cuckmere and Belle Tout members.*

K.1.2

K.1.3 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS)1, is shown in Vol 24 Figure 13.4.1 and Vol 24 Figure 13.4.2 respectively (see separate volume of figures).

K.1.4 The ground investigation undertaken for the Thames Tunnel project has involved drilling boreholes both on the banks and within the main river channel for the purposes of understanding the geology and hydrogeology within the assessment area. The depths and thicknesses of the geological layers have been based on the three ground investigation boreholes located up to 68m from the Greenwich Pumping Station shaft site: these are boreholes SR1018D, PR1023 and SR1024. The locations of these boreholes around the site are shown in Vol 24 Figure 13.4.3. The depths and thicknesses of geological layers encountered are summarised in Vol 24 Table K.2.

Vol 24 Table K.2 Groundwater - anticipated ground conditions

Formation	Top elevation* (mATD)**	Depth below ground level (m)	Thickness (m)
Made Ground	103.36	0.00	2.10
Alluvium	101.26	2.10	1.30
River Terrace Deposits	99.96	3.40	7.00

Formation	Top elevation* (mATD)**	Depth below ground level (m)	Thickness (m)
Lambeth Group (Upnor Formation)	92.96	10.40	5.00
Thanet Sand	87.96	15.40	10.40
Seaford Chalk	77.56	25.80	Not proven

** Based on an assumed ground level of 103.36mATD.*
*** mATD = metres above tunnel datum.*
**** The Lambeth Group was found in boreholes SR1018D, PR1023 and SR1024*

K.1.5 The CSO drop shaft at Greenwich Pumping Station site would extend down to approximately58. 64mATD and would pass through the Made Ground, River Terrace Deposits, Upnor Formation, Thanet Sand and into the Chalk. The base slab would extend to approximately 55. 64mATD and also be founded in the Chalk.

K.1.6 The Made Ground, consisting of silty, sandy gravel with brick, concrete, flint and occasional clinker, is expected to be 2.1m thick at the Greenwich Pumping Station site.

K.1.7 The Alluvium comprising silty clay and clayey silt, with occasional scattered pebbles and granules, is expected to be 1.3m thick at the Greenwich Pumping Station site.

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

K.1.9 The Upnor Formation is a variably bioturbated fine- to medium-grained sand with glauconite, rounded flint pebbles and minor clay, with distinctive pebble beds at its base and top (Upn(Gv)). The Upnor Formation is expected to be 5m thick at the Greenwich site. Other on site boreholes SA4086 and SR4087 (shown in Vol 24 Figure 13.4.1) did not encounter the Lambeth Group.

K.1.10 The base of the Thanet Sands is a unit known as the 'Bullhead Bed', consisting of sandy clay or clayey, sandy gravel and expected to be 0.21m thick at the Greenwich site.

K.1.11 The Seaford Chalk is the upper unit of the White Chalk, comprising of as firm to soft non-nodular Chalk with flint beds. Thin marl seams are found in the lower 8m and absent higher up. A hard ground marks the top of the Seaford Chalk. This unit within the Chalk is expected to be up to 40m thick. It is underlain by the Lewes Nodular Chalk and New Pit Chalk Formations. The total thickness of the Seaford Chalk was found to be 48.3m in SR4087.

K.1.12 In terms of geological structure, it is noted that there is a series of N-S and SSW-NNE trending faults are identified between Battersea and Chelsea bridges – referred to as the Chelsea Embankment (Albert Bridge) Fault Zone - intersecting the tunnel alignment at near to the perpendicular[2]. It is reported that there is up to 5m vertical displacement of strata over this zone (Royse, 2008), resulting in uplift of the top of the Lambeth Group deposits into the proposed tunnel invert on the east side of Albert Bridge Embankment Foreshore and tunnel construction at Chelsea Embankment Foreshore. The Greenwich Pumping Station site is to the east of this fault zone, however, there may be minor faulting and fractures local to the site, together with localised displacement. Faults may also enhance or impede groundwater movement.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at the Greenwich Pumping Station site is shown in Vol 24 Table K.3.

Vol 24 Table K.3 Groundwater - anticipated main hydrogeological units

Group	Formation		Hydrogeology
Superficial deposits	(Made Ground) Alluvium		Hydraulic continuity with upper aquifer
	River Terrace Deposits		Upper aquifer
Lambeth	Upnor		Lower aquifer
No group	Thanet Sand		
White Chalk Subgroup	White Chalk	Undivided mainly Seaford Chalk	
		Lewes Nodular Chalk	
		New Pit Chalk	
		Holywell Nodular Chalk	

K.2.2 The Made Ground and Alluvium overlie the River Terrace Deposits or upper aquifer and are likely to be in hydraulic continuity with the upper aquifer.

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”.[3]

K.2.4 The lower aquifer comprises the Upnor and the Thanet Sand formations (both classified as secondary aquifers by the EA), and the Seaford Chalk

(classified as a principal aquifer by the EA). A principal aquifer is described by the EA as "layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer" (EA website, 2012).

K.2.5 Hydraulic continuity between the upper and lower aquifers is likely at the Greenwich Pumping Station site.

K.2.6 The hydrogeological properties of the Chalk (principal aquifer) are defined by its transmissivity (the ability of rock to transmit water and is a function of its permeability and aquifer thickness) and storativity (the amount of water which the aquifer releases per unit change in water level). The Chalk in the area around Greenwich Pumping Station is expected to have a very high transmissivity value of between 1200m^2/d and 3000m^2/d (average of 2000m^2/d). The storativity value is expected to be approximately 1 x10^{-4} (EA, 2011)[4].

K.2.7 The type of White Chalk present in the face of tunnel excavation is Seaford Chalk, and either Cuckmere Member and Belle Tout Member (TT, 2010). The Seaford Chalk forms a highly transmissive aquifer, with rapid preferential flow commonly established along fissures and enhanced fractures, often along or above flint and marl layers within the Chalk. Transmissivity and groundwater storage therefore vary considerably both laterally and vertically.

K.3 Groundwater level monitoring

K.3.1 Groundwater level monitoring was undertaken at a number of ground investigation boreholes across the assessment area. In addition, the EA has a regional network of observation 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 ground investigation boreholes located within 68m from the Greenwich shaft site (PR1023, SR1018D and SR1024). The origin of these boreholes is detailed in Vol 24 Table K.7. These boreholes have response zones[i] and monitor groundwater levels in the River Terrace Deposits, Thanet Sand and Seaford Chalk. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 24 Table K.4. The manual dip and logger data collected from these monitoring boreholes is shown in Vol 24 Table K.5.

Vol 24 Table K.4 Groundwater – monitoring boreholes

Borehole	Response zone depths mATD	Strata	Monitoring
PR1023(U*)	98.49 - 93.49	River Terrace	Fortnightly dips

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

Borehole	Response zone depths mATD	Strata	Monitoring
		Deposits	and logger
PR1023(L**)	91.49 - 78.99	Thanet Sand Formation	Fortnightly dips and logger
SR1018D	86.39 - 79.39	Thanet Sand Formation	Fortnightly dips and logger
SR1024	78.64 - 66.24	Seaford Chalk	Fortnightly dips

**U – Upper aquifer and **L – Lower aquifer*

Vol 24 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
PR1023(U)	19/11/2009 – 12/04/2012	6.22 (Jan. 2011)	97.77 (Jan. 2011)	7.01 (Apr. 2012)	96.98 (Apr. 2012)	6.51	97.48
PR1023(L)	01/10/2009 – 12/04/2012	6.06 (April 2010)	97.93 (April 2010)	7.00 (Apr. 2012)	96.99 (Apr. 2012)	6.45	97.54
SR1018D	01/10/2009 – 12/04/2012	6.11 (Jan. 2011)	97.78 (Jan. 2011)	6.85 (Apr. 2012)	97.03 (Apr. 2012)	6.38	97.50
SR1024	02/04/2009 – 12/07/2012	5.25 (May 2009)	99.39 (May 2009)	6.65 (Mar. 2012)	97.98 (Mar. 2012)	6.09	98.54
TQ37/254A	04/12/1986 – 19/09/2012	4.72 (June 1995)	98.91 (June 1995)	6.89 (Aug. 2010)	96.74 (Aug. 2010)	5.93	97.70

K.3.3 The recorded water levels in the River Terrace Deposits at PR1023 range from 96.98mAD to 97.77mATD. These water level remain below the top of the formation at 99.96mATD, indicating that the River Terrace Deposits are unconfined and not fully saturated at this location.

K.3.4 The water levels (piezometric head[ii]) in the Thanet Sands are monitored at two locations. The recorded water levels at SR1018D range from 97.03mATD to 97.78mATD and at PR1023 range from 96.99mATD to

[ii] Piezometric head – the level or pressure head to which confined groundwater would rise to in a piezometer if it is open to the atmosphere.

97.93mATD. The recorded water levels are very similar and remain above the top of the formation at 87.96mATD, indicating that the Thanet Sands are fully saturated at this location. The recorded water levels are also very similar to recorded water levels in the River Terrace Deposits at PR1023. This suggests that these units are in hydraulic continuity.

K.3.5 The water levels (piezometric head) in the Seaford Chalk at SR1024 range from 97.98mATD to 98.39mATD. The recorded water levels remain above the top of the formation at 77.56mATD, indicating that the Seaford Chalk is fully saturated at this location. These recorded water levels show very similar trends to those recorded in the River Terrace Deposits and Thanet Sands at PR1023. This suggests that these units are in hydraulic continuity.

K.3.6 The nearest EA groundwater level monitoring boreholes are located within and up to 10m of the Greenwich Pumping Station site, reference numbers TQ37/254A, TQ37/254BL and TQ37/254BU. These boreholes record levels in the lower aquifer (mainly Chalk) and the locations are shown on Vol 24 Figure 13.4.3. These three boreholes show very similar water levels; therefore the manual dip and logger data collected from TQ37/254A only is shown in Vol 24 Table K.5.

K.3.7 These EA groundwater level monitoring boreholes show piezometric levels lower than those recorded in the Chalk by adjacent monitoring boreholes but similar to those recorded in the Thanet Sands. This suggests that the response zones in the EA monitoring boreholes straddle both the Thanet Sands and the Chalk and that there is a downward vertical hydraulic gradient between these units.

K.3.8 A plot of groundwater levels within the River Terrace Deposits, Thanet Sands and the Chalk in the vicinity of the site is shown in Vol 24 Figure 13.4.3 (see separate volume of figures). In addition, a groundwater level hydrograph from the EA monitoring borehole and from the three nearby monitoring boreholes is shown in Vol 24 Figure 13.4.4 (see separate volume of figures).

K.3.9 The EA network does not include any monitoring boreholes sufficiently close by to provide representative water level in the upper aquifer at the site.

K.3.10 The EA have produced regional groundwater contour plots which display the groundwater flowing to the northwest across site[5]. The piezometric head in monitoring borehole SR1024 corresponds with this groundwater flow direction. However, the major groundwater licensed abstraction (see Volume 23 Section K.4) is likely to reverse the regional groundwater flow direction here, flowing to the southeast. As the River Terrace Deposits, the Thanet Sands and the Seaford Chalk appear to be in hydraulic continuity, the groundwater flow direction in the River Terrace Deposits is likely to be in a southeasterly direction in this area.

K.4 Groundwater abstractions and protected rights

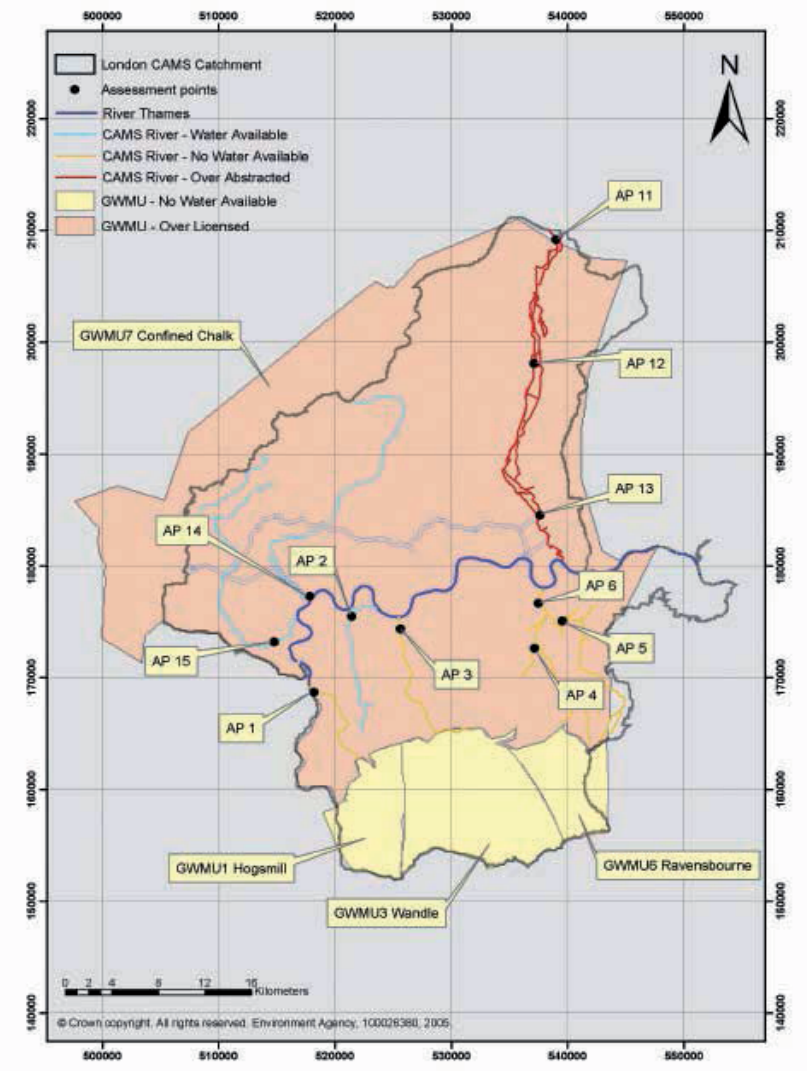
Groundwater licensing policy

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

K.4.2 The EA identifies a condition status for the lower aquifer and defines a policy through its London CAMS, which restricts new abstractions in central, east and south London and further abstraction in areas approaching their sustainable limit6. The Greenwich Pumping Station site is located within the confined Chalk groundwater management unit GWM6, which is classified as being over-licensed (see Vol 24 Plate K.1) (EA, 2006)6. Within this area, there is a limit on the availability of groundwater resources such that large abstractions (>1-2Ml/d) would generally not be granted unless the applicant can demonstrate that the resources are available (EA, 2006). In addition, large abstractions may also have a time limit shorter than the London CAMS common end date of 2013 (EA, 2006).

K.4.3 The estimated dewatering volumes required at Greenwich Pumping Station from the lower aquifer of less than 200m^3/d and 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)6. Therefore a detailed local assessment is unlikely to be required by the EA.

Vol 24 Plate K.1 Groundwater - confined chalk licensing



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

Licensed abstractions

K.4.4 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.4.5 There are no licensed groundwater abstractions from the River Terrace Deposits or upper aquifer located within 1km of the Greenwich Pumping Station site; however there are three licensed groundwater abstractions from the Chalk or lower aquifer.

K.4.6 The nearest licensed abstraction (28/39/43/0019) is located approximately within a kilometre of the Greenwich site and is held by Thames Water Utilities Limited. The groundwater abstracted is used for public supply purposes from six boreholes. The next nearest licensed abstractions (TH/39/44/0003 and TH/39/44/0006) are located approximately 0.9km to the east-northeast of the Greenwich site and are held by the Trustees of

National Maritime Museum. There are two abstractions point and two discharge points used for an open loop GSHP scheme.

K.4.7 Further details of these licensed abstractions are given in Vol 24 Table K.6.

Vol 24 Table K.6 Groundwater - licensed abstractions

Licence Number	Licence holder	Purpose	Aquifer
28/39/43/0019	Thames Water	Drinking water supply	Chalk
TH/039/44/0003 and TH/39/44/0006	Trustees of National Maritime Museum	Non-evaporative cooling (Ground Source Heap Pump (GSHP))	Chalk

K.4.8 There is no known unlicensed groundwater abstractions recorded within a 1km radius of the Greenwich site.

K.4.9 There is an old well situated within Greenwich Pumping Station site which is no longer in use. The well is approximately 2.4m in diameter and 3.6m deep. It is understood that the well dates from the construction of the original pumping station in the 1860's, when it was one of two wells used to dewater the excavations. Subsequently it was used for steam engine boiler and cooling water up until around 1930's. A groundwater level record from 19467, indicated that the level was approximately 7m below ground level or around -0.23mAOD. During the construction phase for the Thames Tunnel project, it is proposed that the well would be demolished /back-filled.

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 Greenwich Pumping Station site straddles a modelled SPZ 1 for a Chalk source (50 day travel time) to SPZ 3 (total catchment) of a major public water supply abstraction located <1km distance to the south (Vol 24 Figure 13.4.2). The shaft is to be constructed in SPZ 2 (400 day travel time). The distance from the shaft location to the boundary of SPZ 1 is less than 80m. This source is located up the regional hydraulic gradient expected beneath the site; however abstraction at this source is likely to reverse the regional groundwater flow direction here to flow towards the southeast.

K.6 Environmental designations

K.6.1 There are no environmental designations relevant to groundwater such as SSSI, SAC or SNCIs, within 1km of the Greenwich site.

K.7 Groundwater quality and land quality assessment

K.7.1 The historical land use mapping at Greenwich Pumping Station, reviewed as part of the land quality assessment, identified a number of potentially contaminative off site uses (Vol 24 Section 8). The search radius has identified areas of previous industrial activities in close proximity to the site and other surrounding areas, including a railway line; gas, tar and naphtha works; chemical works and asphalt works. Land quality may impact on groundwater quality through the creation or promotion of preferential pathways for existing contamination during construction of the proposed development.

K.7.2 The groundwater quality data presented in Vol 24 Table K.7 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tunnel project and includes data from monitoring boreholes located off site (29m from the site) and up to 0.93km away (for boreholes and locations see Vol 24 Figure 13.4.1) and within the River Terrace Deposits and Chalk. Any exceedances of the UK drinking water standards[8] or relevant Environmental Quality Standards (EQS))[9] are shaded in blue in this table.

K.7.3 The data shows exceedances of the relevant standards within the River Terrace Deposits at SA4031 (located at 380m from the site) with respect to chloride, iron, manganese, nickel, polycyclic aromatic hydrocarbons (PAH's) and sulphate. The data also shows exceedances within the Chalk with respect to total aromatic hydrocarbons at SR1018D (located 29m from the site), heavy metals, chloride, sodium, sulphate, pesticides, herbicides and turbidity at SR1024 (located 54m from the site) and ammonia, hydrocarbons and PAH's at PR1023 (located 68m from the site). The data also shows exceedances with respect to heavy metals, hydrocarbons, PAH's, electrical conductivity, chloride, magnesium, sodium, sulphate, pesticides, herbicides and turbidity within the Chalk at various ground investigation points at distance from the site. PAH's may be formed during a range of human activities, including incomplete combustion of carbon-based fuels and other industrial processes[10]. In addition, PAH's are considered to be Priority Hazardous Substances under the Water Framework Directive[11].

K.7.4 The data suggests that brackish conditions exist within the River Terrace Deposits at SA4031 (located at 380m from the site) and within the Chalk at SR1024 and SR4087 (located at 54m and 142m from the site). However the presence of a major public water supply source at 0.7km to the south of the Greenwich site suggests that these conditions are localised.

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show exceedances of the human health

screening values[12] (soil guideline values designed to be protective of human health) within the River Terrace Deposits at SR1019 and SA4031 with respect to hydrocarbons and PAH's and within the Thanet Sands at SR1025B and SR1026 with respect to hydrocarbons. Further detail is provided in the land quality assessment (see Vol 24 Appendix F).

K.7.6 The EA monitors groundwater quality at number of points across London. The nearest EA monitoring is at the Greenwich Deepwater Terminal. The distance of this location from the site (approximately 3km) makes it unreliable as predictor of water quality conditions around the site.

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Vol 24 Table K.7 Groundwater - groundwater quality results

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	TT	SI	SI	TT	SI	TT	SI	TT	SI	SI	SI	SI
Name				SR1018D	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	PR1023	SR4087	SR1019	SR6902D	SR6902D	SA4031	SA4031	SR4117	SR4117	SR1021C	SR1025B	SR1026	SR1044B
Hydrogeological unit**				CK	CK	SCK	SCK	SCK	SCK	SCK	SCK	LCK	CK	CK	RTD	CK	RTD	RTD	RTD	CK	CK	CK	CK	LCK
Distance from site	EQS Criteria			29m	54m	54m	54m	54m	54m	54m	54m	68m	142m	277m	369m	369m	380m	380m	409m	409m	689m	791m	810m	1084m
Chemical	Value	Units	Source	2009	2009	15/8/2011	1/11/2011	11/1/2012	1/5/2012	14/8/2012	17/8/2012	2009	17/7/2012	2009	8/2/2012	18/7/2012	14/2/2012	18/7/2012	14/2/2012	10/8/2012	2009	2009	2009	2009
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-	-	<0.08	<0.08	<0.08	< 0.08	-	<0.08	-	<0.08	-	<1	<0.08	6	18.2	<1	0.74	-	-	-	-
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-	-	<0.2	<0.2	<0.2	< 0.2	-	<0.2	-	<0.2	-	<1	<0.2	<1	<0.2	<1	<0.2	-	-	-	-
1,2 - Dichloroethane {Ethylene Dichloride}	3	ug/l	WS Regs 20	-	-	<0.12	<0.12	<0.12	< 0.12	-	<0.12	-	<0.12	-	<1	<0.12	<1	<0.12	<1	<0.12	-	-	-	-
1,2,4 - Trimethylbenzene	-	ug/l	None	<5.0	<1.7	-	-	-	-	-	-	-	-	<1.7	-	-	-	-	-	-	<5.0	<5.0	-	-
1,3,5 - Trimethylbenzene	-	ug/l	None	<5.0	<1.8	-	-	-	-	-	-	-	-	<1.8	-	-	-	-	-	-	<5.0	<5.0	-	-
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	-	-	<0.05	-	-	<0.05	-	-	<0.05	-	<0.05	-	<0.05	-	-	-	-
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	-	-	-	-	-	<0.00500	-	-	<0.00500	-	<0.00500	-	-	-	-	-	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
2,4,6 - Trichlorophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
2,6 - Dichlorophenol	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	-	-	<0.05	-	-	<0.05	-	-	<0.05	-	<0.05	-	<0.05	-	-	-	-
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	-	-	<0.05	-	-	<0.05	-	-	<0.05	-	<0.05	-	<0.05	-	-	-	-
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
4 - Chlorotoluene	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	<1.9	-	-	-	-	-	-	-	-	-	-
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	-	-	<0.05	-	-	<0.02	-	-	3.7	-	<0.02	-	<0.05	-	-	-	-
Acenaphthene	-	ug/l	None	<0.1	<0.015	-	-	-	-	-	-	-	-	0.0772	-	-	-	-	-	-	<0.1	<0.1	-	40
Acenaphthylene	-	ug/l	None	<0.1	<0.011	-	-	-	-	-	-	-	-	0.0247	-	-	-	-	-	-	<0.1	<0.1	-	<0.01
Acenapthene	-	ug/l	None	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	<0.06	-	<0.02	-	<0.02	-	-	-	-
Acenapthylene	-	ug/l	None	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	<0.06	-	<0.03	-	<0.03	-	-	-	-
Aliphatics >C10-C12	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	<0.1
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	4250	-	<10	-	-	-	-	-	-	<10.0	20.0	<10	<1
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	6720	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	3
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	2400	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	3
Aliphatics >C6-C8	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	<0.1
Aliphatics >C8-C10	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	<0.1
Aliphatics C5-C6	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	7.7
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	-	-	<4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	-	-	218	237	217	226	-	210	-	225	-	-	319	-	282	-	231	-	-	-	200
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	-	-	25.0	-	-	140.0	-	-	830.0	-	110.0	-	20.0	-	-	-	-
Aluminium Total	200	ug/l as Al	DWS 2010	-	-	1,000.0	780.0	120.0	3,300.0	-	28.0	-	65.0	-	0.08	480.0	<0.02	28.0	0.44	25.0	-	-	-	-
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	-	<0.05	<0.05	<0.05	< 0.05	-	<0.05	-	0.13	-	0.436	0.21	0.13	<0.05	0.04112	0.32	-	-	-	-
Ammoniacal nitrogen	-	mg/l	None	0.29000	<0.20000	-	-	-	-	-	-	1.87000	-	0.26800	-	-	-	-	-	-	1.80000	1.50000	<0.20000	0.51000
Ammonium as NH4	0.5	mg/l as NH4	WS Regs 20	0.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2	1.9	-	-
Anthracene	0.1	ug/l	SW WFD	<0.1	<0.015	-	-	-	-	<0.01	-	-	<0.01	<0.015	-	<0.05	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	-	-	0.6	-	-	0.5	-	-	0.7	-	0.7	-	0.7	-	-	-	-
Aromatics >C7-C8	50	ug/l	WFD 2010	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	<0.1
Aromatics >EC10-EC12	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	<0.1
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	792	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	2
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	1690	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	4
Aromatics >EC21-EC35	-	ug/l	None	10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	8

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	TT	SI	SI	SI	TT	SI	TT	SI	TT	SI	SI	SI	SI
Name				SR1018D	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	PR1023	SR4087	SR1019	SR6902D	SR6902D	SA4031	SA4031	SR4117	SR4117	SR1021C	SR1025B	SR1026	SR1044B
Hydrogeological unit**				CK	CK	SCK	SCK	SCK	SCK	SCK	SCK	LCK	CK	CK	RTD	CK	RTD	RTD	RTD	CK	CK	CK	CK	LCK
Distance from site	EQS Criteria			29m	54m	54m	54m	54m	54m	54m	54m	68m	142m	277m	369m	369m	380m	380m	409m	409m	689m	791m	810m	1084m
Chemical	Value	Units	Source	2009	2009	15/8/2011	1/11/2011	11/1/2012	1/5/2012	14/8/2012	17/8/2012	2009	17/7/2012	2009	8/2/2012	18/7/2012	14/2/2012	18/7/2012	14/2/2012	10/8/2012	2009	2009	2009	2009
(Aqueous)																								
Aromatics >EC8-EC10	-	ug/l	None	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	<0.1
Aromatics C6-C7	1	ug/l	DWS 2010	<10.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<10.0	<10.0	<10	5
Arsenic Total	10	ug/l as As	DWS 2010	<5.0	1.41	64.4	111	18	210	-	6.4	5.34	<1.0	<0.75	2.8	1.6	2.5	<1.0	2.1	<1.0	8.0	<5.0	114	<1
Atrazine { }	0.1	ug/l	DWS 2010	-	-	<0.00300	0.00400	<0.00300	<0.00800	-	<0.00800	-	<0.00800	-	<0.01	<0.00800	<0.01	<0.00800	<0.01	<0.00800	-	-	-	-
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	-	150	-	-	66	-	-	40	-	63	-	67	-	-	-	-
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	-	160	-	-	63	-	-	39	-	67	-	68	-	-	-	-
Bentazone	0.1	ug/l	DWS 2010	-	-	<0.00800	<0.00800	<0.00800	<0.00800	-	<0.00800	-	<0.00800	-	<0.1	<0.00800	<0.1	<0.00800	<0.1	<0.00800	-	-	-	-
Benz[a]-Anthracene	-	ug/l	None	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	<0.05	-	<0.02	-	<0.02	-	-	-	-
Benzene	1	ug/l	DWS 2010	<5.0	<10	<0.07	<0.07	<0.07	< 0.07	<0.07	<0.07	<10	<0.07	<10	<1	0.15	<1	<0.07	<1	<0.07	<5.0	<5.0	<10	<0.2
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	-	-	<0.06	-	-	<0.06	-	-	0.07	-	<0.06	-	<0.06	-	-	-	-
Benzo (a) anthracene	-	ug/l	None	<0.1	<0.009	-	-	-	-	-	-	-	-	<0.009	-	-	-	-	-	-	<0.1	<0.1	-	<0.01
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.1	<0.009	<0.00500	<0.00500	<0.00500	0.00980	<0.01	<0.00500	0.0355	<0.01	<0.009	<1	<0.06	<1	<0.02	<1	<0.02	<0.1	<0.1	0.0352	<0.01
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<0.1	<0.023	-	-	-	-	<0.01	-	-	<0.01	<0.023	-	<0.05	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.1	<0.016	-	-	-	-	<0.01	-	0.0258	<0.01	<0.016	-	<0.06	-	<0.02	-	<0.02	<0.1	<0.1	0.0297	<0.01
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	<0.1	<0.027	-	-	-	-	<0.01	-	-	<0.01	<0.027	-	<0.05	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Bicarbonate	-	mg/l as HCO3	None	-	-	-	-	-	-	-	-	-	-	-	390	-	430	-	380	-	-	-	-	-
Bifenthrin	-	ug/l	None	-	-	-	-	-	-	-	-	-	<0.00500	-	-	<0.00500	-	<0.00500	-	-	-	-	-	-
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	-	-	-	-	-	110	-	-	90	-	260	-	47	-	-	-	-
Boron Total	1000	ug/l as B	DWS 2010	180.0	45.8	210.0	230.0	220.0	220.0	-	280.0	204	140.0	-	0.1	84.0	0.27	290.0	0.2	78.0	530.0	150.0	217	380
Bromate	10	ug/l as BrO3	DWS 2010	-	-	<0.5	<0.5	<0.5	< 0.5	-	<0.5	-	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	-
Cadmium Total	5	ug/l as Cd	DWS 2010	<1.0	<0.22	<1.5	3.9	<1.5	8	<1.5	<1.5	<0.22	<1.5	<0.22	<0.02	<1.5	0.05	<1.5	<0.02	<1.5	<1.0	<1.0	<0.22	<2
Calcium Dissolved	250	mg/l as Ca	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	150	-	230	-	200	-	-	-	-	-
Calcium Total	250	mg/l as Ca	DWS 2010	-	-	180	190	190	230	-	210	-	200	-	-	150	-	250	-	140	-	-	-	-
Carbendazim	0.1	ug/l	FW List II	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	<0.1	-	-	-	-	-
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	-	-	-	-	<0.00500	-	<0.00500	-	<0.00500	-	-	<0.00500	-	<0.00500	-	<0.00500	-	-	-	-
Carbetamide	-	ug/l	None	-	-	-	-	-	<0.01000	-	<0.01000	-	<0.01000	-	<0.1	<0.01000	<0.1	<0.01000	<0.1	<0.01000	-	-	-	-
Carbon Dioxide	-	ug/l	None	-	-	-	-	-	-	31800	-	-	22	-	-	-	18,000.0	40700	-	10500	-	-	-	-
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	-	-	2.6	-	-	2.1	-	-	5.7	-	3.7	-	0.6	-	-	-	-
Carbon tetrachloride	3	ug/l	DWS 2010	-	-	<0.07	<0.07	<0.07	< 0.070	-	<0.070	-	<0.070	-	<1	<0.070	<1	<0.070	<1	<0.070	-	-	-	-
Carbonate	-	mg/l	None	-	-	-	-	-	-	-	-	-	-	-	<10	-	<10	-	<10	-	-	-	-	-
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	-	<0.00900	-	<0.01	<0.00900	<0.01	<0.00900	<0.01	<0.00900	-	-	-	-
Chloride	250	mg/l as Cl	DWS 2010	-	-	787	827	966	1120	-	1370	-	350	-	140	173	600	317	88	160	-	-	-	250
Chloroform	100	ug/l	WS Regs 20	-	-	<0.6	<0.6	<0.6	< 0.600	-	<0.600	-	0.93	-	2	<0.600	<1	<0.600	1	<0.600	-	-	-	-
Chlorotoluron	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	<0.1	-	<0.1	-	<0.1	-	-	-	-	-
Chlortoluron	2	ug/l	FW List II	-	-	<0.05000	<0.10000	<0.05000	<0.01000	-	<0.01000	-	<0.01000	-	-	<0.01000	-	<0.01000	-	<0.01000	-	-	-	-
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	-	-	19	22	-	16	-	-	13	-	15	-	14	-	-	-	-
Chromium Total	50	ug/l as Cr	DWS 2010	6.0	6.32	62	28	34	75	-	-	12.3	-	2.64	18	-	19	-	12	-	6.0	<5.0	6.12	<5
Chrysene	-	ug/l	None	<0.1	<0.013	-	-	-	-	<0.01	-	-	<0.01	<0.013	-	<0.05	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Clopyralid	-	ug/l	None	-	-	<0.01900	<0.01900	<0.01900	<0.01900	-	<0.01900	-	<0.01900	-	<0.1	<0.01900	<0.1	<0.01900	<0.1	<0.01900	-	-	-	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	-	955	-	-	-	-	-	-	-	-	1820	-	-	-	-	-	-	4800	2340	-	1200
Copper Total	2000	ug/l as Cu	DWS 2010	<5.0	9.58	7.2	<5.5	<5.5	26	-	<5.5	1.61	<5.5	<1.6	2.2	<5.5	3.7	<5.5	1.5	<5.5	<5.0	<5.0	4.71	<2
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	0.00700	-	-	<0.00500	-	<0.00500	-	-	-	-	-	-
Cresols	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.1
Cyanazine	0.1	ug/l	DWS 2010	-	-	<0.06000	<0.12000	<0.06000	<0.00800	-	<0.00800	-	<0.00800	-	<1	<0.00800	<1	<0.00800	<1	<0.00800	-	-	-	-
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20.0	<50.0	-	-	-	-	-	-	<50.0	-	-	-	-	-	-	-	-	<20.0	<20.0	<50.0	<20

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	TT	SI	SI	TT	SI	TT	SI	TT	SI	SI	SI	SI
Name				SR1018D	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	PR1023	SR4087	SR1019	SR6902D	SR6902D	SA4031	SA4031	SR4117	SR4117	SR1021C	SR1025B	SR1026	SR1044B
Hydrogeological unit**				CK	CK	SCK	SCK	SCK	SCK	SCK	SCK	LCK	CK	CK	RTD	CK	RTD	RTD	RTD	CK	CK	CK	CK	LCK
Distance from site	EQS Criteria			29m	54m	54m	54m	54m	54m	54m	54m	68m	142m	277m	369m	369m	380m	380m	409m	409m	689m	791m	810m	1084m
Chemical	Value	Units	Source	2009	2009	15/8/2011	1/11/2011	11/1/2012	1/5/2012	14/8/2012	17/8/2012	2009	17/7/2012	2009	8/2/2012	18/7/2012	14/2/2012	18/7/2012	14/2/2012	10/8/2012	2009	2009	2009	2009
Cyanide (Total)	50	ug/l as CN	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<40
Cypermethrin	0.0001	ug/l	WFD 2010	-	-	0.11	<0.1	<0.1	< 0.100	-	<0.100	-	<0.100	-	<0.1	<0.100	<0.1	<0.100	<0.1	<0.100	-	-	-	-
Cypermethrin ID	-	Code	None	-	-	-	-	-	-	-	-	-	<5.00	-	-	<5.00	-	<5.00	-	-	-	-	-	-
Dalapon	-	ug/l	None	-	-	<0.05000	<0.05000	<0.05000	<0.05000	-	-	-	<0.05000	-	<1	<0.05000	<1	<0.05000	<1	-	-	-	-	-
Diazinon	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	-	<0.00900	-	<0.01	<0.00900	<0.01	<0.00900	<0.01	<0.00900	-	-	-	-
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.1	<0.016	-	-	-	-	<0.01	-	-	<0.01	<0.016	-	<0.05	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Dichloromethane	20	ug/l	WFD 2010	-	-	<3	<3	<3	< 3.0	-	<3.0	-	-	-	<50	<3.0	<50	<3.0	<50	<3.0	-	-	-	-
Dichlorprop	0.1	ug/l	DWS 2010	-	-	0.56800	<0.01100	<0.01100	<0.01100	-	<0.01100	-	<0.01100	-	<0.1	<0.01100	<0.1	<0.01100	<0.1	<0.01100	-	-	-	-
Diuron	0.1	ug/l	DWS 2010	-	-	<0.00500	0.00600	<0.00500	<0.01000	-	<0.01000	-	<0.01000	-	<0.1	<0.01000	<0.1	<0.01000	<0.1	<0.01000	-	-	-	-
Enterococci (Species)	-	Nr/100ml	None	-	-	-	-	-	-	0	-	-	0	-	-	8	-	-	-	0	-	-	-	-
Escherichia coli (Confirmed)	0	Nr/100ml	WS Regs 20	-	-	-	-	-	-	0	-	-	1	-	-	1	-	0	-	0	-	-	-	-
Ethofumesate	-	ug/l	None	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	<0.01	-	<0.01	-	<0.01	-	-	-	-
Ethylbenzene	-	ug/l	None	<5.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<5.0	<5.0	<10	<1
Fenuron	-	ug/l	None	-	-	-	-	-	-	<0.01	-	-	<0.01	-	-	0.03	-	<0.01	-	<0.01	-	-	-	-
Fluoranthene	0.2	ug/l	EEC MAC	<0.1	<0.014	-	-	-	-	<0.01	-	-	<0.01	<0.014	-	<0.05	-	0.07	-	<0.02	<0.1	<0.1	-	<0.01
Fluorene	-	ug/l	None	<0.1	<0.014	-	-	-	-	<0.01	-	-	<0.01	0.0908	-	<0.06	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Fluoride	1.5	mg/l as F	DWS 2010	-	-	0.21	0.19	0.24	0.193	-	0.29	-	0.256	-	<1.0	0.37	<1.0	0.53	<1.0	0.33	-	-	-	-
Glyphosate	-	ug/l	None	-	-	<0.01400	<0.01400	<0.01400	<0.01400	-	<0.01400	-	<0.01400	-	<0.1	-	<0.1	<0.01400	<0.1	<0.01400	-	-	-	-
GRO C4-C12	-	ug/l	None	-	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	-	-	<10	-
Hardness Total - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	-	-	860	-	-	530	-	-	580	-	750	-	380	-	-	-	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.1	<0.014	-	-	-	-	<0.01	-	-	<0.01	<0.014	-	<0.05	-	<0.02	-	<0.02	<0.1	<0.1	-	<0.01
Iodide Ion	-	ug/l as I	None	-	-	-	-	-	-	18	-	-	110	-	-	13	-	32	-	9	-	-	-	-
Irgarol 1051	-	ug/l	None	-	-	-	-	-	-	-	-	-	<0.00500	-	-	<0.00500	-	<0.00500	-	-	-	-	-	-
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	-	-	920.0	-	-	2,000.0	-	-	2,100.0	-	210.0	-	<18.0	-	-	-	-
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	-	-	900.0	-	-	1,800.0	-	-	2,100.0	-	230.0	-	<18.0	-	-	-	-
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	<0.00800	-	<0.00800	-	<0.00800	-	<0.1	<0.00800	<0.1	<0.00800	<0.1	<0.00800	-	-	-	-
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	-	-	-	-	-	<5.00	-	-	<5.00	-	<5.00	-	-	-	-	-	-
Lead Total	10	ug/l	WS Regs 20	<5.0	3.5	<5	8	<5	15	-	<5	<0.4	<5	0.579	<0.3	<5	<0.3	<5	<0.3	<5	<5.0	<5.0	0.561	<4
Lithium Dissolved	-	ug/l as Li	None	-	-	-	-	-	-	<0.6	-	-	<0.6	-	-	<0.6	-	<0.6	-	<0.6	-	-	-	-
Lithium Total	-	ug/l as Li	None	-	-	-	-	-	-	<0.6	-	-	<0.6	-	-	<0.6	-	<0.6	-	<0.6	-	-	-	-
Magnesium Dissolved	50	mg/l as Mg	EEC MAC	-	-	-	-	-	-	69	-	-	14	-	-	14	-	18	-	8.1	-	-	-	-
Magnesium Total	50	mg/l as Mg	EEC MAC	-	-	41	42	48	60	-	65	-	14	-	17	13	24.85	17	18	8.2	-	-	-	16
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	-	-	13.0	-	-	360.0	-	-	630.0	-	1,600.0	-	34.0	-	-	-	-
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	-	-	12.0	-	-	350.0	-	-	620.0	-	1,600.0	-	35.0	-	-	-	-
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	<0.00900	-	<0.00900	-	<0.00900	-	<0.1	<0.00900	<0.1	<0.00900	<0.1	<0.00900	-	-	-	-
Mecoprop { }	0.1	ug/l	DWS 2010	-	-	<0.01000	<0.01000	<0.01000	<0.01000	-	<0.01000	-	<0.01000	-	<0.1	<0.01000	<0.1	<0.01000	<0.1	<0.01000	-	-	-	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.05	<0.01	0.05	0.026	<0.002	0.055	-	0.002	<0.01	0.007	<0.01	0.38	0.013	<0.05	<0.002	0.52	<0.002	<0.05	<0.05	<0.01	<0.05
Metazachlor	-	ug/l	None	-	-	<0	<0	<0	< 0	-	<0.00800	-	<0.00800	-	<0.1	<0.00800	<0.1	<0.00800	<0.1	<0.00800	-	-	-	-
Methane	-	ug/l	None	-	-	-	-	-	-	<10	-	-	-	-	-	99	-	<10	-	14	-	-	-	-
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	-	-	54	-	-	8	-	-	<5	-	<5	-	8	-	-	-	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<5.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<5.0	<5.0	<10	<1
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	<0.10000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	1.2	ug/l	WFD D 10	<0.1	<0.1	-	-	-	-	<0.02	-	-	0.02	0.24	-	<0.07	-	<0.03	-	<0.03	<0.1	<0.1	-	<0.01
Nickel Total	20	ug/l as Ni	DWS 2010	7.0	4.55	17	11	5	46	-	11	11.5	18	36.1	8	<4	31	14	16	5	21.0	<5.0	7.81	<10
Nitrate - N	11.3	mg/l as N	WS Regs 20	<0.5	0.833	5.15	4.42	3.98	5.01	-	6.51	<0.0677	<0.068	<0.0677	<1.0	<0.068	<2.0	5.39	21	0.887	<0.5	<0.5	5.23	<0.1
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	-	-	6.32	-	-	0.164	-	-	<0.081	-	6.03	-	0.628	-	-	-	-

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	TT	SI	SI	SI	TT	SI	TT	SI	TT	SI	SI	SI	SI
Name				SR1018D	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	PR1023	SR4087	SR1019	SR6902D	SR6902D	SA4031	SA4031	SR4117	SR4117	SR1021C	SR1025B	SR1026	SR1044B
Hydrogeological unit**				CK	CK	SCK	SCK	SCK	SCK	SCK	SCK	LCK	CK	CK	RTD	CK	RTD	RTD	RTD	CK	CK	CK	CK	LCK
Distance from site	EQS Criteria			29m	54m	54m	54m	54m	54m	54m	54m	68m	142m	277m	369m	369m	380m	380m	409m	409m	689m	791m	810m	1084m
Chemical	Value	Units	Source	2009	2009	15/8/2011	1/11/2011	11/1/2012	1/5/2012	14/8/2012	17/8/2012	2009	17/7/2012	2009	8/2/2012	18/7/2012	14/2/2012	18/7/2012	14/2/2012	10/8/2012	2009	2009	2009	2009
Orthophosphate	-	mg/l as P	None	-	-	-	-	-	-	<0.18	-	-	<0.18	-	-	<0.18	-	0.23	-	<0.18	-	-	-	-
Oxamyl	-	ug/l	None	-	-	-	-	-	-	-	-	-	<0.00500	-	-	<0.00500	-	0.00800	-	-	-	-	-	-
o-Xylene	-	ug/l	None	<5.0	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	<5.0	<5.0	<10	-
PAH 16 Total	0.1	ug/l	DWS 2010	0.0	<0.1	-	-	-	-	-	-	5.95	-	0.52	-	-	-	-	-	-	0.0	0.0	0.278	-
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	-	-	<0.01	-	-	0.02	-	-	<0.89	-	14	-	<0.34	-	-	-	-
Pentachlorophenol	9	ug/l	WHO 2004	-	-	-	-	-	-	-	-	-	-	-	<3	-	<3	-	<3	-	-	-	-	-
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	-	<0.10000	<0.10000	-	-	<0.10000	-	<0.10000	-	<0.01	<0.10000	<0.01	<0.10000	<0.01	-	-	-	-	-
pH	10	pH units	DWS 2010	7.8	7.93	-	-	-	-	-	-	8.01	-	7.61	-	-	7.9	-	-	-	7.7	7.9	8.48	-
Phenanthrene	-	ug/l	None	<0.1	<0.022	-	-	-	-	<0.01	-	-	<0.01	0.0873	-	<0.06	-	0.03	-	<0.02	<0.1	<0.1	-	<0.01
Phenol	0.5	ug/l	EEC MAC	<10.0	<2.0	-	-	-	-	-	-	<2.0	-	<2.0	7	-	<3	-	4	-	<10.0	<10.0	<2.0	<1
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	-	<0.00900	<0.00900	<0.00900	<0.00900	-	-	-	<0.00900	-	-	<0.00900	-	<0.00900	-	-	-	-	-	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	-	<800.0	<15.0	41.0	<8.0	-	<8.0	-	<8.0	-	-	<8.0	-	<8.0	-	<8.0	-	-	-	-
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.03
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	-	-	40	-	-	12	-	-	11	-	27	-	5.7	-	-	-	-
Potassium Total	-	mg/l as K	None	-	-	30	32	33	40	-	38	-	13	-	20	10	46	27	26	6.4	-	-	-	-
Preparation (Purge And Trap)	-	Text	None	-	-	-	-	-	-	-	Prepared	-	Prepared	-	-	Prepared	-	Prepared	-	Prepared	-	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	-	<0.04000	<0.08000	<0.04000	<0.00500	-	<0.00500	-	<0.00500	-	<0.01	<0.00500	<0.01	<0.00500	<0.01	<0.00500	-	-	-	-
Propetamphos	0.1	ug/l	DWS 2010	-	-	<0.00500	<0.00500	<0.00500	<0.00500	-	<0.00500	-	<0.00500	-	<0.1	<0.00500	<0.1	<0.00500	<0.1	<0.00500	-	-	-	-
Pyrene	-	ug/l	None	<0.1	<0.015	-	-	-	-	<0.01	-	-	<0.01	<0.015	-	<0.06	-	0.04	-	<0.02	<0.1	<0.1	-	<0.01
Selenium	10	ug/l as Se	DWS 2010	<5.0	2.08	-	-	-	-	2.1	-	3.63	<0.4	<1	-	0.4	-	3.4	-	0.8	16.0	8.0	13.7	<3
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	-	-	-	-	-	14.00000	-	-	27.00000	-	21.00000	-	16.00000	-	-	-	-
Simazine	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	<0.00400	-	<0.00400	-	<0.00400	-	<0.01	<0.00400	<0.01	<0.00400	<0.01	<0.00400	-	-	-	-
Sisumxylene	-	ug/l	None	-	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	-	-	<10	-
Sodium Total	200	mg/l as Na	DWS 2010	-	-	390	420	480	570	-	540	-	140	-	140	150	190	200	110	39	-	-	-	140
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	-	-	-	-	-	0.89	-	-	0.028	-	0.82	-	0.88	-	-	-	-
Strontium Total	-	ug/l as Sr	None	-	-	-	-	-	-	1.1	-	-	0.85	-	-	1.1	-	0.83	-	0.9	-	-	-	-
Sulphate	250	mg/l as SO4	DWS 2010	170	155	192	195	222	211	-	258	205	165	515	160	164	420	443	80	79.9	440	100	208	73
Sulphide	-	ug/l	None	-	-	-	-	-	-	<29.0	-	-	<29.0	-	-	7,290.0	-	<29.0	-	<29.0	-	-	-	<10
Sum of BTEX	-	ug/l	None	-	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	-	-	<10	-
Terbutryn	0.1	ug/l	DWS 2010	-	-	<0.04000	<0.08000	<0.04000	<0.00500	-	0.00600	-	<0.00500	-	<0.01	<0.00500	<0.01	<0.00500	<0.01	<0.00500	-	-	-	-
Tetrachloroethylene	-	ug/l	None	-	-	<0.09	0.22	<0.09	< 0.09	-	0.24	-	<0.09	-	<1	<0.09	<1	<0.09	<1	<0.09	-	-	-	-
Tetrachlorothioanisole	-	ug/l	None	-	-	-	-	-	-	-	-	-	<0.00500	-	-	<0.00500	-	<0.00500	-	-	-	-	-	-
Tin Total	0	ug/l as Sn	GW Regs 98	-	-	-	-	-	-	<5	-	-	<5	-	-	<5	-	<5	-	<5	-	-	-	-
Titanium	0	ug/l as Ti	GW Regs 98	-	-	-	-	-	-	87.0	-	-	74.0	-	-	78.0	-	98.0	-	49.0	-	-	-	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<5.0	<10	-	-	-	-	<0.55	-	<10	<0.55	<10	-	1.17	-	<0.55	-	<0.55	<5.0	<5.0	<10	<1
Total Aliphatic TPH	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14
Total Aliphatics & Aromatics >C12-C44 (Aqueous)	-	ug/l	None	-	<10	-	-	-	-	-	-	16900	-	<10	-	-	-	-	-	-	-	-	<10	-
Total Aliphatics >C12-C35 (Aqueous)	-	ug/l	None	10.0	<10	-	-	-	-	-	-	13400	-	<10	-	-	-	-	-	-	<10.0	20.0	<10	-
Total Aliphatics C5-C12	-	ug/l	None	-	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	-	-	<10	-
Total Aliphatics C5-C35	-	ug/l	None	<10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10.0	20.0	-	-
Total Aromatic TPH	-	ug/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
Total Aromatics >EC12-EC35 (Aqueous)	-	ug/l	None	-	<10	-	-	-	-	-	-	3570	-	<10	-	-	-	-	-	-	-	-	<10	-
Total Aromatics C5-C35	1	ug/l	DWS 2010	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10.0	<10.0	-	-
Total Aromatics C6-C12	1	ug/l	DWS 2010	-	<10	-	-	-	-	-	-	<10	-	<10	-	-	-	-	-	-	-	-	<10	-
Total Chemical Oxygen Demand	-	mg/l	None	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10.00000

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	TT	SI	SI	TT	SI	TT	SI	TT	SI	SI	SI	SI
Name				SR1018D	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	SR1024	PR1023	SR4087	SR1019	SR6902D	SR6902D	SA4031	SA4031	SR4117	SR4117	SR1021C	SR1025B	SR1026	SR1044B
Hydrogeological unit**				CK	CK	SCK	SCK	SCK	SCK	SCK	SCK	LCK	CK	CK	RTD	CK	RTD	RTD	RTD	CK	CK	CK	CK	LCK
Distance from site	EQS Criteria			29m	54m	54m	54m	54m	54m	54m	54m	68m	142m	277m	369m	369m	380m	380m	409m	409m	689m	791m	810m	1084m
Chemical	Value	Units	Source	2009	2009	15/8/2011	1/11/2011	11/1/2012	1/5/2012	14/8/2012	17/8/2012	2009	17/7/2012	2009	8/2/2012	18/7/2012	14/2/2012	18/7/2012	14/2/2012	10/8/2012	2009	2009	2009	2009
Total Hydrocarbons C5-C35	-	ug/l	None	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10.0	20.0	-	-
Total Monohydric Phenols	-	ug/l	None	<10.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10.0	<10.0	-	-
Total Monohydric Phenols (W)	-	ug/l	None	-	<15.0	-	-	-	-	-	-	<15.0	-	<15.0	-	-	-	-	-	-	-	-	<15.0	-
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-	-	<0.07	<0.07	<0.07	< 0.07	-	0.15	-	<0.07	-	<1	<0.07	<1	0.75	<1	<0.07	-	-	-	-
Trietazine	-	ug/l	None	-	-	<0.02000	<0.04000	<0.02000	<0.00800	-	<0.00800	-	<0.00800	-	<0.01	<0.00800	<0.01	<0.00800	<0.01	<0.00800	-	-	-	-
Trifluralin	0.1	ug/l	DWS 2010	-	-	<0.01000	<0.01000	<0.01000	<0.01000	-	-	-	<0.01000	-	<0.01	<0.01000	<0.01	<0.01000	<0.01	<0.01000	-	-	-	-
Turbidity	1	FTU	WS Regs 20	-	-	3.96	346	21.1	221	-	8.52	-	12.1	-	<1	112	2	0.41	<1	0.4	-	-	-	-
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	-	-	1.7	-	-	1.9	-	-	0.8	-	1.6	-	1.2	-	-	-	-
Volatile Hydrocarbons (C5-C12)	-	mg/l	None	<0.01000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.01000	<0.01000	-	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<5.0	<10	0.14	<0.09	<0.09	< 0.09	<0.09	<0.09	<10	<0.09	<10	<1	0.24	<1	<0.09	<1	<0.09	<5.0	<5.0	<10	<1
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	-	-	<0.09	-	-	<0.09	-	-	0.09	-	<0.09	-	<0.09	-	-	-	-
Zinc Total	50	ug/l as Zn	DWS 2010	29.0	10.2	11	7	<5	29	-	<5	<5	<5	<5	9	8	8	<5	6	<5	9.0	<5.0	<5	<1

Notes:

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

* Origin of data: SI – Groundwater quality data collected during site investigation works by Thames Tunnel project (2009-2011), TT – Groundwater quality data collected during ongoing monitoring works by Thames Tunnel project (2009-2012) ** Hydrogeological unit: SCK – Seaford Chalk, LCK – Lewes Nodular Chalk, 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. The Thames River Basin Management Plan (RBMP)13 shows that the Superficial Deposits (River Terrace Deposits and Alluvium), Lambeth Group, Thanet Sands and Chalk Formation in the area of the Greenwich Pumping Station site are designated as the Greenwich Chalk and Tertiaries groundwater body.

K.8.2 The baseline assessment for groundwater status classification for the Greenwich Chalk and Tertiaries shows poor quantitative status with respect to impact on surface waters and saline intrusions, good quantitative status with respect to groundwater dependent terrestrial ecosystems and resource balance for 2009. The baseline assessment also shows poor chemical status with respect to saline intrusions and drinking water protected area status and good chemical status with respect to general chemical assessment, groundwater dependent terrestrial ecosystems and impact on surface water chemical/ ecological status.

K.8.3 The predicted quantitative and chemical quality was poor for 2015 due to treatment or improvement being disproportionately expensive or technically infeasible.

K.8.4 Only eight out of forty-six groundwater bodies within the Thames River basin district are at good status overall; this is not expected to change by 2015 (EA, 2009)13.

K.8.5 The Thames Tunnel project would prevent deterioration of the current and predicted status of groundwater and would adhere to the key actions identified in the RBMP to achieve good status by 2021 or 2027, as follows (EA, 2009)13:

- The control of 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 Greenwich Pumping Station assessment is given in Vol 24 Table K.8.

Vol 24 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 Tunnel project	Ground Investigation (2009) borehole logs, construction details, monitoring regime and available water level records and water quality results from 2009 to 2012	Last updated September 2012	Final ES
Thames Tunnel project	Groundwater monitoring strategy	Draft strategy Feb 2012	

Source	Data	Date received	Notes
Thames Tunnel project	Land quality data	February 2011	
Individual licence holders	Letters sent out to 30 licence holders	December 2011 (last updated 15th October 2012)	

** LBs – London Borough*

References

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

[2] Royse, K.R., 2008. The London Chalk model. British Geological Survey. Commissioned Report CR/08/125.

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

[4] Environment Agency and ESI. London Basin Aquifer Conceptual Model. ESI Report Reference 60121R1 (June 2010).

[5] Environment Agency. Groundwater levels contours in Chalk. Received from Environment Agency, June 2011.

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

[7] British Geological Survey. Geoindex record 270/479/0/42 (TQ37/191)

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

[9] 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/

[10] 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

[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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station 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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Thames Water Utilities Limited

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Appendix M: Water resources - flood risk

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Appendix M: Water resources – flood risk

M.1 Policy considerations

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

M.1.2 The Waste Water NPS considers the Thames Tideway Tunnel project as 'essential 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 Greenwich Pumping Station is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The Greenwich Pumping Station site lies within the Royal Borough (RB) of Greenwich. The borough has produced a Strategic Flood Risk Assessment (SFRA) (JBA Consulting, 2011)[2] which outlines the main flood sources to the borough.

M.1.5 The Greenwich SFRA confirms that the Thames Tidal Defence network (Thames Barrier and Tidal flood defence walls) reduces the annual probability of flooding from the River 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 3a.

b. There has been one sewer flooding incident recorded by Thames Water in the last ten years in the borough.

c. The breach modelling carried out as part of the SFRA indicates that the site is in an area of predominantly no or low risk hazard rating. This means that in the event of a failure in the flood defences either by a breach of the defences or overtopping of the defences, the residual risk would be low.

d. The existing flood defences near the site are in a good condition and the site is in an area with a low breach hazard rating.

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) as part of the Drain London project. The SWMP sets out the preferred surface water management strategy for the borough.

M.1.9 The SWMP has not been made available to inform this study.

Regional policy

Thames Estuary 2100

M.1.10 Greenwich Pumping Station lies within the Greenwich Policy Unit which has been assigned flood risk management policy 'P5' within the Thames Estuary 2100 (TE2100) Plan (Environment Agency, 20012)[3], 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 at this location as including:

a. tidal flooding from the River Thames

b. fluvial and tidal/fluvial flooding from the River Ravensbourne (Deptford Creek)

c. urban drainage sources.

M.1.12 Flood mitigation from these sources include:

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

b. tidal and fluvial defences along the lower reach of the River Ravensbourne (Deptford Creek)

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

d. flood forecasting and warning.

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

M.1.14 The TE2100 Plan states that measures will be needed to control tributary tidal and fluvial flooding on the Ravensbourne River and that there is a risk of urban drainage flooding in this policy unit.

Thames Region Catchment Flood Management Plan

M.1.15 The Thames Region Catchment Flood Management Plan (CFMP) (Environment Agency, 2007)[4] covers fluvial and non-tidal sections of the River Thames, ie, the River Thames upstream of Teddington Weir and the tributaries of the River Thames (including the River Ravensbourne).

M.1.16 The Thames Region CFMP advocates the reduction in flood risk through the design and layout of developments within the floodplain; redevelopment should be compatible with its location within the floodplain (ie, flood resilience measures should be incorporated). This should be

achieved through re-creating more natural river systems and giving space for flood water, aiming for a balance between attenuation and conveyance.

London Regional Flood Risk Appraisal

M.1.17 For the reach between Hammersmith Bridge and the Thames Barrier, City Reach (does not specify inclusion of River Ravensbourne), the London 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 modification, raising and maintenance in a sustainable, environmentally acceptable and cost effective way. Development should be designed in such a way as to take opportunities to reduce flood risk and include resilience.

M.1.18 There is particular concern surrounding confluences of tributaries into the Tidal Thames and the interactions between tidal and fluvial flows in the future due to climate change. This should be taken into consideration during the re-development process.

M.1.19 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 Consulting. *LB of Greenwich Strategic Flood Risk Assessment Final Report.* (October 2011).

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

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

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Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station appendices

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 24 Table N.1 of the resulting development projects, a description of what is proposed and assumptions on phasing. Longer term development projects may be included under both base case, with construction preceding that of the Thames Tideway Tunnel site, and cumulative with construction or operation occurring at the same time as a given Thames Tideway Tunnel site.

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Vol 24 Table N.1 Development schedule for Greenwich Pumping Station

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		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
Block E, 43-81 Greenwich High Road Note: not Mayoral referral development but included due proximity to site (potential new receptors).	Adjacent	12/1588/F	Reefmark Ltd	Change of use of floorspace on part ground, part first and the entirety of the second and third floors from Office (Class B1/B1c) to 68 room Hotel (Class C1).	C	100% complete & operational	100% complete & operational	100% complete & operational	No programme information available but assumed it would be completed by Site Year 1 of construction.	Base case (all years)
83-87 Greenwich High Road, Greenwich Note: not Mayoral referral development but included due proximity to site (potential new receptors).	Adjacent	11/0848/F	Halliard Property Company Limited	Demolition of existing buildings and construction of a part 4/part 5-storey building providing retail or commercial at ground floor level (Use Class A1, A2, A3, A4 or B1) and 5 x 1-bed and 6 x 2-bed flats on upper floors with balconies and terraces. (Opposite Ashburnham Triangle Conservation Area).	B	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – scale of development would suggest a construction period of max. one year. On this basis it is assumed to be complete/operational by Site Year 1 of construction.	Base case (all years)
Greenwich Industrial Estate (land bounded by Norman Road, Greenwich High Road and Waller Way, Greenwich)	Adjacent	11/0271/F & 12/1580/F	Cathedral (Movement Greenwich)	**11/0848/F** Redevelopment of the site for a mixed use development comprising of 181 residential units, 358 student residential units, 1,332sqm of education/office floorspace (B1/D1), l,382sqm health club (leisure (D2) floorspace), 11 incubator/start up business units totalling 635sqm, 200sqm extension to the rear of the Greenwich West Community Centre, a 360sqm nursery (Dl), 480sqm of retail foodstore floorspace (Al) and 37sqm café/bike shop (Al/A3). A 104 bed 3 star hotel and a 30 room boutique hotel and associated restaurant (which includes external works to the existing North Pole public house) together with an onsite energy centre, improvements to the existing public realm at Wailer Way and new public realm, public art and onsite landscaping. A total of 57 car parking spaces plus 2 car club spaces and	B	100% complete & operational	100% complete & operational	100% complete & operational	ES states two year construction programme. Assume completion by Site Year 1 of construction on this basis.	Base case (all years)

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		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
				439 cycle spaces. **12/1580/F** Submission of part details pursuant to Condition 10 (Construction Management Plan) of planning permission dated 26/01/2012 (Ref:11/0271/F).						
Hilton's Wharf, 30 - 52 Norman Road, Greenwich, Note: not Mayoral referral development but included due proximity to site (potential new receptors).	35m north	10/2354/F & 10/2306/F (adjacent plots)	Durkan Estates Ltd	**10/2354/F:** Demolition of existing buildings and construction of 85 residential units, 1250m² of commercial (B1) floorspace and 2 live/work units in an part 7/part 8/part 9 storey building, underground car parking and associated access, landscaping and open space. **10/2306/F:** Demolition of existing buildings and construction of 85 residential units, 489.4m² of commercial floorspace and three live/work units in an eight storey building.	B	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – scale of development would suggest a construction period of max. two years. On this basis it is assumed to be completed/operational by Site Year 1 of construction.	Base case (all years)
Creekside Village East (Thanet Wharf), Copperas Street	120m north	DC/06/63352/X	Ampurius Nuhomes Investments Ltd	The demolition of existing buildings/structures on land bounded by Copperas Street, Deptford Creek and Creekside SE8 and the construction of 4 blocks of 9 to 22 storeys, to provide 11,466 m² of commercial floorspace, including a nursery and healthcare centre and uses within Use Classes B1, A1, A3, A4 and D1 and 9,000 m² of cultural/dance space, archive, exhibition areas and associated facilities for Trinity Laban and 430 residential units, underground car and cycle parking, open space, the reprofiling of the Creek walls and associated landscaping and Creekside walk.	C	Under construction	Under construction	100% complete & operational	ES states construction will take 36 months (3 years). LB of Lewisham have advised that construction will be completed in 2018/19..	**2016 & 2018:** Cumulative **2023:** Base case
Site of old Seagar Distillery and Norfolk House, 4-12 Deptford Bridge	Approx 250m southwest	DC/08/69448	Freshplant Ltd	The redevelopment of Seager Buildings Site, Deptford Bridge/Brookmill Road and the Norfolk House Site, Brookmill Road SE8, to provide a ground plus 26-storey residential tower, a part 5/part 6 storey building fronting Brookmill Road, a 5 storey stepped building rising to 11 storeys, a 3 storey courtyard building, two storey roof extension on Holland House fronting Deptford Bridge and the retention of International House, comprising 207 private residential units, 96 affordable homes, 7 live/work units and a total of 4,697 m² of commercial floorspace, including a	A	100% complete & operational	100% complete & operational	100% complete & operational	Anticipated to be complete 2012/13 based on a 35 month construction period. Permission was granted in 2009.	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
				café/restaurant, gymnasium, retail unit and art gallery, together with 60 basement car parking spaces, associated motor bike/scooter and 393 bicycle spaces and landscaping.						
Greenwich Reach East	Approx 400m northeast	05/1386/F	Greenwich Reach 2000 Ltd	Redevelopment comprising of 980 residential units class A uses, retail, food/drinks, class D1/D2 (non residential institution/assembly/leisure), B1 (business use), ancillary plant, servicing parking 712 cars works to extend/upgrade riverside walk, landscaping, alterations to vehicular/pedestrian access, highway layout, associated enabling work (schedule two dated 22/11/05).	B	100% complete & operational	100% complete & operational	100% complete & operational	No information available from planning application documentation. On the basis that the application has been permitted, it has been assumed that it will be built by Site Year 1 of construction.	Base case (all years)
Bardsley Lane (land at Creek Road/Bardsley Lane)	Approx 420m northeast	05/1222/F	Hyde Housing Ltd. and Andrew Thompson Standard Property Investment	Demolition of existing buildings & redevelopment to provide 106 residential units, A1, A2, A3 & A4 uses together with Class B1 & D1 uses, a nightclub (sui generis) in the basement area, basement parking provision & improvements to existing open space.	B	100% complete & operational	100% complete & operational	100% complete & operational	No information available from planning application documentation. On the basis that the application has been permitted, it has been assumed that it will be built by Site Year 1 of construction.	Base case (all years)
Heathside and Lethbridge Estate	Approx 750m southeast	DC/09/72554/X	Family Mosaic Housing / LB Lewisham	The redevelopment of the Heathside and Lethbridge Estates, Blackheath Hill and Lewisham Road, SE10 seeking outline planning permission (Phases 2-6) for up to 512 square metres of retail floorspace, 768 square metres of community floorspace, an energy centre and 1,054 residential units in buildings ranging from 3 to 17 storeys in height, together with car and cycle parking, associated highway infrastructure, public realm works and provision of open space and detailed planning permission (Phase 1) for the redevelopment of land fronting onto Blackheath Hill for 138 residential units in buildings ranging from 4 to 7 storeys in height, together with car and cycle parking, associated highway infrastructure, public realm works and provision of open space.	A	Under construction	Under construction	Under construction	LB of Lewisham have advised that construction will complete in 2023/24.	Cumulative (all years)
Land at Stockwell Street and John Humphries House, Greenwich	Approx 800m northeast	11/0226/F	University of Greenwich	Construction of a part 2/part 3/part 4 storey building with basement for Education use (D1) with ground floor Retail and Exhibition Space (all or any of use classes A1, A2, A3 and D1), and associated works.	A	100% complete & operational	100% complete & operational	100% complete & operational	Anticipated to be complete by 2014 following a 34 month construction period started in August 2011.	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions			Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2016 (Site Year 1 of construction)	2018 (peak construction traffic year)	2023 (Year 1 of operation)		
Land opposite North Greenwich Pier, Greenwich Peninsula, Greenwich	Approx 860m northeast	12/0860/F 12/1595/V	Skylon Flyer Ltd	12/0860F: Installation of a 35 metre high amusement attraction for a temporary period. 12/1595/V: Variation of condition 1 of planning permission dated 21/06/12 (ref: 12/0860/F) to extend the temporary time limit condition to 31 October 2012 in connection with the temporary installation of a 35 metre high amusement attraction.	B	100% complete & operational	100% complete & operational	100% complete & operational	Professional judgement – scale of development would suggest a construction period of max. one year. On this basis it is assumed to be complete/operational by Site Year 1 of construction.	Base case (all years)

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

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Thames Water Utilities Limited
Clearwater Court, Vastern Road, Reading RG1 8DB

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