Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

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

Lindsay Speed

Sarah Fairbrother

September 2014

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

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Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

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

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Appendix A: Introduction

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Appendix A: Introduction

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Appendix A: Introduction

A.1 Summary

A.1.1 This document presents the appendices that accompany the *Environmental Statement* Volume 9 King George's Park site assessment.

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

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

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

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

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Appendix B: Air quality and odour

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Appendix B: Air quality and odour

B.1 Model verification

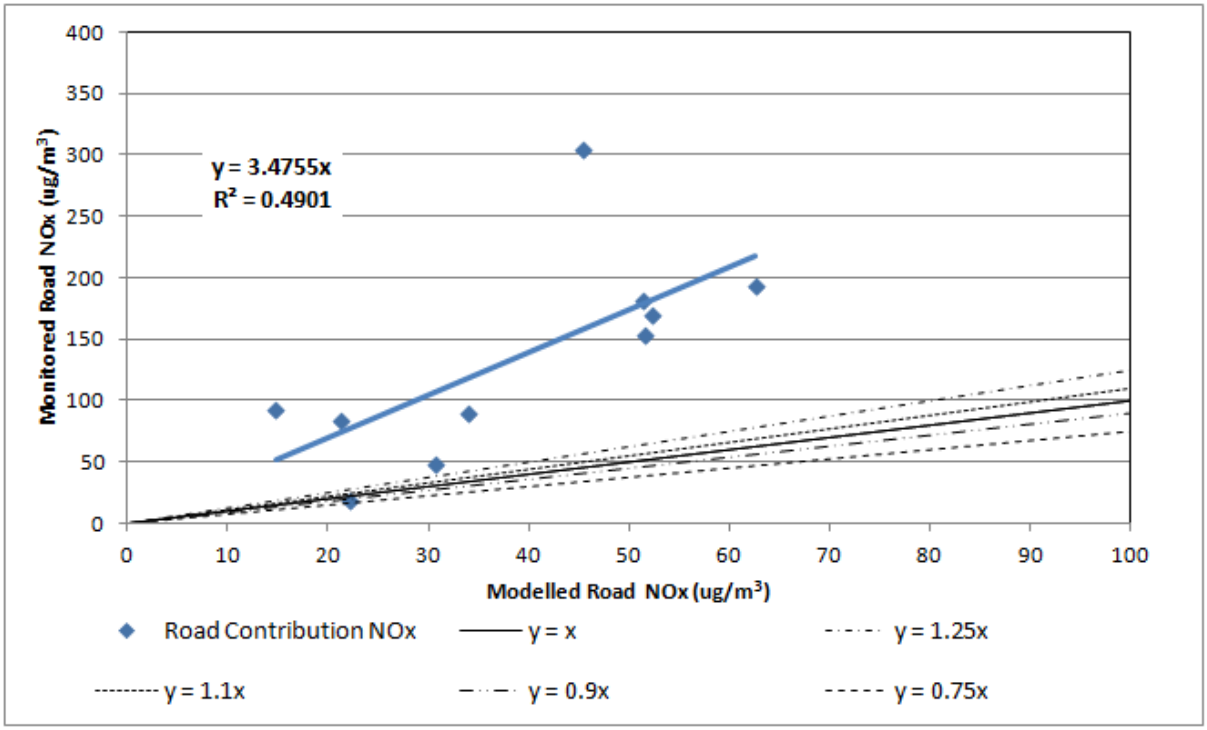
B.1.1 Modelled NO_2 concentrations have been plotted against monitored concentrations at ten diffusion tube sites (KGPM1–KGPM5, DSTM1-DSTM4 and W12/W13) as shown in Vol 9 Figure 4.4.1 (see separate volume of figures).

B.1.2 This showed that the modelled results underestimated NO_2 concentrations by between -3% and 50%. 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.

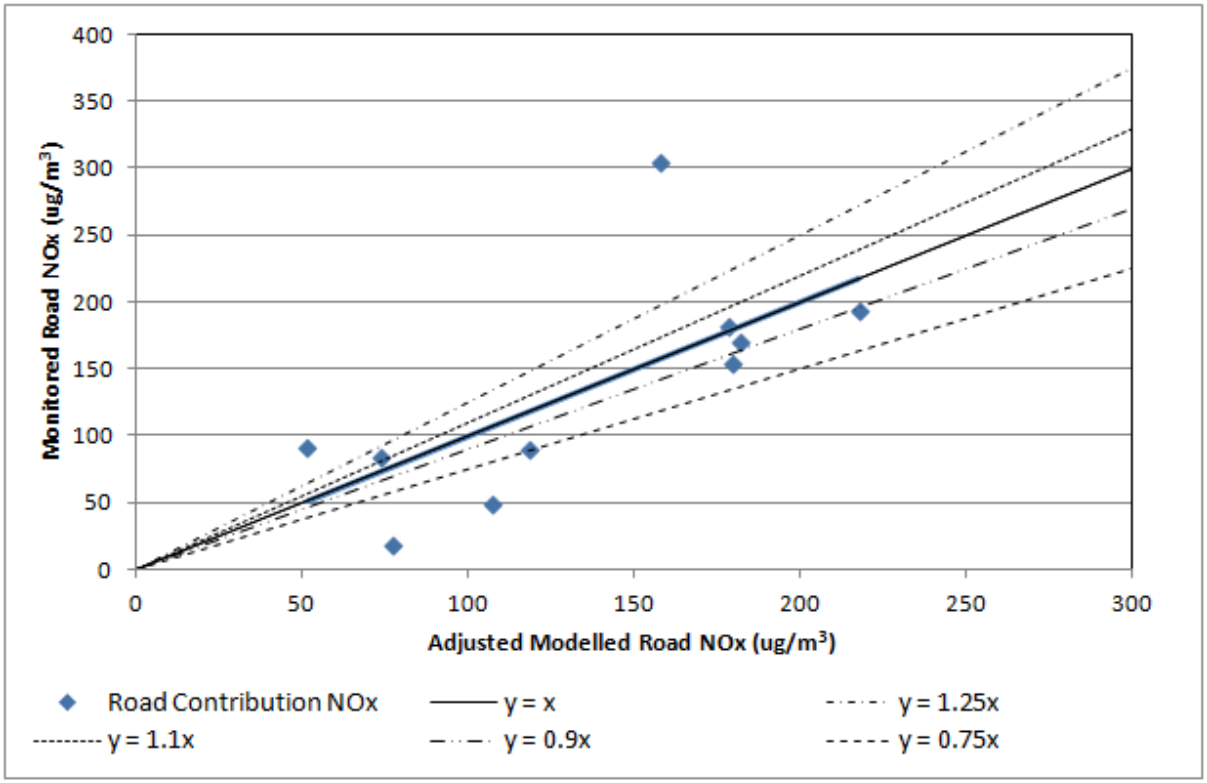
B.1.3 To derive the adjustment factor, modelled road NO_X concentrations were plotted against calculated monitored road NO_X concentrations (see Vol 9 Plate B.1 below). An adjustment factor of 3.48 was calculated for adjusting modelled roadside NO_X concentrations, in accordance with LAQM.TG(09)[1] and 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 9 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 9 Plate B.3, indicated that six of the ten modelled concentrations were within 10% of the measured value and that the other one was within 25% of the modelled value.

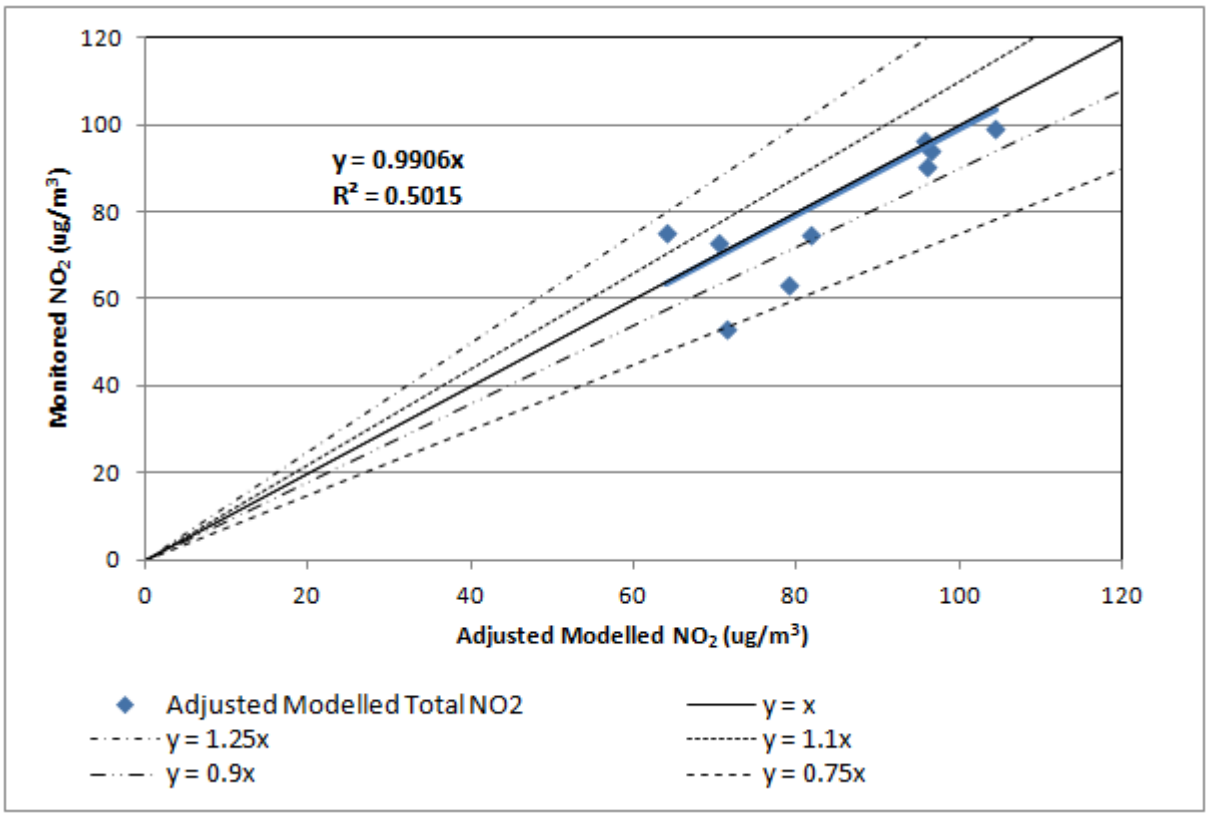
Vol 9 Plate B.1 Air quality - monitored road NO_X vs. modelled road NO_X



Vol 9 Plate B.2 Air quality – monitored road NO_X vs. adjusted modelled road NO_X



Vol 9 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 King George's Park site are shown in Vol 9 Table B.1.

Vol 9 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 construct-ion year develop-ment case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
Speed Limit	Neville Gill Close	3148	2.0%	30	30.0	4.7%	3297	0	3297	2.0%
TfL Model	Buckhold Road south of Neville Gill Close	18398	7.4%	30	27.7	4.7%	19268	0	19307	7.3%
TfL Model	Buckhold Road north of Neville Gill Close	18629	7.5%	30	27.7	4.7%	19510	6	19555	7.5%
TfL Model	Wandsworth High Street east of Buckhold Road	36965	8.5%	30	15.0	4.7%	38713	16	38797	8.6%
TfL	Wandsworth	38134	8.6%	30	15.0	4.7%	39937	16	40021	8.6%

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 construct-ion year develop-ment case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
Model	High Street west of Buckhold Road									
CTC** survey	Dormay Street	898	24.5%	30	30.0	4.7%	941	16	957	25.7%
CTC survey	The Causeway	251	25.8%	30	30.0	4.7%	262	0	262	25.8%
CTC survey	Armoury Way A217	44821	10.4%	30	27.9	4.7%	46941	16	47029	10.4%
CTC survey	Armoury Way A217	44782	10.4%	30	27.9	4.7%	46900	16	46988	10.4%
CTC survey	Ram Street	8540	14.7%	30	6.9	4.7%	8944	8	8955	14.8%
CTC survey	Old York Road A217	38317	10.9%	30	9.7	4.7%	40129	8	40206	10.9%
ATC*** survey	Swandon Way A217	28975	12.2%	30	32.1	4.7%	30345	14	30359	12.3%
TFL model	Fairfield Street A3	38672	3.2%	30	18.5	4.7%	40501	6	40541	3.2%

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 construct-ion year develop-ment case (total AADT)	Peak construct-ion year develop-ment case AADT % HGV (>3.5t)
TFL model	Wandsworth High Street A3	51226	5.4%	30	12.7	4.7%	53648	8	53727	5.4%
TFL model	Garratt Lane A217	18398	1.7%	30	32.4	4.7%	19268	0	19283	1.7%
TFL model	Wandsworth Plain A217	6639	4.5%	30	9.6	4.7%	6953	2	7005	4.5%
TFL model	Wandsworth High Street A3	56235	4.9%	30	14.1	4.7%	58894	14	58933	5.0%
TFL model	Putney Bridge Road A3209	52410	4.6%	30	30.2	4.7%	54889	12	54921	4.7%
TFL model	Armoury Way A217	51865	3.6%	30	12.5	4.7%	54318	14	54356	3.6%
TFL model	Merton Road	54458	3.8%	30	24.6	4.7%	57033	0	57036	3.8%
TFL model	Wandsworth Hill A3	83830	3.7%	30	10.8	4.7%	87794	24	87822	3.7%

** 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 9 Table B.2 has been modelled for the peak construction year at the King George's Park site.

Vol 9 Table B.2 Air quality - construction plant assessment model inputs

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Site set up and general site	Ground level behind hoarding	Compressor 250cfm*	1	50	104	8.5×10^{-7}	5.3×10^{-8}
	Ground level behind hoarding	Generator - 200kVA	1	100	160	2.6×10^{-6}	1.6×10^{-7}
	Ground level behind hoarding	JCB with hydraulic breaker	1	50	67	5.5×10^{-7}	3.4×10^{-8}
	Ground level behind hoarding	Cutting equipment (diamond saw)	2	10	2.3	1.2×10^{-7}	1.1×10^{-8}
	Ground level behind hoarding	Telescopic handler / FLT**	1	30	60	2.9×10^{-7}	1.8×10^{-8}
	Ground level behind hoarding	Hiab*** lorry/crane	1	5	56	4.6×10^{-8}	2.8×10^{-9}
	Ground level behind hoarding	Well drilling rig	1	50	403	3.6×10^{-6}	2.3×10^{-7}
Piling	Ground level behind hoarding	100t crawler crane	1	50	240	2.0×10^{-6}	1.2×10^{-7}
	Ground level behind hoarding	25t mobile crane	1	50	275	2.2×10^{-6}	1.4×10^{-7}

Construction activity	Typical location	Typical plant	Unit No(s)	% on-time	Power (kW)	NO_X emission rate ($g/s/m^2$)	PM_{10} emission rate ($g/s/m^2$)
Shaft sinking by sprayed concrete lining	Within excavation	Shotcrete robot	1	20	14	7.3×10^{-7}	6.8×10^{-8}
	Ground level behind hoarding	Concrete deliveries (agitating)	1	80	223	2.9×10^{-6}	1.8×10^{-7}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	7.3×10^{-7}	4.5×10^{-8}
	Ground level behind hoarding	12t excavator	1	80	66	8.6×10^{-7}	5.4×10^{-8}
	Ground level behind hoarding	100t crawler crane	1	80	240	3.1×10^{-6}	2.0×10^{-7}
	Ground level behind hoarding	25t mobile crane	1	20	275	9.0×10^{-7}	5.6×10^{-8}
	Ground level behind hoarding	25t excavator	1	50	125	1.0×10^{-6}	6.4×10^{-8}
	Ground level behind hoarding	400cfm compressor	1	50	104	8.5×10^{-7}	5.3×10^{-8}
Shaft secondary lining	Ground level behind hoarding	100t crawler crane	1	50	240	2.0×10^{-6}	1.2×10^{-7}
	Ground level behind hoarding	Service cane 40t mobile Crane	1	25	275	1.1×10^{-6}	7.0×10^{-8}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	7.3×10^{-7}	4.5×10^{-8}
	Ground level behind hoarding	Concrete pump	2	20	223	1.5×10^{-6}	9.1×10^{-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 ($g/s/m^2$)
Culvert works	Ground level behind hoarding	Service crane – 100t mobile crane	1	50	280	2.3×10^{-6}	1.4×10^{-7}
	Ground level behind hoarding	25t excavator	1	50	125	1.0×10^{-6}	6.4×10^{-8}
	Ground level behind hoarding	Dumper	1	50	81	6.6×10^{-7}	4.1×10^{-8}
	Ground level behind hoarding	Concrete deliveries (discharging)	1	20	223	7.3×10^{-7}	4.5×10^{-8}
	Ground level behind hoarding	Concrete boom pump	1	20	223	7.3×10^{-7}	4.5×10^{-8}

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

References

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

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Appendix C: Ecology - aquatic

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Appendix C: Ecology – aquatic

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.1.16 A Phase 1 Habitat Survey was carried out on 24 November 2010 at the King George's Park site as shown on Vol 9 Figure 6.4.2 (see separate volume of figures). Based on this, surveys for the following species have been undertaken:

a. bats

b. wintering birds.

D.1.17 The purpose of the surveys is to determine the presence or likely absence of these species at and around the site.

D.1.18 This report presents the survey findings. The survey area for each species is described with reference to the habitat types identified during the Phase 1 Habitat Survey as having potential for notable species (see paras. D.1.20 to D.1.26). The results from the surveys are then presented (see paras. D.1.27 to D.1.35). The final section provides an interpretation of the results (see paras. D.1.41 to D.1.46). Figures referred to in this report are contained within Vol 9 King George's Park Figures.

D.1.19 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 volume.

Survey area

Bats

D.1.20 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.1.21 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, two locations were chosen for the installation of the remote recording devices as shown on Vol 9 Figure 6.4.3 (see separate volume of figures).

D.1.22 Location one is to the north of the site on the northeast boundary of King George's Park. This location was selected to record potential bat activity associated with roosting within the King George's Park, in addition to foraging and commuting along the tree-lines in this area and to record the movement of bats entering and leaving the site along this boundary.

D.1.23 Location two is to the west of the site on the northwest boundary of the site. This location was also selected to record potential bat activity associated with roosting within the King George's Park, in addition to foraging and commuting along the tree-lines in this area.

D.1.24 The bat activity recorded during the remote recording surveys triggered the need for an additional dawn survey (see Vol 2 Methodology for bat triggering criteria). Therefore, a second stage of bat surveying was undertaken, comprising one dawn survey visit by two ecologists to assess the usage of the site and immediate surrounds by bats. The survey area for the bat activity (dawn) surveys, is shown in Vol 9 Figure 6.4.3 (see separate volume of figures). The survey area includes the site and the wider park to the east, south and west.

D.1.25 The third stage comprised an additional bat triggering survey. This was undertaken to determine whether the dawn recordings, associated with the first remote recording survey (first stage), were associated with mature trees on site (locations 3 and 4), or with a roost identified off site during the dawn activity survey (second stage). A dusk emergence and dawn re-entry survey would have been preferable for the third stage, but this was not possible due to safety concerns associated with surveying at this location at night. Therefore, stage three comprised the installation of remote recording devices on trees within the site boundary. The trees were chosen as they displayed features considered to be suitable for roosting bats (location three and location four on Vol 9 Figure 6.4.3).

Wintering birds

D.1.26 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. One wintering bird survey visit was undertaken on 13 December 2010. The survey area is shown on Vol 9 Figure 6.4.4 (see separate volume of figures). The survey includes the site and the waterbody to the south of the site, where wintering birds may rest and forage.

Results

D.1.27 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.1.41 to D.1.46.

Desk Study

D.1.28 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 9 Table D.1.

Vol 9 Table D.1 Terrestrial ecology – species found within 500m of the site between 2001 - 2011

Common name	Latin name	Record count
Mammals		
West European hedgehog	*Erinaceus europaeus*	7
Birds		
Herring gull	*Larus argentatus*	1
Common kingfisher	*Alcedo atthis*	5
Yellow wagtail	*Motacilla flava*	2
Song thrush	*Turdus philomelos*	1
Common starling	*Sturnus vulgaris*	5
House sparrow	*Passer domesticus*	23
Amphibians		
Smooth newt	*Lissotriton vulgaris*	2
Common toad	*Bufo bufo*	1
Common frog	*Rana temporaria*	18
Invertebrates		
Stag beetle	*Lucanus cervus*	39
Cinnabar moth	*Tyria jacobaeae*	2

Bat surveys

Bat triggering (remote recording) surveys

D.1.29 The bat triggering (remote recording) surveys were undertaken between 17 and 19 May 2011 in suitable weather conditions (Vol 9 Table D.2).

D.1.30 The survey experienced an equipment failure on two out of the three nights of surveying, at location two. The absence of data from this failure is not considered to compromise the robustness of the assessment. It is considered that the data collected at location one, the single night of data at location two and the completion of a dawn activity survey on the site ensures that adequate data was obtained over these surveys to enable a robust assessment of effects to be undertaken.

D.1.31 The remote recording surveys undertaken at this site recorded three species of bats using the site, common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pygmaeus)* and Noctule (*Nyctalus nyctalus).*

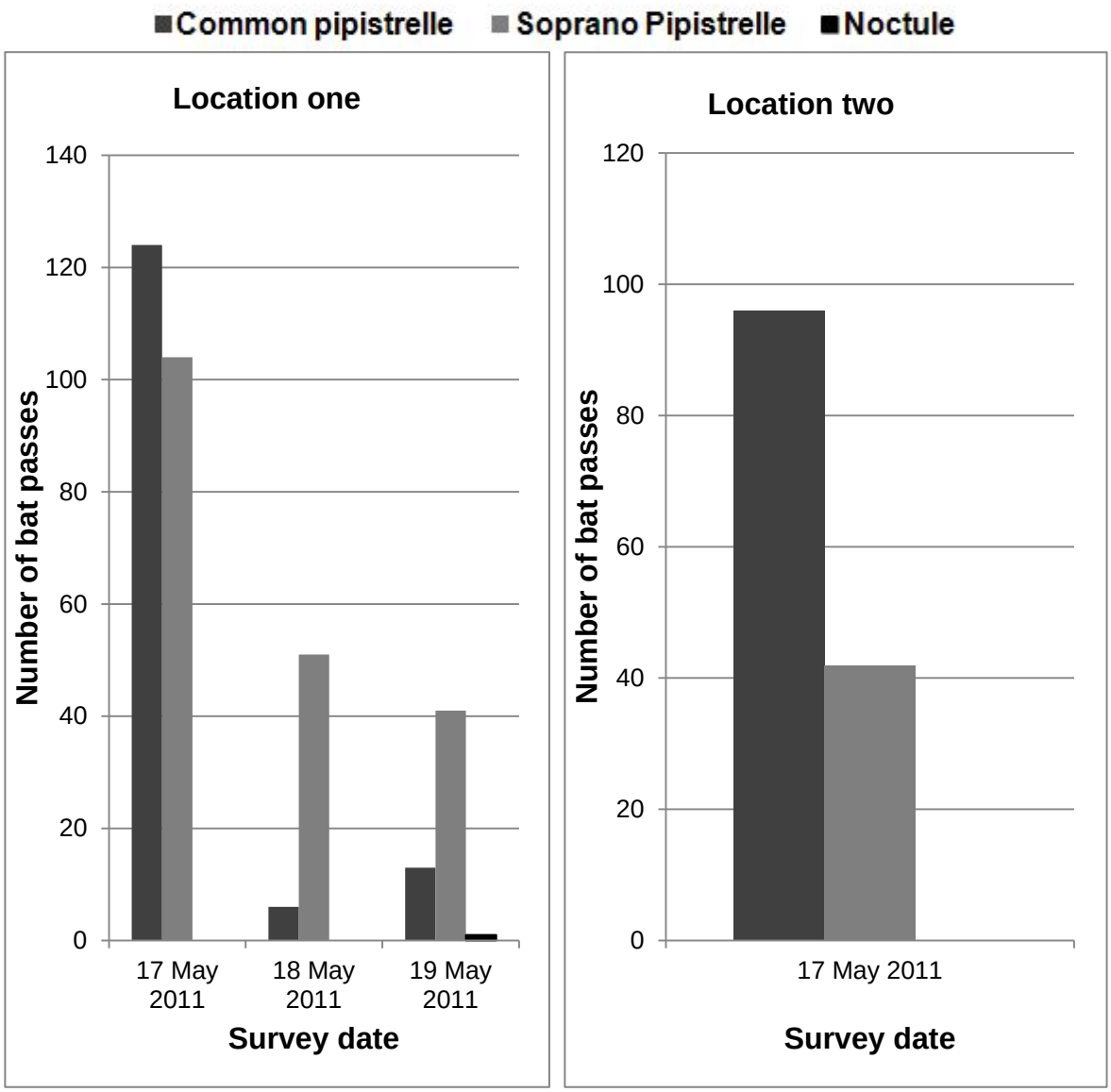
D.1.32 Common pipistrelle was the most commonly recorded species using the site with a maximum number of passes per night of 124 at location one and 96 at location two (Vol 9 Plate D.1). Soprano pipistrelle were also recorded at moderately high numbers with a maximum number of passes

per night of 104 at location 1 and 42 at location two. Noctule was recorded in single numbers and only on one survey night.

Vol 9 Table D.2 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
17 May 2011	12°C, moderate breeze, 80% cloud cover, dry
18 May 2011	13°C, moderate breeze, 60% cloud cover, dry
19 May 2011	10°C, light breeze, 70% cloud cover, dry

Vol 9 Plate D.1 Terrestrial ecology – bat passes recorded during remote recording surveys at locations one and two at King George's Park site



Bat activity (dawn) surveys

D.1.33 As there were high numbers of bats recorded during the remote recording survey and more than two species were recorded, this triggered the need for a bat activity (dawn) survey to be undertaken (based on bat triggering

criteria in Vol 2 Section 6). The bat activity survey was undertaken on 1 July 2011 in suitable weather conditions (14^{o}C, calm, 60% cloud cover, dry). The bat activity survey results are shown on Vol 9 Figure 6.4.3 (see separate volume of figures).

D.1.34 The activity (dawn) survey identified common pipistrelle activity within an hour of dawn and a small common pipistrelle roost was confirmed off site to the south of the lake where one pipistrelle bat entered a group of trees at dawn. Foraging activity of common pipistrelle was recorded along the tree line on the eastern boundary of King George's Park.

D.1.35 Soprano pipistrelle and noctule bats were not recorded during the dawn survey.

Additional remote recording surveys

D.1.36 Additional remote recording surveys were undertaken within King George's Park to confirm whether there is a bat roost present on site. The surveys were undertaken in suitable weather conditions (Vol 9 Table D.3).

D.1.37 A remote recording surveys were undertaken on 25 September 2012, and the 3 to 4 October 2012. The remote recording device equipment failed at location four on 25 September 2012. However, the remote recording device at location three recorded a high level of bat activity. Due to the high level of activity, the batteries drained at approximately 03:40am and the device ceased recording at this time. This is approximately 3 hours prior to dawn when bats typically return to their roosts for the day. Therefore, remote recording devices were installed again on the 3 October to the 4 October 2012. These successfully recorded for one night.

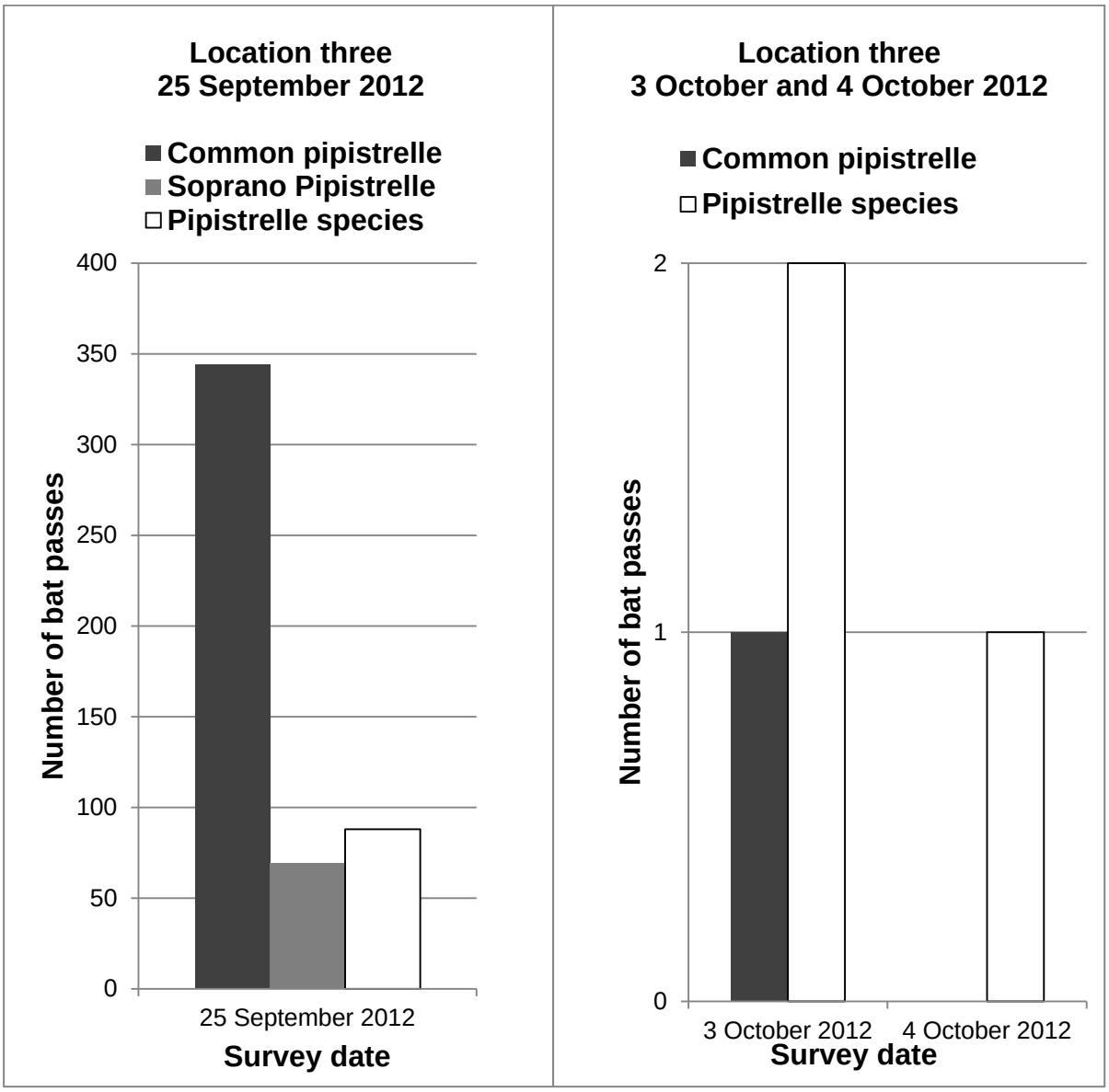
D.1.38 On 25 September 2012 at location three, 344 common pipistrelle bat passes were recorded with 41 of these within 30 minutes after sunset when bats typically leave their roosts for the night. A total of 69 soprano pipistrelle bat passes were recorded, with nine of these within 30 minutes after sunset. A further 88 pipistrelle bat passes were recorded, with none of these within 30 minutes after sunset. It was not possible to determine from the electronic recordings which pipistrelle species these were.

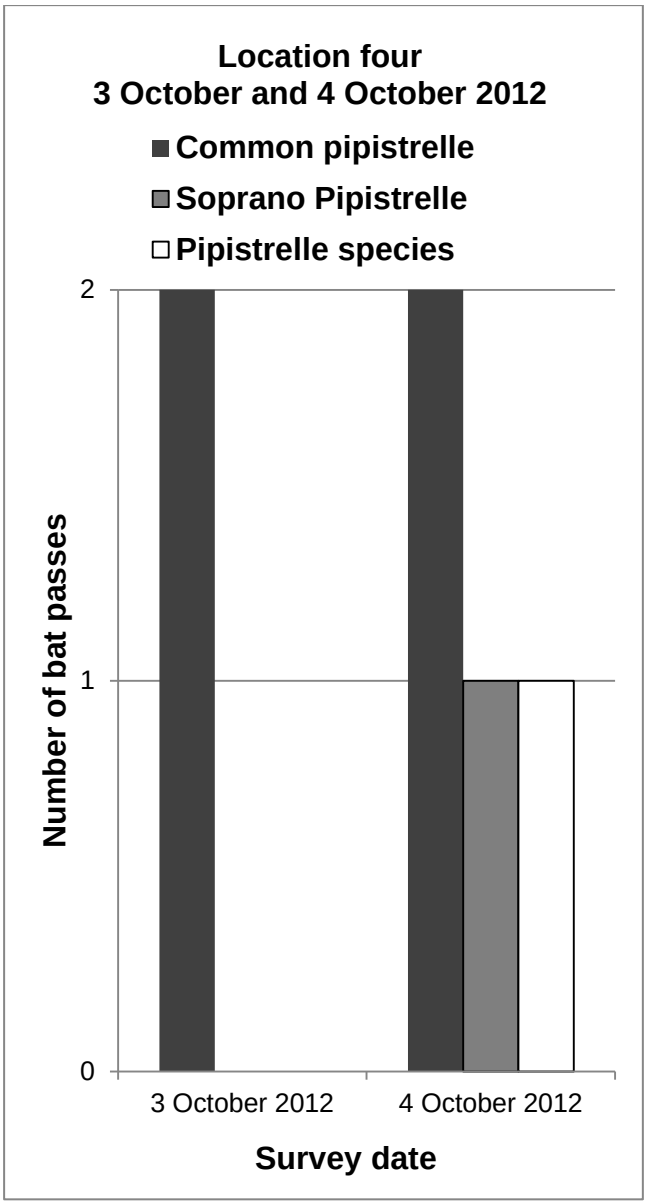
D.1.39 On the 3 October, low levels of activity were recorded at both locations, with a maximum bat pass count of two common pipistrelle, two soprano pipistrelle and one unidentified pipistrelle species. One pipistrelle bat was recorded at both locations within 30 minutes after sunset. No records were close to dawn.

Vol 9 Table D.3 Terrestrial ecology – bat survey weather conditions

Survey visit	Weather conditions
25 September 2012	11^{o}C, moderate breeze, no cloud cover, dry
3 October 2012	14^{o}C, moderate breeze, 50% cloud cover, dry
4 October 2012	10^{o}C, light breeze, no cloud cover, dry

Vol 9 Plate D.2 Terrestrial ecology – bat passes recorded during remote recording surveys at locations three and four at King George's Park site





Wintering birds

D.1.40 No notable wintering bird species were recorded on or in close proximity to the site.

Interpretation

Bats

D.1.41 The remote recording survey and dawn activity survey results indicate that the site and the wider King George's Park provides a foraging resource for common pipistrelle bats. The remote recording surveys from 2011 and 2012 indicate that the trees on site are likely to provide roost sites for common pipistrelle bats, used intermittently through the active season of April to October. The high bat pass count recorded on the 25 September 2012 suggests that bats roost and forage on and adjacent to the site.

D.1.42 During the dawn survey, a common pipistrelle roost was identified near to the site, within a group of trees on the southern side of the lake.

D.1.43 During remote recording surveys undertaken in 2011, soprano pipistrelle bats were recorded in moderate numbers with a maximum number of soprano pipistrelle bats passes in one night of 104 at location one. The majority of calls occurred later in the night between midnight and dawn. No records were close to sunrise or sunset and soprano pipistrelle bats were not recorded during the dawn survey.

D.1.44 The remote recording surveys undertaken in 2012 recorded a lower number of soprano pipistrelle bat passes overall, but a higher number of passes within 30 minutes after dawn. These results suggest that there is a soprano pipistrelle roost on site but this is likely to be used intermittently through the active season of April to October. The results also indicate that the site and surrounding area is used by soprano pipistrelles as foraging habitat and soprano pipistrelle bats may commute through the site.

D.1.45 Noctule was recorded using the site only on one occasion during the remote recording surveys at location one when a single bat pass was recorded. This species was not recorded during the dawn survey. This suggests that small numbers of noctule bats occasionally visit the site for foraging and/or commuting purposes.

Wintering birds

D.1.46 Given the proximity of the site to the River Thames, the habitats on site, and desk study data, the site was considered potentially suitable for wintering birds. However, the initial wintering bird survey recorded no notable wintering bird species on or in close proximity to the site. This is likely to be due to disturbance within this part of the park, which is subject to recreational usage including dog walking.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

Appendix E: Historic environment

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

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 9 King George's Park appendices

Appendix E: Historic environment

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Appendix E: Historic environment

E.1 Gazetteer of known heritage assets

E.1.1 Details of known heritage assets within the assessment area are provided in Vol 9 Table E.1below, with their location shown on the historic environment features map (Vol 9 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. Where appropriate, the table includes the asset's reference number from the Greater London Historic environment Record (GLHER) and / or the fieldwork site code allocated by the London Archaeological Archive and Research Centre.

Vol 9 Table E.1 Gazetteer of known heritage assets within the site and assessment area

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
1A	King George's Park. Laid out between 1921–23 by Stephen Percival (Percy) Cane (1881–1976) and opened by King George V in 1923.	-
1B	Ornamental gateway and railings at the northern extent of King George's Park.	-
1C	Possibly artificial water channel shown crossing the site on the Ordnance Survey 1st edition 25" scale map of 1866	-
2	Territorial Army Centre, Buckhold Road, SW18. An archaeological evaluation and excavation by Museum of London Archaeology Service (MoLAS, now MOLA) in 1992. The site lies on the western edge of the Wandle Valley. London Clay was cut by two ditches, either field boundaries or drainage ditches, which predated a building interpreted as a boathouse, erected in the second half of the 17th century and completely rebuilt in the early 18th century. Both were constructed of brick, though the eastern wall of the later one may have been of timber; a Flemish tiled floor survived in this later building. Outside the east end of the building was a timber-lined watercourse, while to the north two watercourses were located: one containing 18th-century material may have represented a diversion eastwards towards the River Wandle after the demolition of the	TAW92

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	boathouse, probably in the late 18th century.	
3	The site of the early medieval to 16th-century settlement of Wandsworth. The point is located by the GLHER c. 180m south of the High Street but the settlement is more likely to have grown up in the vicinity of the river crossing and church.	025283
4	Wandsworth Business Village, 3–9 Broomhill Road, SW18. An archaeological evaluation by Sutton Archaeological Services (SAS) in 2007. One trench was excavated, revealing the remains of a 19th-century wall and cobbled surface above the natural clay. Made-ground, from which medieval, 17th–18th and 19th-century material was recovered, was recorded above the clay, as were modern services.	WBV07
5	Stimpsons Buildings. An archaeological excavation by Wandsworth Historical Society (WHS) in 1969. The site of a building, a wall, a sewer dating from the medieval to the 17th century and a quay, timber piles, a midden and a dump deposit all dating to the post-medieval period. Recorded on the GLHER.	13013 13015 13127 23323
6	Site of Upper Mill. Documentary evidence for the site of one or two mills in 1559, probably two of the mills mentioned in Domesday Book. An oil mill that was used to grind corn after 1776, was rebuilt as corn mill in c. 1818 and burnt down in 1926. WHS excavation of the 'Eastern Upper Mill' in 1973 revealed brick culverts and masonry.	11669 11671 23329 8209 WAN1/73
7	Garratt Lane (Arndale Centre) Wandsworth, SW18. A geoarchaeological investigation carried out by MoLAS in 2001. Deposits spanning the Mesolithic to modern periods were excavated. Although no archaeological finds and features were encountered, environmental remains have provided a reconstruction of the changing environment of the site and its surroundings and indirect evidence of past human activity.	GLW01
8	Wandsworth Workshop, 85–89 Garratt Lane, SW18. An archaeological watching brief by Compass Archaeology (CA) in 2000. Alluvial deposits of the River Wandle were located during hand augering; they appeared to be a mixture of undisturbed and redeposited material.	GTN00
9	177 Wandsworth High Street, SW18. An archaeological evaluation by CA in 2005. Two fairly large pits produced evidence for early and later 18th-century occupation,	WDI05

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
	probably relating to houses on the adjacent High Street. There was no indication of commercial activity. The pottery was mainly of common domestic wares, but included one notable item in the form of a large slipware dish made in Isleworth or at Hanworth Road, Hounslow. Elsewhere modern activity had removed most deposits and had truncated the natural gravel.	
10	1–9 Hardwick's Way, SW18. An archaeological evaluation by SAS in 2002. The natural gravel was overlaid by 19th–20th-century made ground.	HWK02
11	2–6 Hardwick's Way, Wandsworth, SW18. An archaeological evaluation by SAS in 2004. Modern concrete and make-up were revealed above the natural gravels, the latter probably having been cut for gravel extraction in the area behind the High Street. In one of the trenches were found the patchy remains of several floors of a building which had been cut by four pits and a brick wall, all dated to the 18th century. Other pits and make-up seem to date to 16th–18th century. A 19th-century pit was also recorded.	HKW04
12	The chance find of a Palaeolithic flint flake. Recorded on the GLHER.	12247
13	The chance find of a Palaeolithic flint flake and a Roman spoon. Recorded on the GLHER.	10416 13100
14	Church of All Saints, Wandsworth High Street. Grade II listed.	1357684
15	The chance find of a medieval dagger, a Roman knife, a medieval horse harness, an Iron Age blade and an unclassified Roman object. Recorded on the GLHER.	11010 13106 23215 24668 24774
16	The chance find of a Bronze Age blade. Recorded on the GLHER.	10472
17	The chance find of a Bronze Age spear head. Recorded on the GLHER.	031273
18	The chance find of a number of Palaeolithic flint flakes. Recorded on the GLHER.	11967
19	The projected line of a medieval road.	---
20	Down Lodge, Merton Road. Grade II listed.	1357650
21	The Brewery Tap, Ram Street. Grade II listed.	1391087

HEA Ref no.	Description	Site code/ GLHER ref/ List Entry Number
22	The Spread Eagle Public House, Wandsworth High Street. Grade II listed.	1065502
23	Old County Court House, 11 Garratt Lane. Grade II listed.	1065530
24	140–142 Wandsworth High Street. Grade II listed.	207201
25	1–6 Church Row. Grade II* listed.	207002
26	70 Wandsworth High Street. Grade II listed.	207171
27	Former Ram (Youngs) Brewery Complex. Grade II* listed.	207172
28	23, 25, 27, 29 and 32 West Hill. Grade II listed.	207176 207177 207178
29	Remains of the footings of the Bazalgette sewer aqueduct (Southern High Level Extension).	
30	Line of the Bazalgette Southern Lower Level sewer.	
31	A MoLAS watching brief at Wandsworth High Street Bridge in 1993 during renovation. Timber piles and a baseplate were found on the west bank, interpreted as belonging to either the bridge known to have crossed the river before 1569 or, more likely, its replacement dating from 1602. 18th-century brick footings associated with the bridge approach were recorded. The river wall and abutment of a bridge dating to 1820 was found to have been incorporated into the present structure. No structural evidence pre-dating the 1820 bridge was recorded on the eastern bank, suggesting that the river extended further to the east prior to this date. Considerable deposits of organic silt along with environmental evidence of early post-medieval date were recorded. All archaeological material was disturbed by services and sealed by 19th and 20th-century road surfaces.	WWD93
32	The Surrey Iron Railway, which opened in 1803, connected the Thames with Croydon and Merstham, using horse-drawn carts on iron rails. It was the first railway run by a public company independent of a canal or other enterprise. Running south from Wandsworth High Street the line crossed the Wandle from east to west and passed to the west of the Upper Mill and mill pond. The line closed in 1846.	

E.2 Site location, topography and geology

Site location

E.2.1 The site is located in the northern part of King George's Park, bounded by Buckhold Road to the northwest, Neville Gill Close to the northeast and a pathway and lake in St George's Park to the south. The site lies c. 200m to the west of the current course of the River Wandle and c. 800m to the south of the River Thames.

Topography

E.2.2 The area is generally flat with a slight slope down towards the lake at the southern edge of the site. The northeast corner of the site lies at c. 105.1m ATD (above Tunnel Datum; the equivalent of 5.1m above Ordnance Datum) the southeast corner lies at c. 104.5m ATD, the southwest corner lies at c. 104.7m ATD and the northwestern edge lies at c. 105.2m ATD.

Geology

E.2.3 The site is situated at the western edge of the floodplain of the Wandle where alluvial deposits overlie sands and gravels (British Geological Survey digital data)[1]. Geoarchaeological investigation locally (**HEA 7**) has found that the alluvium consists of clays, silts and peats deposited by the river during the last 10,000 years, from the Mesolithic to post-medieval period. The Wandle is a major tributary of the Thames with the confluence of the two rivers only some 800m to the north.

E.2.4 The site lies on the western edge of the Wandle valley floodplain. The western boundary of the site runs close to the edge of the Kempton Park river terrace gravels. The river terrace forms the lowest step of the valley side, which stretches c. 30m west from the edge of the site, to where the valley side is underlain by Head (a sand and gravel slope deposit) at the base of an isolated outcrop of Hackney gravels[2]. Floodplain / valley side marginal locations such as this would have been advantageous from the prehistoric period, offering easy access to the resources of the floodplain for people settling on the higher, drier ground nearby. The geology would also have influenced the development of agriculture, as soils developing on silt and gravel Head deposits are easy to cultivate, being permeable and well drained, with the wetter areas of the floodplain eventually used as seasonal pasture.

E.2.5 If waterlogged deposits exist on the site they would have good potential to preserve indirect evidence (from pollen, plant remains and insects) for past activity taking place on the adjacent valley side; as well as direct evidence for exploitation of the floodplain and its channels (such as timber revetments, fish-traps and so forth).

E.2.6 Borehole logs are sparse for the area as a whole with only three on or within 300m of the site. The only one within the site (SA1110) was located close to its southwestern edge and showed made ground 4m in depth directly overlying London Clay. The absence of alluvium indicates truncation; the borehole may have been sunk in the footprint of a former

drainage channel (possibly one that fed into the lake). This is likely to be an anomalous result, probably reflecting a modern intrusion and therefore not representative of the deposit sequence present elsewhere on the site.

E.2.7 Some 40m to the north of the site in an area with similar topographical characteristics, a borehole (SR1109) indicates sandy gravels overlying the London Clay up to 101.0m ATD, overlain by alluvium in the form of slightly gravelly sandy clay to 102.5m ATD, which in turn was overlain by undated made ground to 105.5m ATD. The borehole indicates that the clays retain shells and organic matter. Similar sequences to that recorded in SR1109 might exist in non-truncated parts of the site. Slope deposits – perhaps interfingering with alluvium – might be found with potential for snails and organic remains useful for past environment reconstruction, and with possible survival of organic artefacts and structures. The tentative suggestion from the limited geotechnical data is that because the site lies on the western edge of the floodplain there are not deep alluvial deposits with organic preservation.

E.3 Past archaeological investigations within the assessment area

E.3.1 Eight archaeological investigations have been carried out within the 300m-radius assessment area around the site, although none have been within the site itself. The nearest investigation was an evaluation and excavation by MoLAS (now MOLA) at the Territorial Army Centre (**HEA 2**), c. 40m to the northeast, in 1992. This recorded post-medieval field boundaries or drainage ditches, including a timber-lined watercourse, predating a possible late 17th-century boathouse.

E.3.2 In 2007, an archaeological evaluation by SAS (**HEA 4**), c. 50m to the north of the site, revealed later medieval and post-medieval finds, in addition to a 19th-century wall and cobbled surface.

E.3.3 Other archaeological investigations within assessment area (see the historic environment features map; Vol 12 Figure 7.5.1 in separate volume of figures), recorded evidence of a 17th-century quay along the River Wandle, and 18th and 19th-century occupation and quarrying, as well as geoarchaeological deposits relating to the river dating back to the prehistoric period. 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 River Wandle is one of the oldest rivers in the Thames system, existing prior to the diversion of the Thames from its earlier course across East Anglia, and would have attracted prehistoric hunters, foragers and settlers. Chance finds of Palaeolithic worked flints have been found over a number of years around the mouth of the River Wandle and along the Thames foreshore, c. 860m to the north of the site and also on the valley sides (Greenwood, 2009)[3].

E.4.3 During the prehistoric period, the floodplain of the River Wandle would have consisted of numerous multi-threaded freshwater river channels, some redundant and some active, winding around islands of higher, drier, gravels. The redundant channels commonly would infill with organic clays and peats creating areas of shallow standing water. The active channels would have been relatively swift flowing, with reasonably clear water flowing across a floodplain that was open and scrubby and not yet wet and marshy, although the floodplain would have become increasingly marshy over time as water levels rose. The site and much of the assessment area to the east is likely to have been too wet for settlement, but was probably exploited for a range of wetland resources, with any settlement taking place on the drier ground to the west. In wetland areas wooden trackways were sometimes constructed to provide access between gravel islands on the floodplain, or platforms to use as a base for hunting. Water was associated with certain religious or votive practices and ritual deposits of metals and other objects may also be found near wooden trackways or other structures.

E.4.4 Deposits laid down by the River Wandle were recorded during a geoarchaeological investigation at Garratt Lane (**HEA 7**), c. 140m to the southeast of the site. The earliest of these deposits were dated to the Mesolithic and suggest the potential for survival of Mesolithic and possibly later prehistoric archaeology and environmental evidence within the alluvium of the site.

E.4.5 Evidence for human activity within the assessment area during the prehistoric period is, however, limited to isolated chance finds including Palaeolithic flint flakes (**HEA 12**, **HEA 13** and **HEA 18**), c. 180m to the north of the site and c. 200m to the south; a Bronze Age blade (**HEA 16**), c. 210m to the northeast, a Bronze Age spearhead (**HEA 17**), c. 240m to the northeast, and an Iron Age blade (**HEA 15**), c. 190m to the north of the site. The significance of these isolated discoveries is uncertain. Many of the finds are likely to have been deposited by the River Wandle and may be residual (i.e., found outside of the context that they were originally deposited), but they suggest prehistoric activity in the area, probably based on the dry valley sides and exploiting the resources of the floodplain.

Roman period (AD 43–410)

E.4.6 The site lay c. 8.8km to the southwest of the Roman town of *Londinium*, which grew up in the mid 1st century AD in the area of the modern City of London. The relationship of *Londinium* to settlements in its hinterland was symbiotic. Small nucleated settlements, typically located along the Thames and the major roads which radiated out from *Londinium*, acted both as markets and as producers for the town (Museum of London Archaeology Service, 2000)[4].

E.4.7 Although no evidence of Roman settlement has been found at Wandsworth, it has been suggested that the High Street originally followed the line of an east-west Roman road that branched off the major route later known as Stane Street, c. 3km to the east, in the area of Clapham (Farrant, 1975)[5]. There is evidence for an east-west road through Mortlake and Putney to the west, which may have formed part of the same road (Gerhold, 1998)[6]. The road is likely to have attracted settlement and other activity, particularly near its crossing of the Wandle. Despite the presence of the possible road and suitable topographical and geological conditions, evidence of Roman activity in Wandsworth has been elusive to date, comprising a small number of isolated Roman objects largely found by chance.

E.4.8 Evidence for Roman activity in the assessment area is limited to an isolated chance find of a knife and an unclassified object (**HEA 15**), found c. 190m to the north of the site. The site was probably located on the bank of the River Wandle which, by this time, had developed into a largely single channel river, situated in marsh or fenland prone to flooding. Increasingly, the periphery of the floodplain is likely to have been cleared and used as grazing particularly during the summer months.

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

E.4.9 Wandsworth (Wendleswurthe - 'Wendel's farm') is first mentioned in AD 693 when it is referred to as a single large estate, granted to the nuns of Barking Abbey, and covering much of the area of modern Battersea and Wandsworth (Gerhold, 1998)[7]. It reverted back to the Crown following the destruction of the Abbey by the Danes (Victoria County History,1967)[8], and Domesday Book (1086) records that the manor (estate) of Wandsworth was held by Edward the Confessor prior to the Conquest (1066). At that time it was occupied by six freemen tenants farming land with a considerable amount of meadowland (Williams and Martin, 2003)[9].

E.4.10 The exact location of Saxon settlement within the manor is not known, but probably grew up on or in the vicinity of the later medieval village (**HEA 3**), which centred on the High Street Bridge, c. 200m to the northeast of the site.

E.4.11 No direct evidence of early medieval activity or occupation has, however, been recorded during archaeological investigations within the assessment area. In all likelihood the site was located in marsh pasture on the western bank of the River Wandle, and outside the settled area.

Later medieval period (AD 1066–1485)

E.4.12 Although Wandsworth was included in the entry for Battersea manor within Domesday Book, the reference to the 'berewick' (outlying part of an estate) of Wandsworth in King William's grant to the Abbey suggests that at this time it was a distinct place. The Wandsworth berewick was administered from Savage Farm, which stood just north of Wandsworth's medieval church (Gerhold, 1998)[10]. This church stood on the site of the current 17th/18th-century All Saints Church (**HEA 14**), c. 200m to the north of the site (Cherry and Pevsner, 1983)[11]. Wandsworth developed as a roadside settlement along the east-west road from south London into Surrey, beside the church and bridge crossing of the River Wandle. Until the 19th century the High Street bridge, which is known to have existed before 1539, was the only bridge across the river. Land to the north of the bridge beside the mouth of the Wandle would have been a marshy area (Gerhold, 1998)[12].

E.4.13 Domesday Book records 13 mills along the River Wandle, seven of which fell within the manor of Wandsworth, indicating the economic importance of the river, and its use in the processing of corn for flour and malt for brewing. The fast flow and the reported cleanness of the Wandle was exploited for a number of other industries including fishing, bleaching and hat-making, known to have been carried out in the area as early as the 13th century (Weinreb and Hibbert, 1983)[13]. Two of the seven mills noted in Domesday Book, later known collectively as the Upper Mills (**HEA 6**), were located c. 130m east of the site.

E.4.14 The site is likely to have been within the manor (estate) of Downe (Victoria County History, 1912)[14], with a manor house at its administrative centre probably on or close to the site of the existing Down Lodge, c. 175m southwest of the site (**HEA 20**).

E.4.15 Limited evidence of later medieval activity has been recorded archaeologically within the assessment area. In 1969, an archaeological excavation at Stimpsons Buildings (**HEA 5**), c. 170m to the northeast of the site, recorded a building, a wall and a sewer which in their earliest phase dated to the later medieval period. The GLHER also records the chance find of a medieval dagger and horse harness (**HEA 15**), c. 190m to the north of the site. The site lay some distance from the High Street and bridge crossing, and the lack of finds close to the site suggests that it was outside the village, probably in meadow or pasture. Parts of the floodplain were probably drained and reclaimed piecemeal during this period.

Post-medieval period (AD 1485–present)

E.4.16 Documentary evidence suggests that a stone bridge across the River Wandle existed on the site of the present bridge, prior to 1569 (Gerhold, 1998)[15], and this was confirmed when remains of a 16th-century bridge abutment were recorded during an archaeological watching brief in 1993 (**HEA 31**). Savage Farm, the bridge and the church formed the focus of the settlement, to the north and northeast of the site.

E.4.17 The site lay outside the settlement, probably on reclaimed land beside the River Wandle, the course of which was altered throughout this, and earlier,

periods. The main channel became in effect a succession of level pools between mills, and originally occupied more of central Wandsworth than the present channel (Gerhold, 1998)[16]. It remained a focus for many types of manufacturing and industrial processes which characterised the development of much of Wandsworth through the post-medieval period. In the 16th century, dye works were established along the Wandle, and the area diversified in the 17th century with the production and/or processing of iron, gunpowder, leather, linen and copper (Saxby, 2008)[17].

E.4.18 Rocque's map of 1746 (Vol 9 Plate E.1) shows the topography of the area and the location of the main settlement and roads. It is difficult to place the site on the map accurately but it is likely that it lay as indicated in fields used for pasture to the west of the River Wandle. To the west of the site was a farmstead and gardens, probably the former manorial centre of Downe, and shown on Stanford's map of 1862 (Vol 9 Plate E.2) as Down Lodge (**HEA 20**). The map also suggests that the area was prone to flooding, as there are a number of drainage ditches through the site and the surrounding fields. To the east of the site, buildings forming the Upper Mill group (**HEA 6**) occupy an island between two channels of the Wandle. The largest of the Wandle's corn mills were at Wandsworth. By 1770 the eastern part of the Upper Mill (**HEA 6**) was an oil mill and the western part a corn mill. They were rebuilt in brick as a corn mill c. 1818 (Saxby, 2008)[18].

E.4.19 In the 18th and 19th centuries, Wandsworth became a notable centre of the textile-finishing industries, although by the middle of the 19th century many of these industries had ceased to operate (Gerhold, 1998)[19].

E.4.20 In 1801, the Surrey Iron Railway Company was incorporated by Act of Parliament and empowered to construct and manage a goods railway from Wandsworth to Croydon (**HEA 32**). The railway, which opened in 1803, used horse-drawn carts running on a pair of flanged rails set into sunken stone blocks. Documentary evidence indicates that through the assessment area it followed the course of the Wandle and to the south of Wandsworth High Street ran close to the west side of the Wandle river channel and millpond (Bayliss, 1985)[20], c. 100m to the east of the site: its approximate route through the assessment area is shown on Vol 9 Figure 7.4.1 (see separate volume of figures). The railway is notable as being the first public railway, built by the first railway company in the world. It worked on a toll principle with users providing their own horses and carts: it closed down in 1846 in the face of competition from steam railways (Weinreb and Hibbert, 1983)[21], but contributed substantially to the industrial development of the Wandle valley (Gerhold, 1998)[22]. The former route of the track from Wandsworth High Street can be traced curving round to the east of a reservoir on Stanford's map of 1862 (Vol 9 Plate E.2).

E.4.21 The Ordnance Survey 1st edition 25":mile map of 1866 (Vol 9 Plate E.3) shows the site as open land to the west of a reservoir. It was crossed by an open water channel (marked "153") probably an early sewer/drain, on a southwest to northeast alignment. A storm relief channel is understood to

currently cross the site on this alignment. Belts of trees ran alongside the channel and towards the reservoir.

E.4.22 By the time of the Ordnance Survey 2nd edition 25":mile map of 1896–8 (Vol 9 Plate E.4), the water channel which had run through the site had been culverted as a foul water drainage channel, with another open storm relief channel (identified on later maps as the New Cut) constructed just outside the eastern edge of the site alongside the reservoir, along the line of what is now Neville Gill Close. Buckhold Road had been built along the northwestern edge of the site, which remained open ground with no buildings shown. Outside the site to the south, within a park, an ornamental lake had been constructed, which is now the lake within King George's Park. A tree-lined path ran around the edge of the lake extending within the southern and eastern boundary of the site. A pathway also crossed south through the site with the main entrance to the parkland area at the north-east corner. To the east of the site is the Upper Mills complex (**HEA 6**) producing flour, with the mill pond to the south and the former route of the Surrey Iron Railway still visible between the mill pond and reservoir.

E.4.23 The Ordnance Survey 3rd edition 25":mile map of 1909–20 (not reproduced) shows no change within the site.

E.4.24 The park (**HEA 1a**), originally called Southfields Park, was laid out between 1921–23 by Stephen Percival (Percy) Cane (1881–1976) and opened by King George V in 1923 (London Parks Discovery Project 2011, 2012)[23]. The park is not included on the English Heritage Register of Parks and Gardens of Special Historic Interest in England.

E.4.25 In the early-1930s, to the southeast of the site, the formerly open land between the New Cut and the mill pond was developed as Wandsworth Stadium for greyhound racing. In 1938, additional work to the park saw the introduction of an outdoor swimming pool. The Ordnance Survey 1:2500 scale map of 1952 (Vol 9 Plate E.5) shows the park with ornamental gardens, trees and winding pathways in the northern part where the site is located. To the south of the lake are tennis courts and a bowling green: the park is crossed by the storm relief sewer aqueduct, and there is a bandstand and playing fields in the southern part of the park. The stone-lined edge of the New Cut is shown sloping down outside the eastern edge of the site.

E.4.26 The recently restored lake with footbridge is separated from the southern part of the park by a pathway which leads to open grass and sports area to the south (Wandsworth Council's website, 2011)[24]. The Sports Pavilion, located in the south of the park, is a single-storey structure constructed around a courtyard in 1966 (Cherry and Pevsner, 1983)[25].

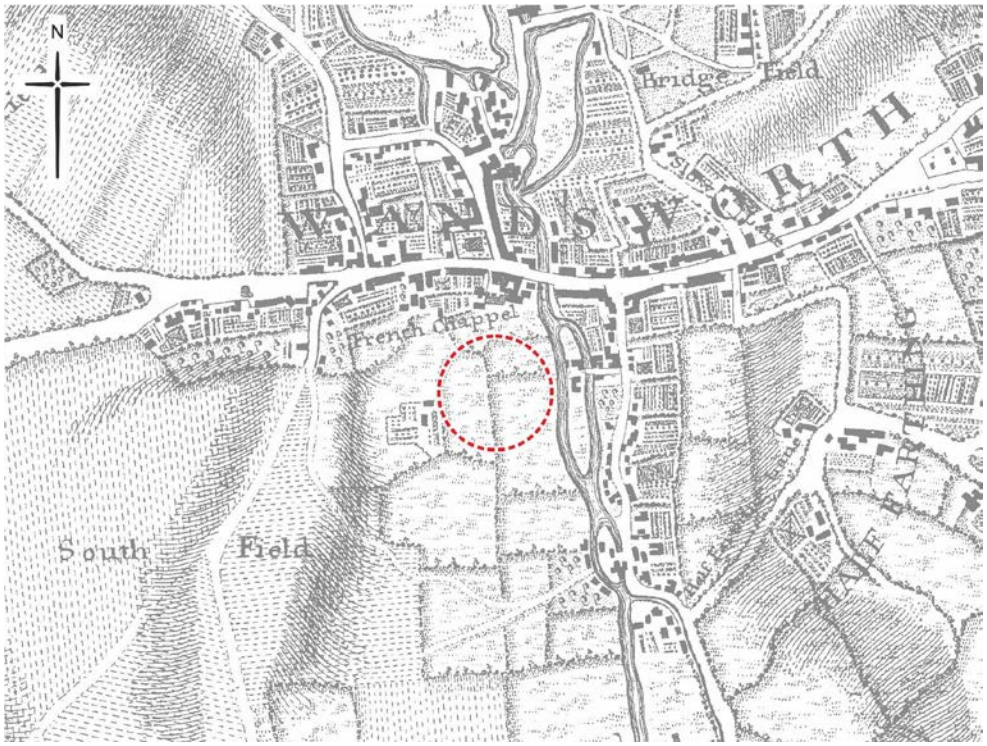
The current site

E.4.27 The site currently comprises a public park which contains grassed areas, paths and scattered trees (Vol 9 Plate E.8, Vol 9 Plate E.9 and Vol 9 Plate E.10) with bushes around the edges. Some trees may date to the 1920s park design. The northeastern and eastern edges of the site are bounded

by original railings (**HEA 1B**) (Vol 9 Plate E.6 and Vol 9 Plate E.7); to the south lies King George's Park lake.

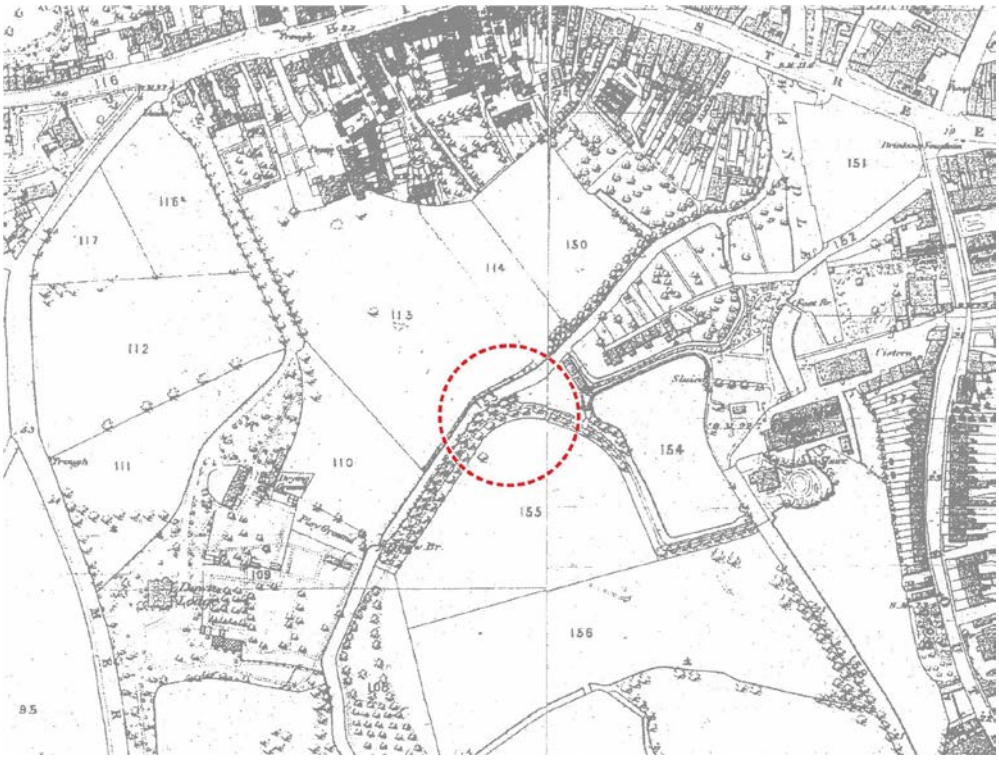
E.5 Plates

Vol 9 Plate E.1 Historic environment – Rocque's map of 1746

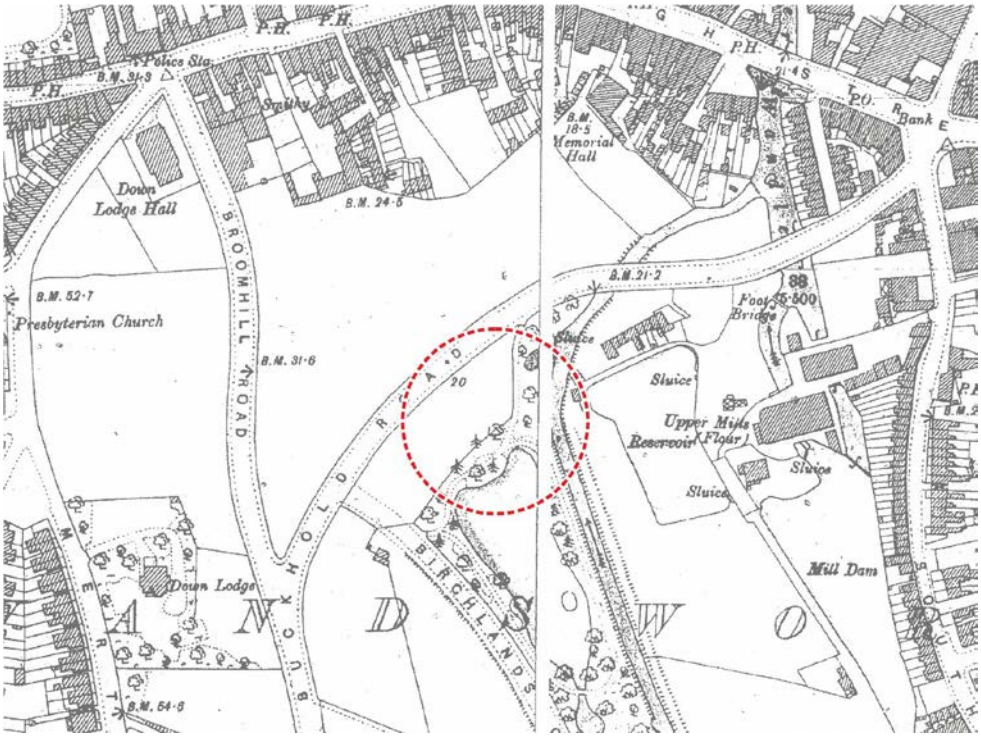


Vol 9 Plate E.2 Historic environment – Stanford's map of 1862

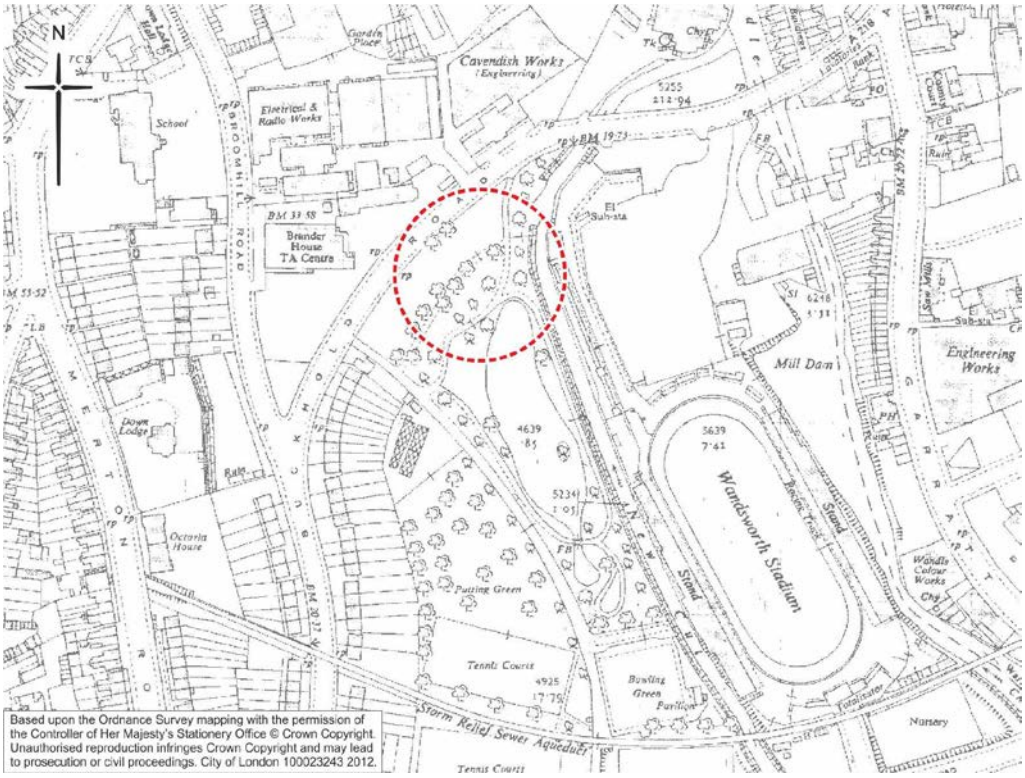
Vol 9 Plate E.3 Historic environment – Ordnance Survey 1st edition 25” scale map of 1866 (not to scale)



Vol 9 Plate E.4 Historic environment – Ordnance Survey 2nd edition 25” scale map of 1894–6 (not to scale)



Vol 9 Plate E.5 Historic environment – Ordnance Survey 1:2500 scale map of 1952 (not to scale)



Vol 9 Plate E.6 Historic environment – Northern gate of King George's Park

March 2011; standard lens; looking south-west from Buckhold Road (MOLA 2011)

Vol 9 Plate E.7 Historic environment – Railings along the north edge of King George's Park

March 2011; standard lens; looking north-east along Buckhold Road (MOLA 2011)

Vol 9 Plate E.8 Historic environment – King George's Park and modern residential blocks to the west

March 2011; standard lens; looking west from the site (MOLA 2011)

Vol 9 Plate E.9 Historic environment – The area of the site within King George's Park

November 2010; standard lens; looking north (MOLA 2010)

Vol 9 Plate E.10 Historic environment – The north end of King George's Park (the eastern part of the site)

March 2011; standard lens; looking north (MOLA 2011)

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

Appendix F: Land quality

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

Hard copy available in

Box **23** Folder **B**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 9 King George's Park appendices

Appendix F: Land quality

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Appendix F: Land quality

F.1 Baseline report

F.1.1 Baseline data is sourced from:

a. a walkover survey

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

c. stakeholder consultation

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

Site walkover

F.1.2 A site walkover of the site was undertaken on 9th November 2010.

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

F.1.4 The park itself is relatively flat but landscaped with an artificial lake immediately to the south of the proposed worksite; the worksite is heavily vegetated with mature tree species. The park is at an elevation approximately 1m lower than the surrounding street level.

F.1.5 Located directly north of the site is a business park 'The Business Village', Army Cadet Force and, adjoining this, Eurocar offices and a car repair garage. No evidence of petrol pumps or tanks were observed in this area during the survey.

F.1.6 No potential contamination sources were identified on-site during the survey.

F.1.7 Detailed site walkover notes are provided in Vol 9 Table F.1 below.

Vol 9 Table F.1 Land quality – site walkover report

Item (Site ref: PWH3X, King George's Park)		Details
Date of walkover	9th November 2010	
Site location and access	King George's Park (Northern Entrance),Buckhold Road (A218) Wandsworth.	
Size and topography of site and surroundings	Record elevation in relation to surroundings, any hummocks, breaks of slope etc.	Relatively flat landscaped park land, approximately 1m below surrounding street level.
Neighbouring site use (in particular note any potentially	North	Buckhold Road (A218) forms northern boundary. Directly north of the site is a business park 'The Business Village', Army Cadet Force

Item (Site ref: PWH3X, King George's Park)		Details
contaminative activities or sensitive receptors)		and, adjoining this, Eurocar offices and a car repair garage. No evidence of petrol pumps or tanks were observed in this area during the survey.
	South	To the south is further parkland. Within the park is a nursery school 'One o Clock centre' and play area, south-west of the proposed worksite. Tennis courts and bowling greens are located to the far south of the northern section of the park. Mapleton Road divides the two sections of the park and playing fields dominate the southern section.
	East	Neville Gill Close forms the eastern boundary and directly east of this is a retail area including the Southside shopping centre.
	West	The road forming the northern entrance to the park forms the western boundary. The surrounding area is mixed with residential and commercial areas.
Site buildings	Record extent, size, type and usage. Any boiler rooms, electrical switchgear?	No buildings on-site.
Surfacing	Record type and condition	Parkland – hard surfaced pathway through grassland and mature trees of the park.
Vegetation	Any evidence of distress, unusual growth or invasive species such as Japanese Knotweed?	Heavily vegetated with mature trees/scrub.
Services	Evidence of buried services?	None observed
Fuels or chemicals on-site	Types/ quantities?	None observed
	Tanks (above ground or below ground)	None observed
	Containment systems (eg, bund, drainage interceptors). Record	None observed

Item (Site ref: PWH3X, King George's Park)		Details
	condition and standing liquids	
	Refill points located inside bunds or on impermeable surfaces etc?	None observed
Vehicle servicing or refuelling onsite	Record locations, tanks and inspection pits etc.	None observed
Waste generated/stored onsite	Adequate storage and security? Fly tipping?	No contaminating wastes, parkland only.
Surface water	Record on-site or nearby standing water	Man made pond immediately south of the site.
Site drainage	Is the site drained, if so to where? Evidence of flooding?	None observed
Evidence of previous site investigations	Eg trial pits, borehole covers.	None observed
Evidence of land contamination	Evidence of discoloured ground, seepage of liquids, strong odours?	None observed
Summary of potential contamination sources		None observed
Any other comments	Eg access restrictions/ limitations	No

Review of historical contamination sources

F.1.8 Historical mapping (dated between 1868 and 1985) was reviewed to identify potentially contaminating land-uses at the site and within the 250m assessment area.

F.1.9 Vol 9 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.1.10 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.1.11 Items listed in the Vol 9 Table F.2 below are also shown on Vol 9 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 9 Appendix E.

Vol 9 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			
5	Backfilled river cutting (located on the edge of the north-eastern corner of the site)	c1964-c1973	Depending upon its source, backfill could contain a variety of substances and if bio-degradable could represent a source of landfill gas.
Off-site			
1	Wandsworth Brewery (185m northeast)	c1868-present	Volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), heavy metals, ethanol/methanol, ammonia, chlorinated alkalis, benzene, toluene, ethybenzene and xylenes
2	Backfilled reservoir (15m east)	c1874	Depending upon its source, backfill could contain a wide variety of substances and if bio-degradable could represent a source of landfill gas. Given the relatively recent age of the backfilling works this is unlikely to be of concern
3	Colour works (215m southeast)	c1896-c1965	Heavy metals, arsenic, selenium, nitrates, sulphates, sulphides, asbestos, polyaromatic hydrocarbons (PAHs), phenols, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, organotin compounds
4	Incandescent mantle factory (40m north west)	c1916-c1938	Heavy metals, arsenic, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, radioactive isotopes
6	Saw mill/timber yard (195m east)	c1916-c1988	Heavy metals, arsenic, boron, sulphates, phenols, acetone, aromatic hydrocarbons, PAHs, cresols
7	Electrical/radio engineering	c1951-present	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic

Ref	Item	Inferred date of operation	Potentially contaminative substances associated with item[1,2]
	works (40m northwest)		hydrocarbons, chlorinated aliphatic hydrocarbons, polychlorinated biphenyls (PCBs)
8	(a) Smithy (130m northwest)	c1896	Heavy metals, PAHs
	(b) Garage/motorbody works (130m northwest)	c1951-present	Heavy metals, asbestos, TPHs, aromatic hydrocarbons, PAHs, chlorinated aliphatic hydrocarbons, organotin compounds
9	Engineering works (8m north)	c1951-c1965	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
10	(a) Smithy (205m northwest)	c1896	Heavy metals, PAHs
	(b) Engineering works (205m northwest)	c1951-c1952	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
	(c) Garage (205m northwest)	c1965-c1988	Heavy metals, oil and fuel hydrocarbons (TPH, PAHs), degreasers, cutting oils, paints, solvents
11	Engineering works (190m east)	c1951-c1977	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCBs
12	Electrical substation (35m east)	c1952-present	Oils, PCBs
13	(a) Laundry (208m north)	c1951-c1952	Chlorinated aliphatic and aromatic hydrocarbons (eg perchloroethylene (PCE)
	(b) Garage/motorbody works (208m north)	c1965-present	Heavy metals, oil and fuel hydrocarbons (TPH, PAHs), degreasers, cutting oils, paints, solvents
14	Works (225m north)	c1965	Heavy metals, arsenic, boron, free cyanide, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAHs, PCBs, chlorinated aliphatic hydrocarbons

On-site

F.1.12 The historical mapping shows the site to have had no significant previous contaminative land-uses, having been parkland/recreation grounds since prior to the publication of the earliest map reviewed. However there is a backfilled river cutting located within the northeastern corner of the site.

F.1.13 However, given the age of the cutting and probable composition ie granular fill, on which Neville Gill Close is constructed, it is unlikely to represent a potential source of contamination. In addition this feature was not highlighted by the LB Wandsworth.

Off-site

F.1.14 The historical mapping within the 250m assessment area has identified pockets of industrial activities in the vicinity of the site, notably the Incandescent Mantle Factory (operation which has ceased).

F.1.15 Engagement with the London Borough (LB) of Wandsworth has identified that the factory has represented a source of low level radioactive contamination which was restricted to the confines of the factory site and which is subject to remedial action in relation to other development, and ongoing activities such as garages/motorbody works and Wandsworth Brewery.

Geology

F.1.16 Data from the Thames Tideway Tunnel project ground investigation indicates the anticipated geological succession, as summarised in Vol 9 Table F.3 below.

Vol 9 Table F.3 Land quality – anticipated site geology

Geological unit/ strata	Description	Approximate depth below ground level (m)
Made Ground	Clayey and sandy gravel of brick and concrete and gravelly clay.	0-3.6
Alluvium	Gravelly clay	3.6-4.0
River Terrace Deposits	Sand and gravel (predominantly quartz sand and flint gravel).	4.0-4.5
London Clay Formation	Silty and locally sandy clay with selenite crystals.	4.5-46.5

Unexploded ordnance

F.1.17 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.1.18 A desk based assessment for UXO threat was undertaken by 6 Alpha Associates Limited for the King George's Park site[3]. The report reviews

information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

F.1.19 The report establishes that there were no direct high explosive strikes to the site, although one was noted within the assessment buffer to the west and a further three approximately 20m from the site (two east and one south).

F.1.20 Taking into account the findings of this study and the known extent of the proposed works at the King George's Park site, it was considered that there is an overall medium/high threat from UXO.

Thames Tideway Tunnel ground investigation data

F.1.21 This section summarises the ground investigation undertaken by the Thames Tideway Tunnel project.

F.1.22 Boreholes were drilled in the immediate vicinity of the King George's Park site as part of the project-wide ground investigation (borehole ref SA1110: on-site and SR1109: northeast) as shown on Vol 9 Figure F.1.2 (see separate volume of figures).

F.1.23 Vol 9 Figure F.1.2(see separate volume of figures) also identifies a number of other boreholes excavated in vicinity of the site, these are not considered relevant to the contamination status of the site, either due to their distance from the proposed shaft location or because certain boreholes were excavated purely for geotechnical purposes.

Soil contamination testing

F.1.24 Soil contamination testing was undertaken at borehole SA1110 where two samples retrieved from the Made Ground and London Clay were tested for the Waste Acceptance Criteria (WAC) suite of analysis only. The results of this testing identified that these soils may be classified as inert.

F.1.25 Although primarily a waste classification test several of the results can contextualise the quality of the materials tested, which in this case indicates that the soils are unlikely to pose a specific risk to human health (or other receptors).

F.1.26 Soil contamination testing was undertaken on two samples of Made Ground and London Clay retrieved from borehole SR1109 to the northeast. This is outside the limits of land to be acquired and used and given the differing site setting is not judged to be appropriate to inform on soil quality within the St George's Park site.

F.1.27 Refer to Volume 2 Environmental assessment methodology for full guidance on the benchmarks used.

Soil gas testing

F.1.28 Four rounds of gas monitoring of the two standpipes installed in borehole SA1110 were available for review which showed no elevated concentrations of methane or carbon dioxide.

Groundwater contamination data

F.1.29 Groundwater data shows low levels of ammoniacal nitrogen in the shallow aquifer. This is typical of the unconfined shallow aquifer in an urban

environment. Refer to Section 13 Water resources – groundwater of this volume for further information on groundwater quality.

Third party ground investigation data

F.1.30 No third party ground investigation was available for review at the King George's Park site.

Other environmental records

F.1.31 Details of environmental records (hazard and waste sites) in the vicinity of the site held by the Environment Agency (EA) and other bodies have been obtained from the Landmark Information Group and are presented in Vol 9 Table F.4. Pertinent records are discussed in further detail below.

F.1.32 The location of these records is shown on Vol 9 Figure F.1.3 (see separate volume of figures).

Vol 9 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
Active RAS Authorisation	0	1
Control of major accident hazard sites	0	0
Historical landfill site	0	0
LA pollution prevention and control	0	2
Licensed waste management facility	0	0
Notification of installations handling hazardous substances	0	0
Past potential contaminated industrial uses	0	There are a number of areas classified as past potential contaminated industrial uses within 250m of the site.
Pollution incident to controlled water*	0	2
Registered waste transfer site	0	0
Registered waste treatment or disposal site	0	0

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

F.1.33 Inspection of the data has identified no on-site hazard and waste sites King George's Park.

F.1.34 Within 250m of the King George's Park site, inspection of the data has identified two LA pollution prevention and controls identified, both located on Wandsworth High Street, approximately 200m north of the site.

F.1.35 There are a number of areas of past potentially contaminating industrial use within a 250m of King George's Park site. The closest located north/northwest of the site and is within an area where previous industrial use include the presence of an incandescent mantle factory and works/engineering works, as highlighted on Vol 9 Figure F.1.1 (see separate volume of figures). Contaminants associated with these types of previous land-use are identified in Vol 9 Table F.2.

F.1.36 There are two recorded pollution incidents to controlled waters identified within the 250m boundary. These are located in Traders Hall, directly east of the site, and by All Saints Church on Wandsworth High Street.

Land quality data from local authority

F.1.37 The LB of Wandsworth was consulted in relation to data on land quality that the council hold in respect of the site and search area.

F.1.38 The council reported that the former Gas (Incandescent) Mantle Factory adjacent to the site (as identified in the historical map review) represented a source of low level radioactive contamination which was restricted to the confines of the factory site. It is understood that this is scheduled for remedial action as part of proposed redevelopment works.

F.1.39 The contaminated land officer at LB of Wandsworth regarded this potential contamination source as a low risk to the King George's Park site.

F.1.40 The full response is provided in Section F.2.

Summary of contamination sources

F.1.41 The site (and location of the main below ground works) comprises parkland, and no contaminating uses have been identified within this area.

F.1.42 It is noted however that the northeastern corner of the site (the location of proposed utility works in the highway) encompasses a small section of Neville Gill Close, which comprises a former river cutting that was infilled between c1964 and c1973: this cutting followed a similar alignment to the existing highway. Depending upon the quality of the backfill this could potentially comprise a contamination source although it is judged to be represent a low risk overall.

F.1.43 UXO potentially present at the site could represent an on-site source of contamination which may impact on the construction of the proposed development.

F.1.44 Limited off-site contamination sources were identified from the baseline review, notably, the former incandescent mantle factory and pockets of industry to the south.

F.2 Local authority consultation

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

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

Our Ref: SR153416
Your ref:
Date: 18 January 2011

Dino Giordanelli
Mott MacDonald Ltd
8-10 Sydenham Road
Croydon, CR0 2EE

Dear Mr Giordanelli

Re: King Georges Park site, London, SW18

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

- The 1869 OS mapping shows the site to be open land (fields or park land) with little local development other than a flour mill 120m to the east. The mill is serviced by a mill pond and reservoir situated in the eastern part of the area of concern.
- The 1896 OS mapping shows the King Georges Park pond to be in place. The preferred area is parkland. The wider area is broadly similar to earlier mapping other than land beyond the northern boundary to the site of interest where there has been considerable built development.
- The 1916 mapping shows a gas mantle factory along the northern boundary of the site of concern (centered on 525339, 174543). These works used thorium nitrate which is a radioactive substance with an extremely long half life. As part of a redevelopment proposal the site has been investigated to assess potential risks to future users and allow the design of a scheme of remediation to the agreement of the Council. The radioactive pollution is mostly within the oldest site structures but there is some relatively low level radioactive material in the yard area within the boundary of your area of interest. No investigations have been carried out beyond the area of the mantle factory. The site investigation reports can be made available if this is found necessary.
- The 1930s mapping shows that the mantle factory use has ceased and the building was being used as a tyre store. During this period the houses in the south west corner of the site were constructed. The mill reservoir has been infilled and the land created forms the northern part of a site running north-south to the east of the site in question including a running track to the south. The 'new cut' has been constructed, which is a channel of the River Wandle

and runs along what is the present eastern boundary of King Georges Park, within the area of concern.

- The 1947 mapping shows the site of the mantle factory to be used for an electrical and radio works. The structure to the northeast boundary of the site houses an engineering works. The Territorial Army centre (shown as number 1 on your plan) is present at this time. The remainder of the area is relatively unchanged. Unfortunately, the map tiles for this area for the 1950s to the 1970s are missing from our records, but the 1971 aerial photography helps show that there was relatively little change on the site itself other than that associated with the building of the shopping centre and council estate to the east (see next point).
- Applications for the development of the land to the east to the 'Arndale Shopping Centre' (now Southside) were approved in 1963 & 1964, with further approvals of details in 1966 to 1973. This was built over the site of the mill & ex-reservoir land, the running track. The River Wandle flows in a culvert under this structure. It is assumed that the 'New Cut' was infilled and is under the road adjoining the park to the east.
- Most of the area of the site and also to the east has alluvium superficial deposits overlying London Clay solid geology. A narrow band of gravels is located to the west between the alluvium and head clay deposits further west. The gravels and alluvium are classified as a minor aquifer but no abstractions are taken from them. The King Georges Park pond has been supplied by a deep borehole into the chalk aquifer in the past but it is not clear whether this source is still used.
- Our premises database does not contain any events that may indicate that there is polluted land at the site, such as discoloration of soils or malodours.
- There is no record of bombs recorded to have fallen in the area during the Second World War.

Based on the information within our possession we conclude that it is unlikely that there is an issue of land contamination at this part of King Georges Park, although surrounding sites are, or may be, impacted by contaminating substances. The preferred area has never been developed and has always been fields or parkland. There is a possibility that it has been affected by mobile contaminants from surrounding land but the likelihood for this is low.

I trust that this information is useful to you. If you would like to discuss any matter raised in this letter, please do not hesitate to contact me. Please note that a fee of £50 is payable for carrying out this search. Kindly send a cheque to the above address made payable to 'Wandsworth Council'.

Yours sincerely,

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

F.3 Detailed Unexploded Ordnance (UXO) risk assessment – King George's Park

References

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

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

[3] 6 Alpha Associates Limited. *Detailed Unexploded Ordnance Risk Assessment. Study site: Work area: PWH3X – Kin g George's Park* (4th February 2011)

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Study Site: Work Area PWH3X
Client Name: Thames Water
6 Alpha Project Number: P2278_R71_V2.0
Date: 4th February 2011

Originator: Gary Hubbard (4th February 2011)
Quality Review: Lee Gooderham (6th February 2011)
Released by: Simon Cooke (6th February 2011)

Contents

Figures

EXECUTIVE SUMMARY	
Study Site	The Study Site is referred to as Work Area PWH3X. 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.
Potential Threat Source	The threat is predominately posed by Second World War (WWII) German High Explosive (HE) bombs and to a lesser extent, British Anti-Aircraft Artillery (AAA) projectiles used to defend against German bombing raids.
Risk Pathway	If Unexploded Ordnance (UXO) is encountered by a site investigation (or subsequent construction method), that generates significant kinetic energy (e.g. of the sort generated by cable percussion boreholes or drilling activities), then it could be initiated.
Key Findings	The final risk level has been assessed on the following pertinent facts; • The study site is located within the open ground of King Georges Park. • Throughout WWII the site is shown to have been open parkland with lightly wooded areas, with the eastern boundary occupied by a river. • As the site was predominantly open ground during WWII, it is therefore unlikely that any UXBs landing within the confines of this site would have been witnessed or recorded, particularly within any water features. • There has been no significant development on site post WWII, although the river channel to the east has been in filled. In light of the potential risk on site and the ground conditions, 6 Alpha would recommend the “pro-active” measures specified below.
Final Risk Level	**MEDIUM/HIGH**
Risk Mitigation For All Works	1. Hold documentary procedures to outline the actions to be taken in the event of a suspicious find; 2. Brief all personnel involved with the intrusive works on the potential risk of an associated UXO discovery; 3. Subject to ground conditions, conduct a non-intrusive magnetometer survey ahead of all works and then avoid or investigate targets modelling as potential UXO; 4. If a non-intrusive survey proves impracticable due to the made ground, then an Explosive Ordnance Disposal Engineer should conduct site supervision of the excavations.

ASSESSMENT METHODOLOGY

Approach	The UXO related risk on the site has been assessed using the process advocated by the Construction Industry Research & Information Association (CIRIA) best practice guide (UXO – A Guide for the Construction Industry) which has been endorsed by the Health & Safety Executive (HSE). Potential UXO hazards have been identified through investigation of Local and National archives covering the site, Ministry of Defence (MoD) archives, local historical groups, historical mapping and contemporaneous aerial photography, wherever 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 has been cross-referenced within this document, whilst less significant data has been set aside, it is available upon request. The assessment of 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 to the hazard at the moment of encounter. Wherever a significant UXO risk has been identified, 6 Alpha will design and recommend methods of risk mitigation to "reasonably and sufficiently" reduce them, not only to an acceptable and tolerable level but also in accordance with the As Low As Reasonably Practicable (ALARP) principle. In this way we ensure that any risk mitigation solutions we design, delivers the Client the most cost effective solution. We believe that 6 Alpha's holistic and intelligent application of the ALARP principle to UXO risk management is a critical and differentiating factor in our approach, because; it provides a transparent means for assessing the tolerability of risk; and it ensures that if the cost of reducing a risk outweighs the benefit, then the risk may be considered "tolerable". This is considered especially pertinent, because the potential to reduce UXB risk to zero, is *de facto* unnecessary and prohibitively expensive.
Important Notes	Although this report is up to date and accurate, the databases are continually being populated as and when additional data becomes available. 6 Alpha have exercised all reasonable care, skill and due diligence in providing this service and producing this report. The assessment levels have been generated from historical data and third party sources. Wherever possible 6 Alpha have sought to verify the accuracy of all data, but cannot be accountable for inherent errors that may exist in third party data sets (e.g. National Archive or other library sources). 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 the Threat & Preliminary Risk Assessment Report (*P1087_Version 3*). Although 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 Study Site is referred to as Work Area PWH3X. 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.
Location Description	The work site is situated on open ground laid to grass within King Georges Park, it is located at the junction of Buckhold Road and Neville Gill Close in the London Borough of Wandsworth. The surrounding area comprises of commercial properties occupying the north and east, residential properties west with King Georges Park in the south. The main site working area is 1,840m^2 located to the north within King Georges Park.
Proposed Works	The following works will be conducted at this location, please note that this may not represent the full scheme but are those that may be presented with UXO Risk: • Construction of a 7.5m internal diameter shaft, approximately 35m deep. It is anticipated the shaft will be constructed using a sprayed concrete primary lining with a cast in-situ concrete lining. A pre-cast segmental lining could also be used as a alternative to the sprayed concrete. • An interception chamber upon the Frogmore-Bell Lane Creek relief sewer. • A length of connection culvert to convey flows from the interception chamber to the shaft. A valve chamber will be located upon the culvert. • A 10m high ventilation column; • A control kiosk containing equipment to operate a penstock.
Ground Conditions	Thames Water have informed 6 Alpha that the ground conditions for this preferred site are expected to be: • **Made Ground (MG)** – Ground Level to 3.60m below ground level (bgl); • **Alluvium** – 3.60m to 4.00m bgl; • **River Terrace Deposits** – 4.00m to 4.50m bgl; • **London Clay** – 4.50m to 47.50m bgl; • **Harwich Formation** – 47.50 bgl (thickness unproven). MG/fill may comprise of locally available materials (e.g. Alluvium and Terrace Deposits together with waste materials such as building rubble, clinker or ash). It may also comprise a range of inert materials and/or domestic refuse. The presence of ferrous metal is not known (but is considered likely), as is the presence of red brick (both of which can interfere with magnetometry). However, all MG/fill It is likely to be heterogeneous and may also contain buried sub–structures and foundations.

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. London County Council WWII Bomb Damage Mapping; 2. Home Office WWII Bomb Census Maps; 3. WWII & post-WWII Aerial Photography; 4. Official Abandoned Bomb Register; 5. National Archives in Kew; 6. 33 Engineer Regiment (Explosive Ordnance Disposal) at Carver Barracks, Wimbish.	
WWII Historical Data	**WWII Site Usage**	The site was situated within the most northern reaches of King George's Park, used predominantly for recreation, which consisted mainly of open grassland and lightly wooded areas.
	Bombing Targets	There are two primary Luftwaffe bombing targets in the local region; "Wandsworth, Wimbledon and Epsom Gas Works" and an "Electricity Generating Station" located approximately 600m to the north. Railway infrastructure was considered to be a secondary target, this is located approximately 500m to the north.
	HE Bomb Strikes (*Figure 3*)	There are no recorded HE bomb strikes on site however, one has been noted to the west within the assessment buffer and a further three approximately 20m from the boundary, two to the east and one to the south.
	WWII HE Bomb Density (*Figure 4*)	The site is located within the administrative district of Wandsworth, which recorded 160 HE bombs per 1,000 acres.
	WWII Bomb Damage (*Figure 5*)	There is no recorded damage either within the work area or within the assessment buffer. However, it should be noted that no structures occupied the site at this time.
	Abandoned Bombs	There are no abandoned bombs recorded at this location.

STAGE THREE – DATA ANALYSIS	
Is there a reason to suspect that the immediate area was a bombing target during WWII?	There is no direct evidence to suggest that the Luftwaffe specifically targeted the Work Area. However, the Work Area is located within the "bombing footprint" of a number of strategic Luftwaffe bombing targets.
Is there firm evidence that ordnance landed on site?	There are no recorded HE bomb strikes within the work area. However, there is one bomb strike recorded to the west within the assessment buffer.
Would an UXB entry hole have been observed and reported during WWII?	As the site was open ground with areas of woodland it is highly unlikely that any UXBs landed within the confines of this site would have been witnessed or recorded.
Was the ground undeveloped during WWII?	Yes, the site was undeveloped land. During WWII a watercourse branching off the River Wandle ran adjacent to the work area to the east. It must also be noted that the assessment buffer also incorporates a large portion of the park lake.
Is there any reason to suspect that Live Firing or military training may have occurred at this location?	There is no evidence to support that live firing took place on the site.
Is there any reason to suspect that other activities on site may have resulted in ordnance and / or explosives being present?	Although unlikely, it is possible that UXO may have been imported to the site, contained within the fill material used to infill the watercourse adjacent to the eastern boundary post WWII.
Would previous earthwork have removed the potential for UXO to be present?	Highly unlikely as according to historical mapping the site usage has not changed from prior to WWII.

STAGE FOUR – RISK ASSESSMENT	
Threat Items	The threat is predominately posed by Second World War (WWII) German High Explosive (HE) bombs and to a lesser extent, British Anti-Aircraft Artillery (AAA) projectiles used to defend against German bombing raids.
Maximum Penetration	After reviewing the site-specific geotechnical data, the maximum Bomb Penetration Depth (BPD) is assessed to be 7m below ground level (m bgl).
Risk Pathway	Given the type of munitions that may be present on site, all types of aggressive intrusive engineering activities may generate a significant risk pathway.
Consequence	Consequences of a UXB initiation include: 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. Consequences of UXO discovery include: 1. Delay the project; 2. Disruption to local community/infrastructure; 3. Incurring of additional costs.

UXO RISK CALCULATION			
Activity	**Probability** (SHxEM=P)	**Consequence** (DxPSR=C)	**Risk Rating** (PxC=RR)
Enabling Works	2x1=2	3x2=6	2x6=12
Shaft Installation	2x2=4	2x2=4	4x4=16
Open Excavations	2x2=4	2x2=4	4x4=16
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 ground survey is largely dependant on depth and composition of made ground. The borehole report indicates made ground to a depth of 3.6m. Therefore, it is important to establish the location of this borehole, as there is evidence of infill to the east of the site. Thus the cover of the made ground will certainly limit the suitability for non-Intrusive survey. **Intrusive Methods of Mitigation** – Yes this type of survey is likely to be affective on site. However when designing the mitigation strategy the cost of this type of survey should be balanced with the benefit gained in terms of area actually mitigated.

MITIGATION MEASURES TO REDUCE RISK TO 'ALARP'		
Activity	**Risk Mitigation Measures**	**Final Risk Rating (Post Mitigation)**
All Works	1. Hold documentary procedures to outline the actions to be taken in the event of a suspicious find; 2. Brief all personnel involved with the intrusive works on the potential risk of an associated UXO discovery; 3. Subject to ground conditions, conduct a non-intrusive magnetometer survey ahead of all works and then avoid or investigate targets modelling as potential UXO; 4. If a non-intrusive survey proves impracticable due to the made ground, then an Explosive Ordnance Disposal Engineer should conduct site supervision of the excavations.	LOW = ALARP
This assessment has been conducted based on the information provide by the Client, should the proposed works change then 6 Alpha should be re-engaged to refine this risk assessment.		

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Report Figures

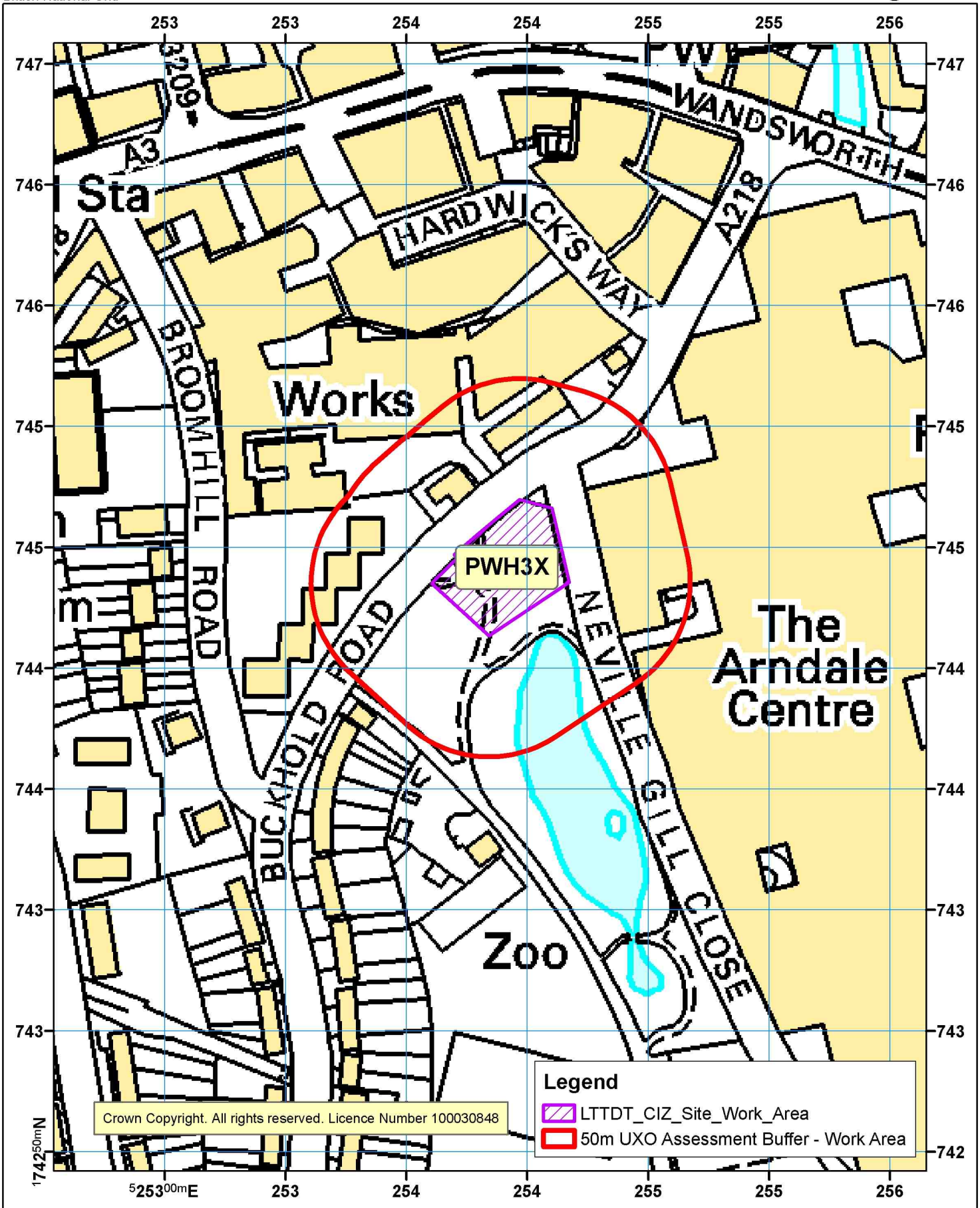
Figure One

Location of the Proposed Works

Thames Tideway Tunnel - Work Area PWH3X
Work Area Location

Figure 1

British National Grid



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0 10 20 40 60 80 100 Meters

N

Project Number: P2278_R71

Drawn By: Gary Hubbard

Checked by: Lee Gooderham

Date: 4th January 2011

Figure Two

Current Aerial Photography

Thames Tideway Tunnel - Work Area PWH3X
Current Aerial Photograph

British National Grid

Figure 2

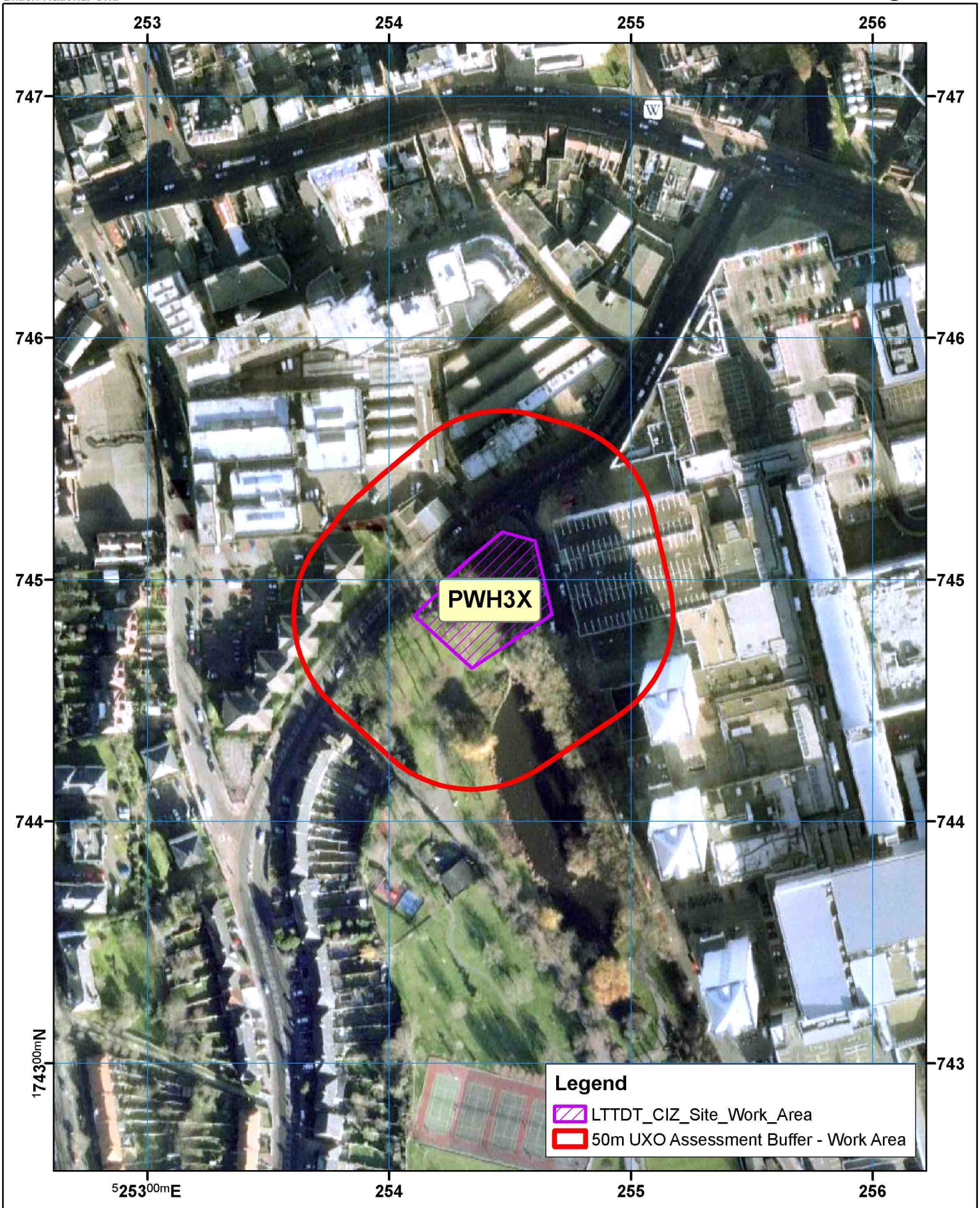

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Figure Three

WWII High Explosive Bomb Strikes

Thames Tideway Tunnel - Work Area PWH3X
Location of WWII High Explosive Bombs

British National Grid

Figure 3

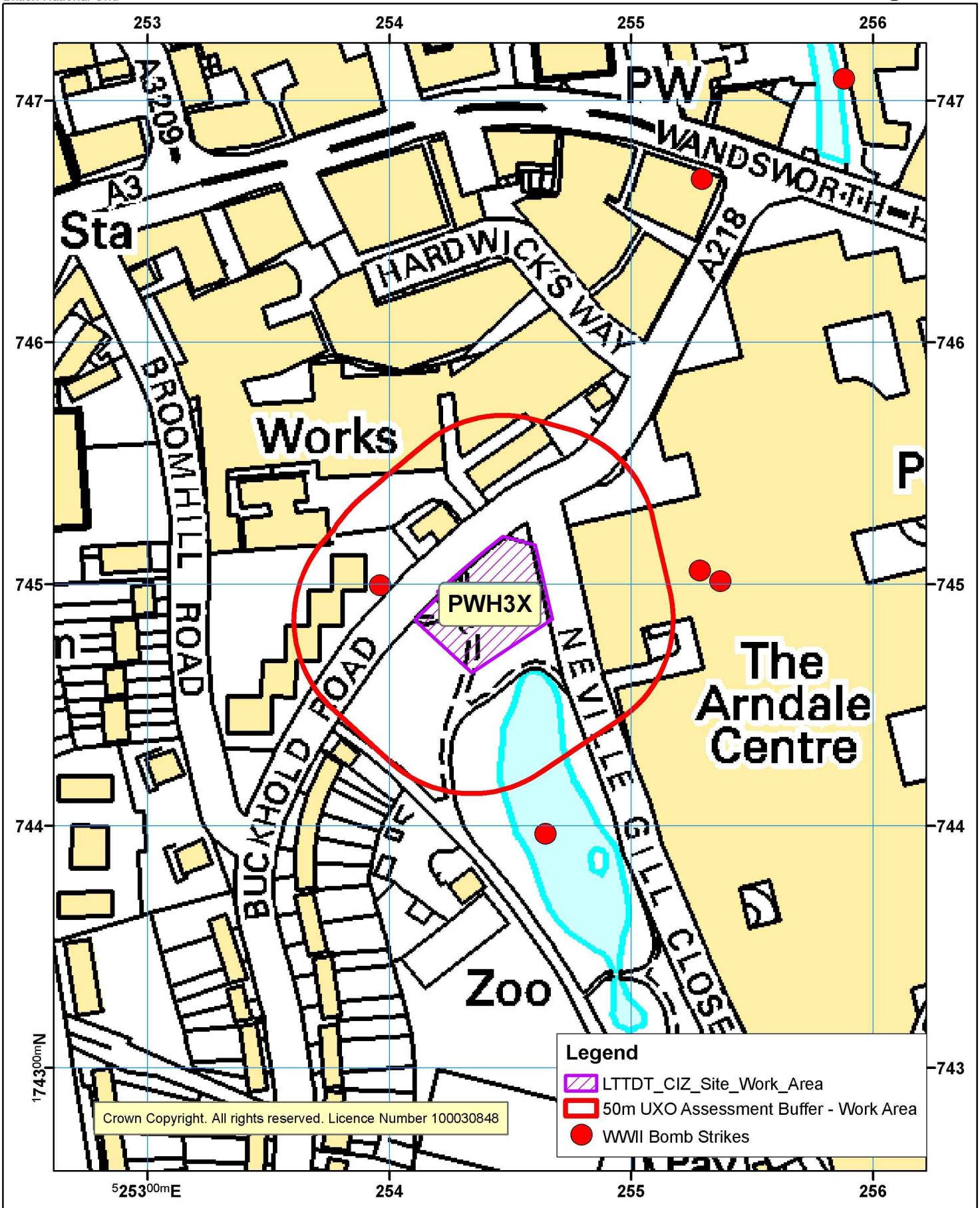

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Figure Four

WWII High Explosive Bomb Density

Thames Tideway Tunnel - Work Area PWH3X
WWII High Explosive Bomb Density

British National Grid

Figure 4

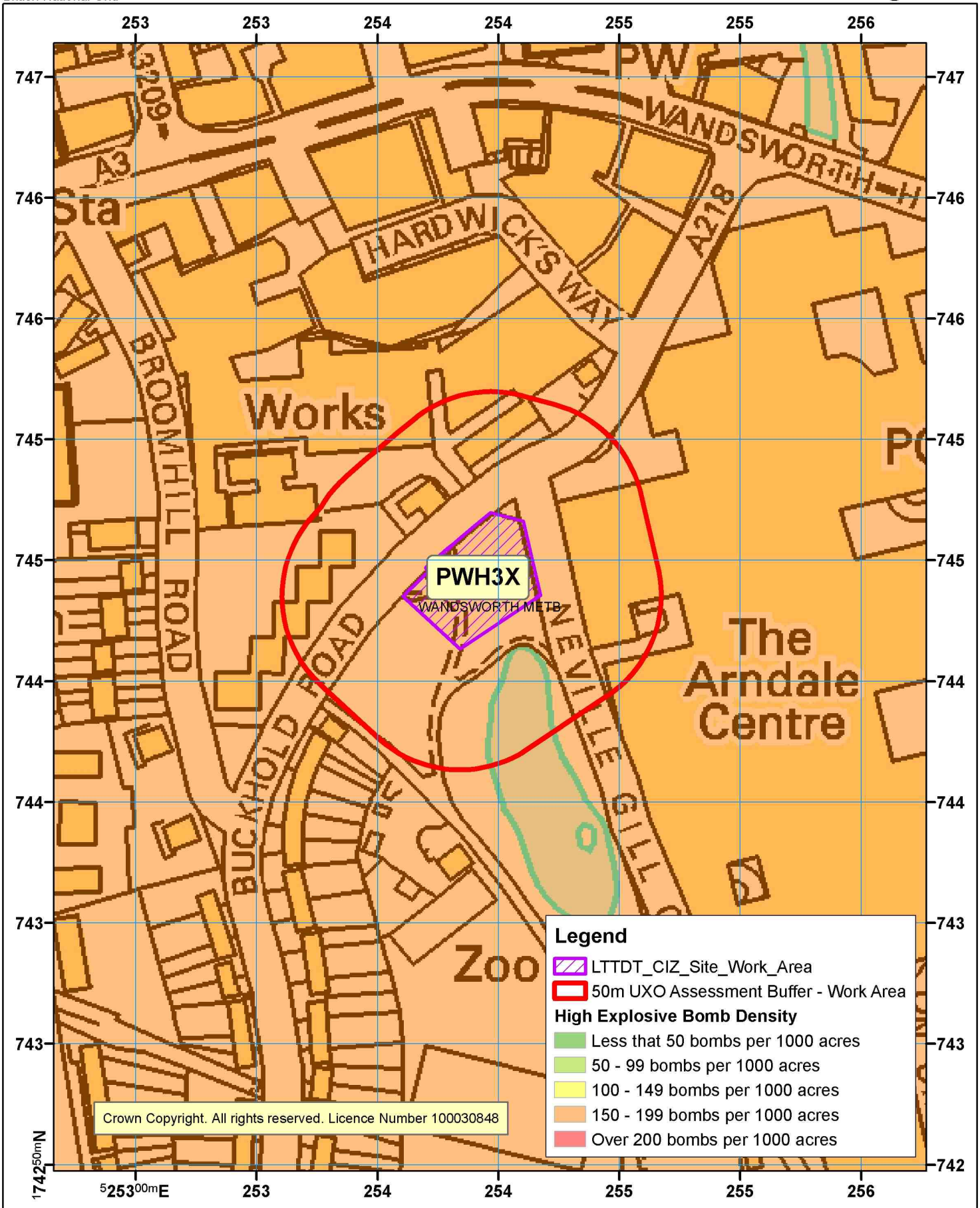

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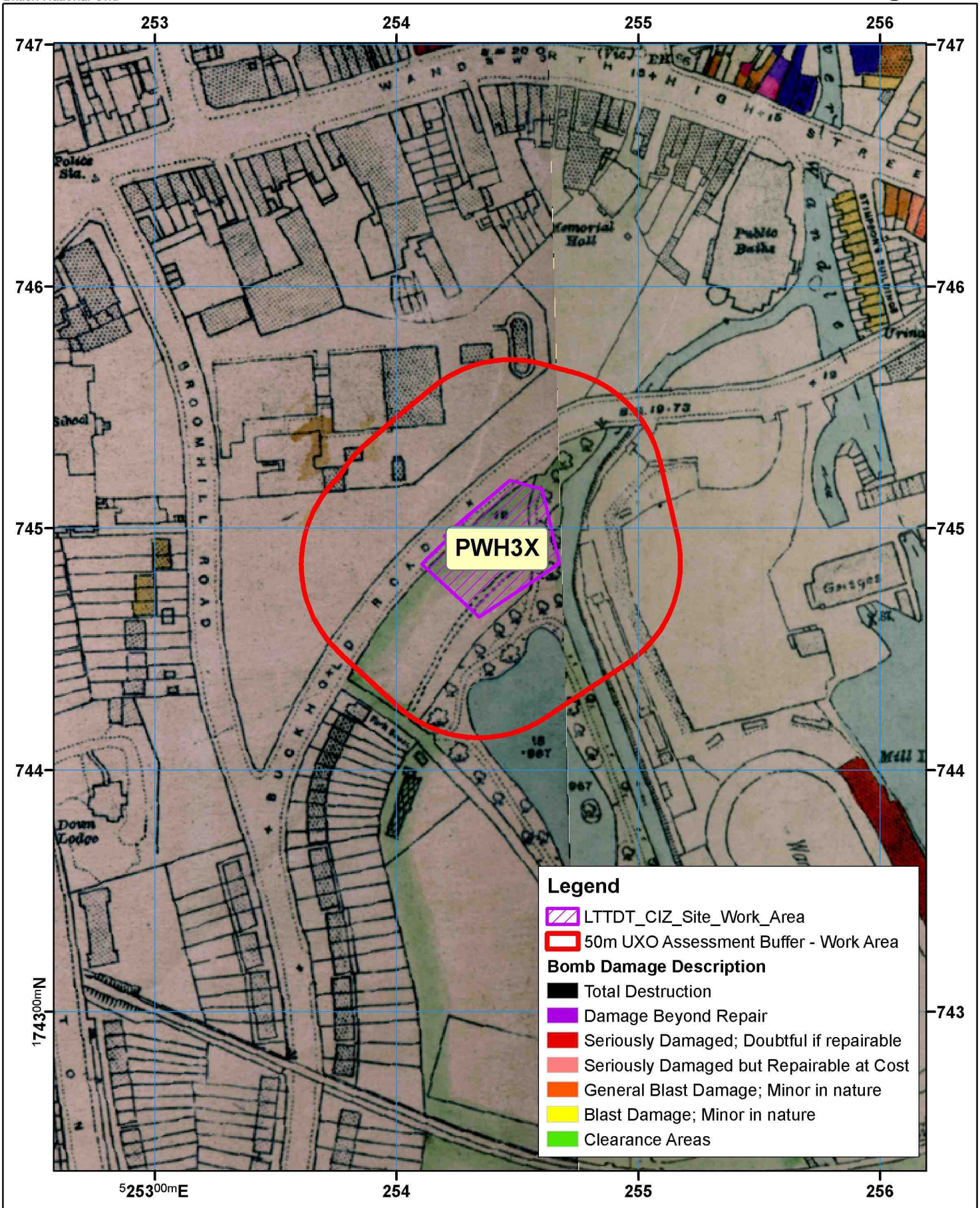
Figure Five

London County Council Bomb Damage Mapping

Thames Tideway Tunnel - Work Area PWH3X
London County Council Bomb Damage Mapping

British National Grid

Figure 5



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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

Appendix G: Noise and vibration

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

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January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 9 King George's Park 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 King George's Park are the dwellings at Park View Court and Buckhold Road, the One O'clock Childrens Centre, the Penfold Centre and people using the park.

Survey methodology

G.1.3 The London Borough (LB) of Wandsworth has been consulted regarding the noise assessment and monitoring locations, prior to completing the surveys.

G.1.4 A baseline noise survey was completed on 7th April, 2011 which comprised short term attended measurements taken during the daytime at all measurement locations.

G.1.5 Measurements were undertaken during the interpeak periods of 10:00-12:00 and 14:00-16:00 on a typical weekday, so that the baseline data is representative of the quieter periods where any disturbance from construction would be most noticeable.

G.1.6 Vol 9 Table G.1 describes the survey equipment that was used to collect the baseline data at the site.

Vol 9 Table G.1 Noise – survey equipment

Item	Type	Manufacturer	Serial Number(s)	Laboratory Calibration Date*
Baseline Survey – 7th April, 2011				
Hand-held analyser(s)	2250	Brüel & Kjær	2626230 2626231	15/02/2010
½ " microphone(s)	4189	Brüel & Kjær	2621208 2621209	15/02/2010
B&K sound calibrator(s)	4231	Brüel & Kjær	2619373	21/01/2010

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

G.1.7 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 sound level meters were tripod-mounted with the microphone approximately 1.3m above ground level. A windshield was fitted over the microphone at all times during the survey period to minimise the effects of any wind induced noise.

G.1.9 The prevailing weather conditions observed for both baseline surveys are described in Vol 9 Table G.2.

Vol 9 Table G.2 Noise – weather conditions during baseline noise survey

Wind Speed (ms^{-1})	Wind Direction	Temperature (°C)	Precipitation?	Description
Baseline Survey – 7th April, 2011 (daytime, 10:00-12:00)				
Maximum: 1.4-2.9 Average: 0.4-1.5	Westerly	20-22	No	Dry, clear and calm
Baseline Survey – 7th April, 2011 (daytime, 14:00-16:00)				
Maximum: 2.4-3.8 Average: 0.6-1.5	Variable	22-24	No	Dry clear and calm with a slight breeze

Measurement locations

G.1.10 Vol 9 Table G.3 details the measurement locations which are also presented in Vol 9 Figure G.1 Noise – measurement locations (see separate volume of figures), and shown in Plates G.1 to G.3.

Vol 9 Table G.3 Noise – measurement locations

Measurement Location Number	Description	Co-ordinates	
		X	Y
KGP01	Footpath adjacent to Buckhold Road (In front of Park View Court)	525390	174483
KGP02	Footpath adjacent to Neville Gill Close (In front of Albon House)	525496	174440
KGP03	Footpath within King George's Park	525412	174418

Results

G.1.11 The range of values for each of the parameters collected during the baseline surveys are summarised in Vol 9 Table G.4 to Vol 9 Table G.6.

Vol 9 Table G.4 Noise – sampled noise survey results - KGP01

Location Detail: KGP01, on public footpath adjacent to Buckhold Road, in front of Park View Court residential flats						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Facade**	**Facade**
Daytime (10.00-12.00, 14.00-16.00)	98	56	69-71	70	73*	75

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

Vol 9 Table G.5 Noise – sampled noise survey results - KGP02

Location Detail: KGP02, on public footpath adjacent to Neville Gill Close, in front of Albon House (high rise residential building)						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Facade**	**Facade**
Daytime (10.00-12.00, 14.00-16.00)	79	53	58-61	60	63*	65

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

Vol 9 Table G.6 Noise – sampled noise survey results - KGP03

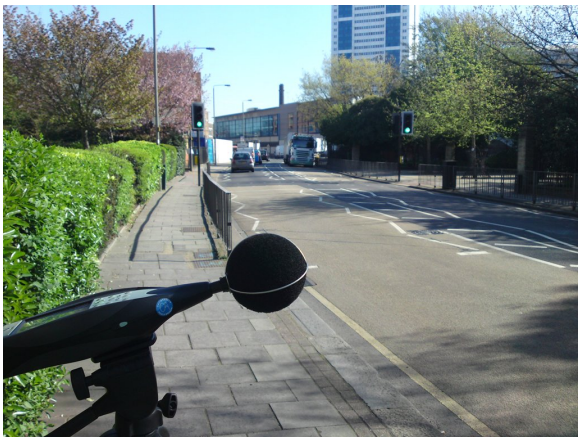
Location Detail: KGP03, on public footpath within King George's Park						
Measurement period	**Noise level (dB(A) free-field)**			**Averaged ambient noise level, $dBL_{Aeq,15min}$**		**$dBL_{Aeq,15min}$ (rounded to nearest 5dB)**
	L_{AFmax}	**$L_{A90,15min}$**	**$L_{Aeq,15min}$**	**Free field**	**Facade**	**Facade**
Daytime (10.00-12.00, 14.00-16.00)	81	51	57-58	57	60*	60

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

Plates of noise measurement locations

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

Vol 9 Plate G.1 Noise measurement location KGP01



Note: On public footpath adjacent to Buckhold Road, looking northeast

Vol 9 Plate G.2 Noise measurement location KGP02

Note: On public footpath adjacent to Neville Gill Close Road, looking east towards Albon House

Vol 9 Plate G.3 Noise measurement location KGP03

Note: On public footpath within King George's Park, looking southeast

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 9 Table G.7.

G.2.4 Time histories of the predicted daytime construction noise levels across the programme of construction works are shown in Plates G.4 to G.10.

Vol 9 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[i]: Table C.2, Item 2	Tracked excavator, 71 t
	Generator 35kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Circular saw cutting timber	1	110	10	BS5228-1: Table D.7, Item 77	Hand-held electric circular saw, 225 mm blade
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Nail guns for erection of hoarding	2	101	10	BS5228-1: Table C.4, Item 95	Handheld cordless nail gun, 15 to 50 mm nails
	Compressor 250cfm	1	93	30	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker,
	Hand-held percussive breaker	1	111	20	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	Oxyaceteline cutting equipment	1	93	10	BS5228-1: Table C.3, Item 35	Hand-held gas cutter, 230 bar

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
site	JCB with hydraulic breaker	1	116	10	BS5228-1: Table D.5, Item 1	Backhoe mounted hydraulic breaker,
	Cutting equipment (diamond saw)	1	108	10	BS5228-1: Table C.4, Item 93	Angle grinder (grinding steel), 4.7 kg
	Compressor 250cfm	1	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker,
	Generator - 200 kVA	1	94	100	BS5228-1: Table C.4, Item 78	Diesel generator,
	Fuel delivery vehicle	1	104	5	BS5228-1: Table C.4, Item 15	Fuel tanker lorry,
	Telescopic Handler/FLT	1	99	30	BS5228-1: Table C.2, Item 35	Telescopic handler, 10 t
	Wheel wash	1	91	20	BS5228-1: Table C.3, Item 13	Water jet pump,
	Water settling/treatment	1	104	100	Measured	Dirty water plant
	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Dewatering Pump	1	105	100	BS5228-1: Table D.7, Item 67	Draining trench water pump, 0.42 m3/s
	Well drilling Rig	1	107	50	Manufacturer	Bauer BBA well drilling rig,
Demolition	Service Crane 25T mobile Crane	1	98	30	BS5228-1: Table C.4,	Wheeled mobile crane,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
General site equipment also applicable during this phase					Item 43	35 t
	Site dumper	1	104	30	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Pneumatic breaker	1	111	20	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Vibrating rollers	2	101	50	BS5228-1: Table C.2, Item 38	Roller, 18 t
Piling for shaft/culvert support	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25 tonne mobile crane	1	98	50	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t
	Vibratory piling rig	1	116	80	BS5228-1: Table C.3, Item 8	Vibratory piling rig, 52 t
Shaft sinking General site equipment also applicable during this phase note: piling and backfilling	Concrete deliveries (aggitating)	1	99	80	BS5228-1: Table C.4, Item 19	Cement mixer truck (idling),
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	12t excavator	1	97	80	BS5228-1: Table C.2, Item 25	Tracked excavator, 14 t
	100t crawler crane	1	103	80	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
	25t mobile crane	1	98	20	BS5228-1: Table C.4,	Wheeled mobile crane,

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
will be concurrent however the two operations will be separated by some distance.					Item 43	35 t
	Vent fans	1	90	100	Measured	Ventilation plant,
	Sump pump	4	105	100	BS5228-1: Table D.7, Item 65	Draining trench water pump,
	25t excavator	1	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Pneumatic breakers	4	111	20	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	400 cfm compressor	1	93	50	BS5228-1: Table C.5, Item 5	Compressor for hand-held pneumatic breaker, 1 t
	Waste collection via skip or tipper lorry	1	106	10	BS5228-1: Table C.8, Item 21	Skip wagon,
Long connection tunnel drive – (TBM disassembly)	250t mobile (dissassembly)	2	106	80	BS5228-1: Table C.4, Item 38	Wheeled mobile telescopic crane, 400 t
Shaft secondary lining	100t crawler crane	1	103	50	BS5228-1: Table C.4, Item 52	Tracked mobile crane, 105 t
General site	Service Crane 40T mobile Crane	1	98	25	BS5228-1: Table C.4, Item 43	Wheeled mobile crane, 35 t

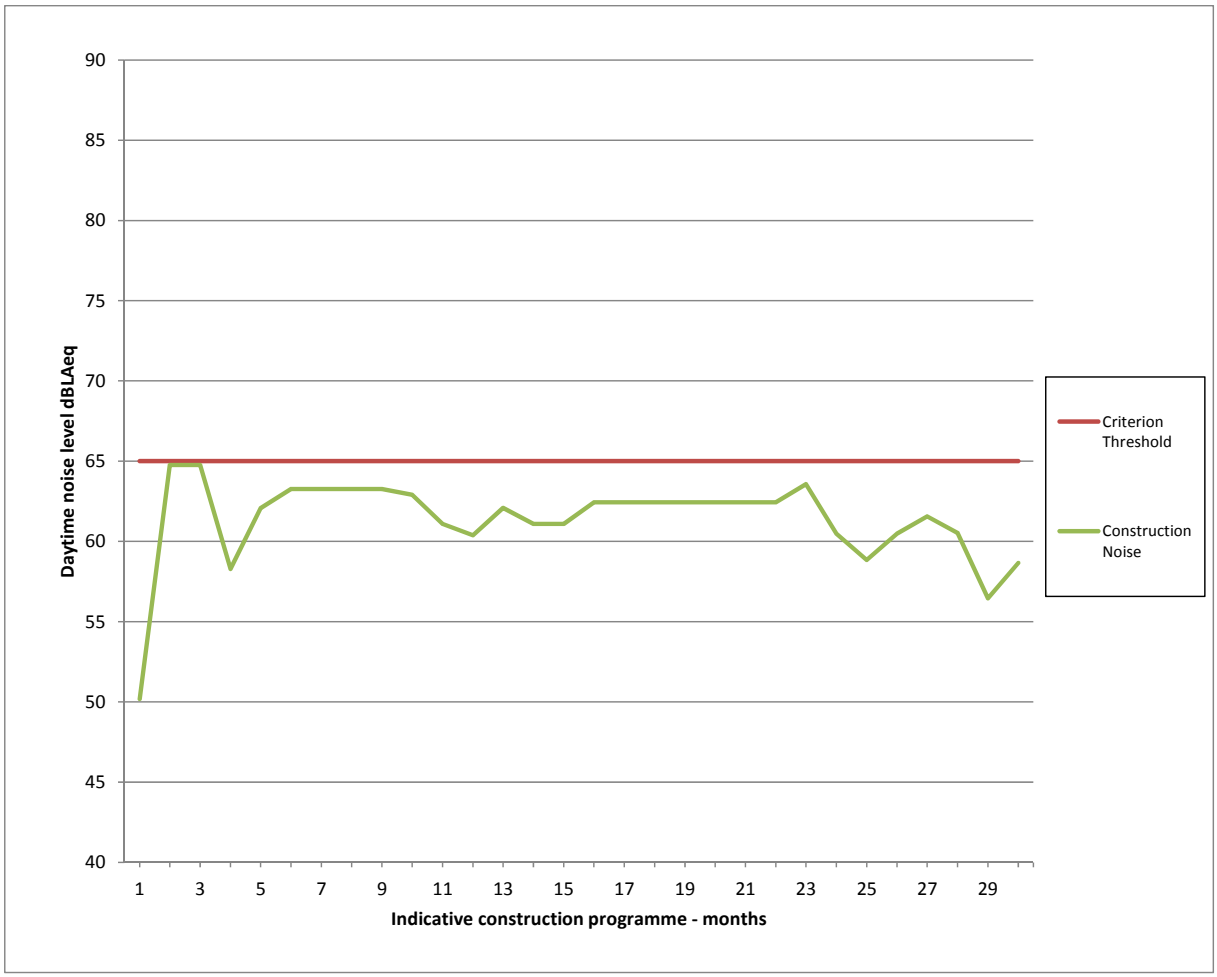
Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
equipment also applicable during this phase	Concrete deliveries (discharging)	1	108	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete pump	2	95	20	BS5228-1: Table C.4, Item 24	Concrete pump + cement mixer truck (discharging), 8 t / 350 bar
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	105	50	BS5228-1: Table C.2, Item 19	Tracked excavator, 25 t
	Dumper	1	104	50	BS5228-1: Table C.4, Item 3	Dumper, 7 t
	Concrete deliveries (discharging)	1	103	20	BS5228-1: Table C.4, Item 18	Cement mixer truck (discharging),
	Concrete boom pump	1	108	20	BS5228-1: Table C.4, Item 29	Truck mounted concrete pump + boom arm, 26 t
	Fixed and portable concrete vibrators	4		20		
Landscaping General site equipment NOT applicable during this	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

Construction activity	Plant	Unit No(s)	Activity LWA (dB)	% on-time	Data Source	Description of equipment used in the assessment
phase	Hiab lorry/crane	1	105	5	BS5228-1: Table C.4, Item 53	Lorry with lifting boom, 6 t
	Compressor for hand-held breaker	1	102	10	BS5228-1: Table C.1, Item 8	Hydraulic breaker power pack, 63 kg/ 138 bar
	Hand-held percussive breaker	1	111	10	BS5228-1: Table C.1, Item 6	Hand-held pneumatic breaker,
	Plate compactors	2	108	10	BS5228-1: Table C.2, Item 41	Vibratory plate (petrol) ,
	Vibrating rollers	1	101	20	BS5228-1: Table C.2, Item 38	Roller, 18 t

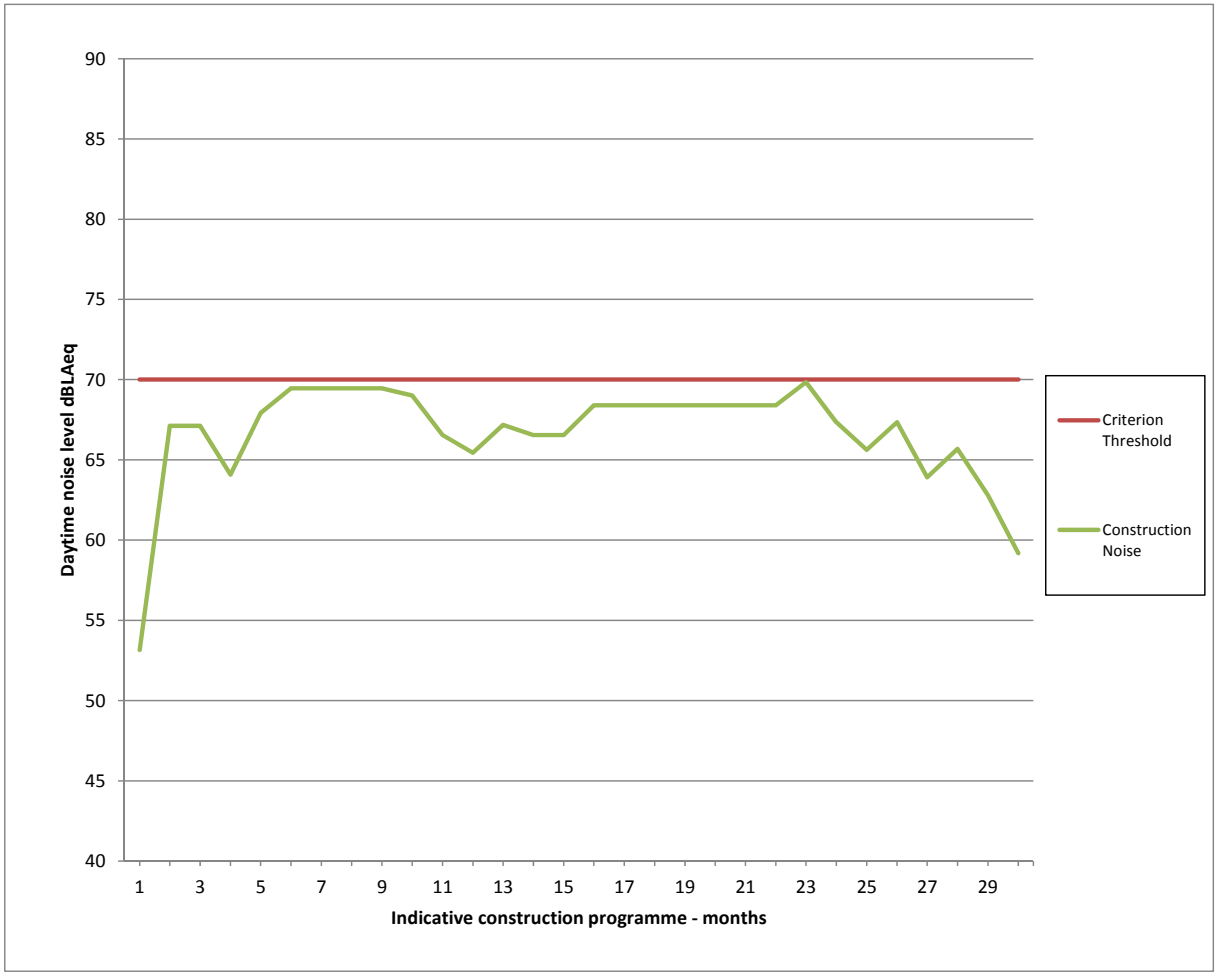
Note: This schedule provides an illustration of typical plant that could be used in the construction of the Thames Tideway Tunnel at this site. The appointed Contractor must comply with section 6 of the CoCP but may vary the method and plant to be used. This schedule therefore represents the most reasonable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

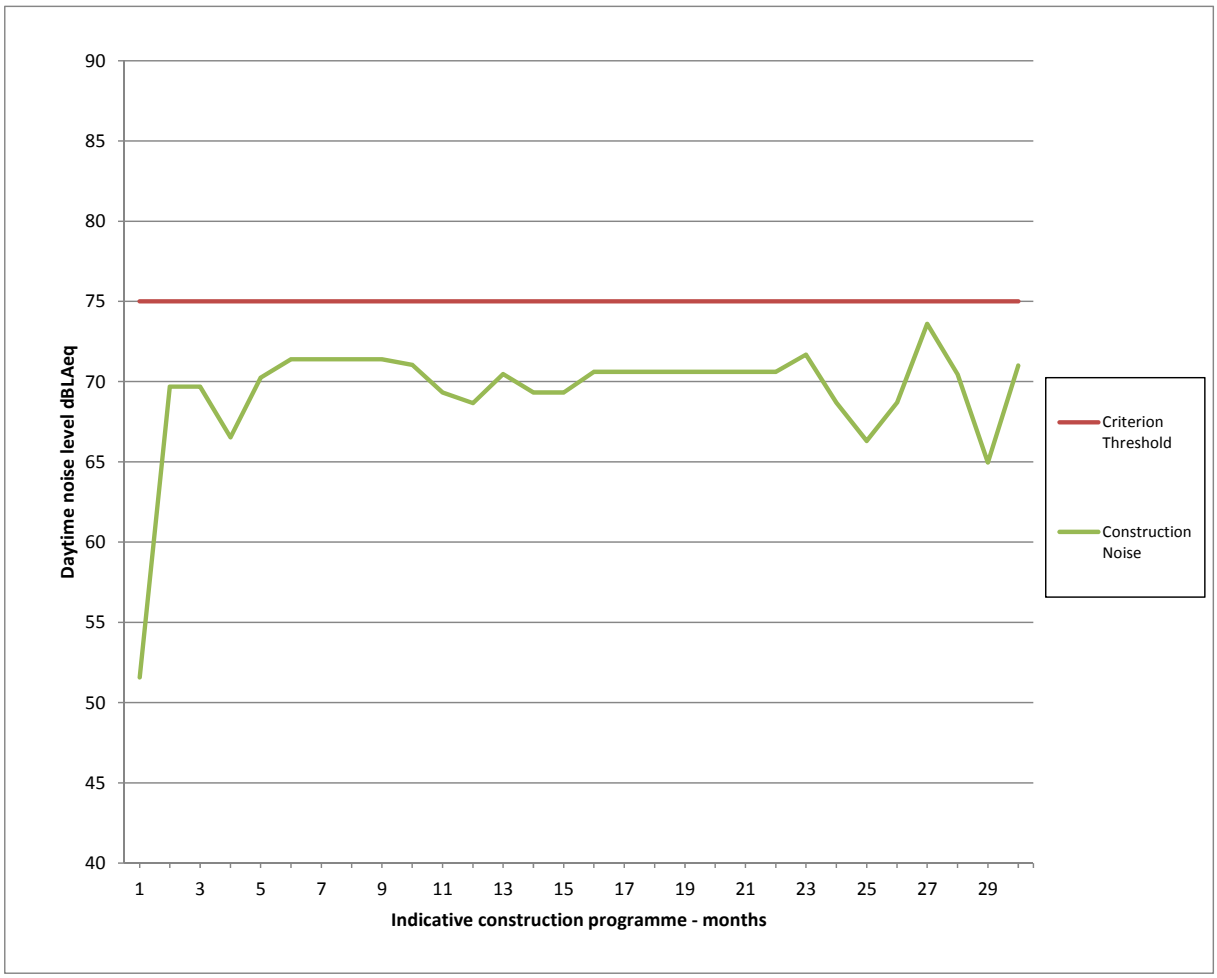
Vol 9 Plate G.4 Average monthly daytime noise level over duration of construction – 55-75 Buckhold Road (KG1)



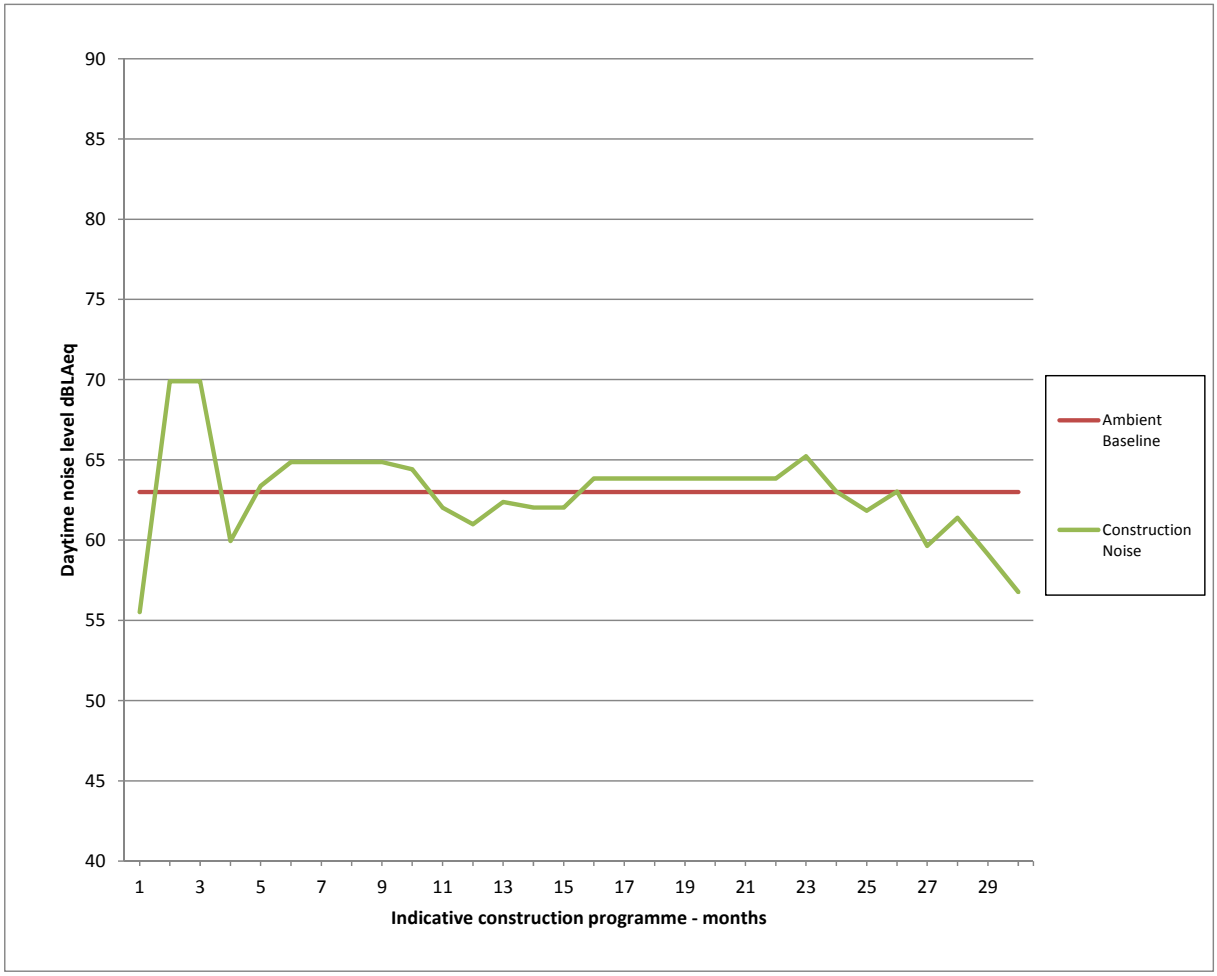
Vol 9 Plate G.5 Average monthly daytime noise level over duration of construction – 1-72 Albon House (KG2)



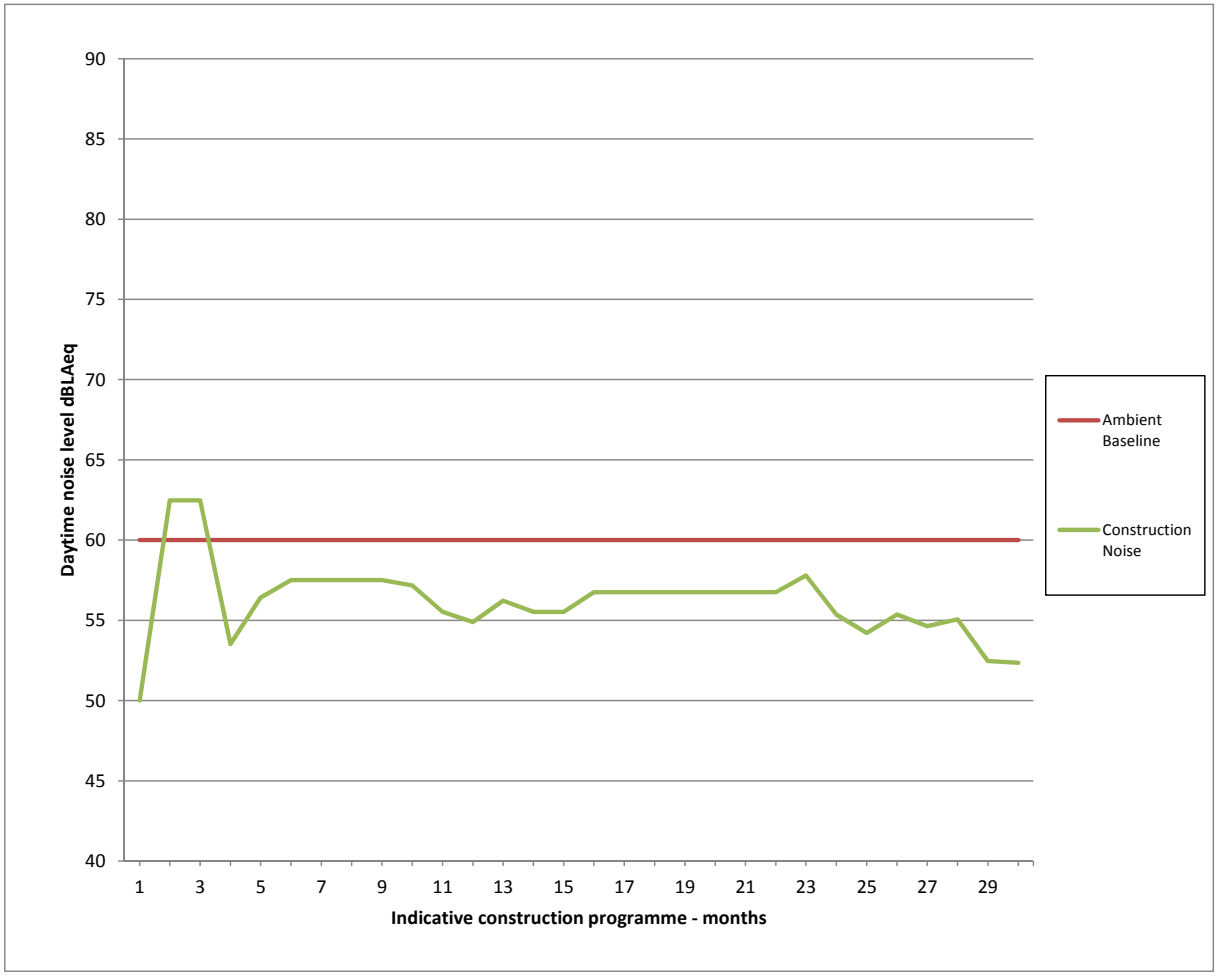
Vol 9 Plate G.6 Average monthly daytime noise level over duration of construction – 1-20 Park View Court (KG3)



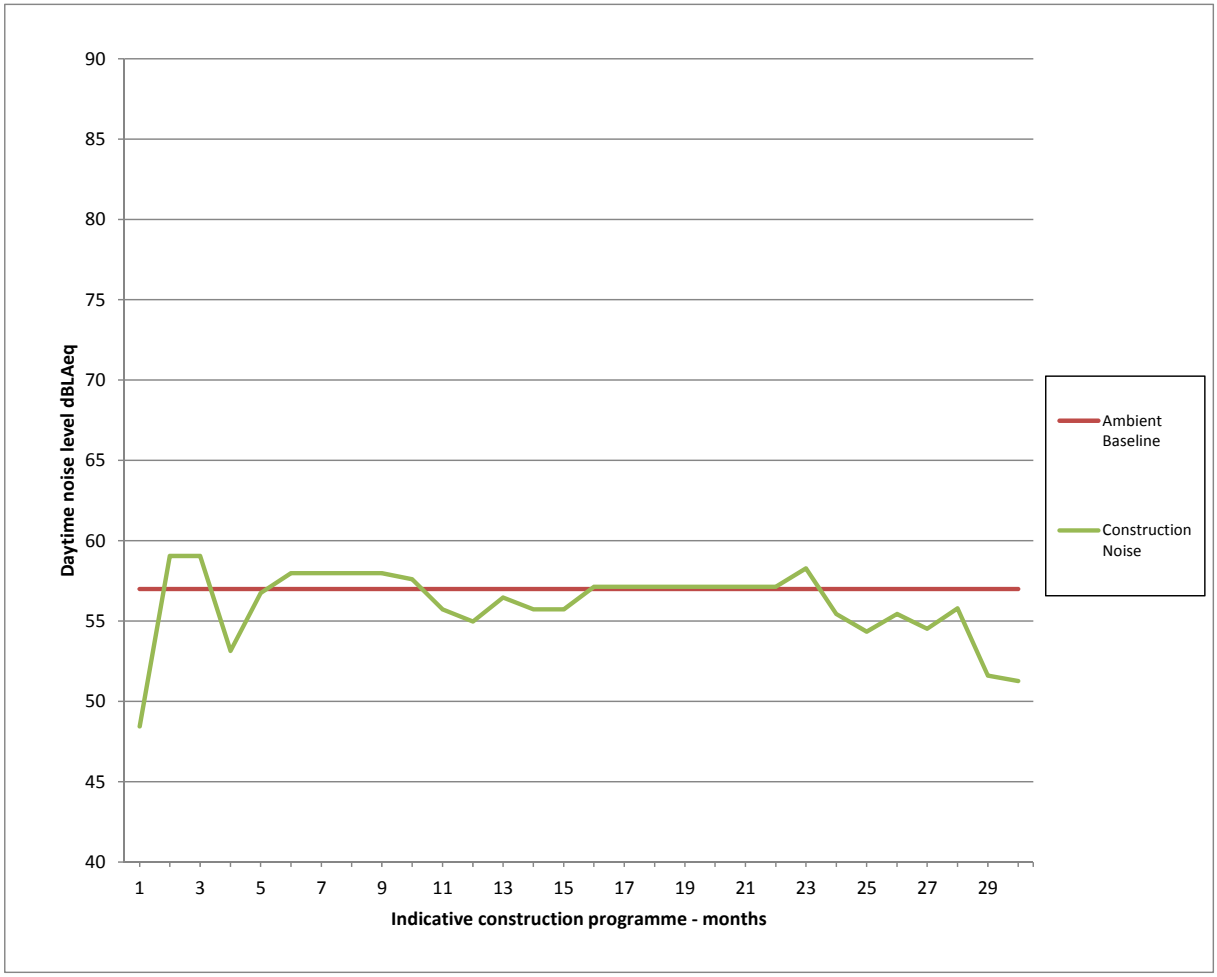
Vol 9 Plate G.7 Average monthly daytime noise level over duration of construction – The Penfold Centre (KG4)



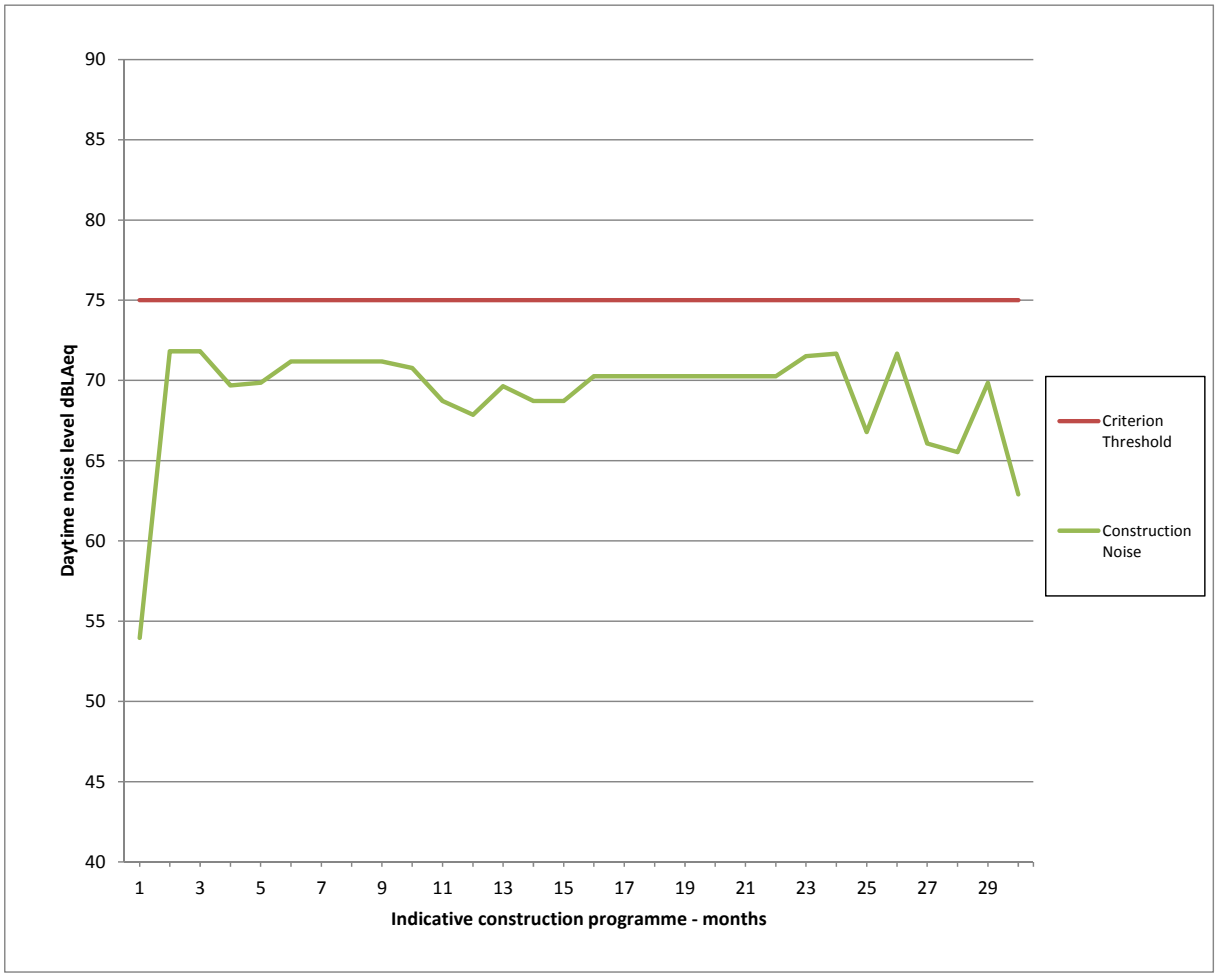
Vol 9 Plate G.8 Average monthly daytime noise level over duration of construction - One O'clock Centre (KG5)



Vol 9 Plate G.9 Average monthly daytime noise level over duration of construction - King George's Park (KG6)



Vol 9 Plate G.10 Average monthly daytime noise level over duration of construction - Cockpen House (KG7)



References

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

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

Appendix H: Socio-economics

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

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 9 King George's Park appendices

Appendix H: Socio-economics

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Appendix H: Socio-economics

H.1 Baseline community profile

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

H.1.2 On the basis of likely impacts on receptors identified in this socio-economic assessment, the community profile examines the 'immediate area' surrounding the construction site (ie, within an assessment area of 250m), the 'wider local area' (ie, within an assessment area of 1km) and the overall borough level (which in this case is the London Borough [LB] of Wandsworth).

H.1.3 The main protected characteristic groups concentrated within 250m and 1km of the proposed construction site are:

a. persons aged under 16 years old

b. persons belonging to Black and Minority Ethnic (BME) groups.

H.1.4 Further detail on the socio-economic profile of the local community is provided below.

Resident population

H.1.5 The resident population was approximately 1,975 within 250m of the construction site and 26,225 within 1km at the time of the last census.

Gender and age

H.1.6 Of the total population within 250m of the site 53.3% of residents are female. Within 1km there is a slightly lower percentage of females (52.2%), however they still remain predominant within a wider local area, the LB of Wandsworth (52.5%) and Greater London (51.6%).

H.1.7 Vol 9 Table H.1 outlines age breakdown by assessment area, it illustrates that the proportion of under 16 year olds within 250m (23.6%) is moderately higher than within 1km (15.8%) and the LB of Wandsworth (16.3%), and somewhat higher than the Greater London level (20.2%).

[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.

Within 250m, the proportion of over 65 year olds (7.0%) is somewhat lower than within 1km (9.3%), moderately lower than the LB of Wandsworth proportion (10.4%) and considerably lower than the Greater London average (12.4%).

Vol 9 Table H.1 Socio-economics – age breakdown by assessment area

Age group	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Under 16 years old	23.6%	15.8%	16.3%	20.2%
Over 65 years old	7.0%	9.3%	10.4%	12.4%

Ethnicity

H.1.8 Vol 9 Table H.2 outlines ethnicity by assessment area, showing that within 250m of the site White residents comprise over half the population (58.7%) with BME groups comprising the remaining 41.3% of residents.

H.1.9 The proportion of White residents within 250m (58.7%) is considerably lower than within 1km (82.9%) and the LB of Wandsworth (78.0%) and somewhat lower than the Greater London average (71.2%).

H.1.10 The proportion of Black residents within 250m of the site (25.7%) is considerably higher than within 1km (7.0%), the LB of Wandsworth (9.6%) and Greater London (10.9%). Proportions of Black residents within LB of Wandsworth and Greater London (9.6% and 10.9% respectively) are slightly higher than within 1km (7.0%).

H.1.11 Within 250m, the proportion of Mixed residents (5.0%) is somewhat higher than the LB of Wandsworth (3.4%) and Greater London (3.2%) levels and considerably higher than within 1km (2.8%).

Vol 9 Table H.2 Socio-economics – ethnicity by assessment area

Ethnicity	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
White	58.7%	82.9%	78.0%	71.2%
BME	41.3%	17.1%	22.1%	28.8%
Asian	7.8%	5.6%	7.0%	12.1%
Black	25.7%	7.0%	9.6%	10.9%
Other	2.7%	1.7%	2.1%	2.7%
Mixed	5.0%	2.8%	3.4%	3.2%

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

Religion and belief

H.1.12 Christians are the predominant religious group within 250m of the site (58.6%), 1km (64.5%) and at a borough wide level (61.8%). Muslims are the second most predominant religious group within all assessment areas. The proportion of Muslims within 250m (10.7%) is approximately twice as high as both within 1km (5.0%) and within the LB of Wandsworth overall (5.2%).

Health indicators

H.1.13 Vol 9 Table H.3 outlines health indicators by assessment area, noting that the proportion of residents suffering from a long term limiting illness within 250m of the site (12.6%) is slightly higher than within 1km (11.4%) and slightly lower than at a borough wide (13.4%) level. There is a slightly lower instance of residents with a long term limiting illness within the above assessment areas in comparison with Greater London.

H.1.14 Disability living allowance claimants within 250m (5.3%) are moderately higher than both within 1km (3.3%) and the borough as a whole (3.9%) and somewhat higher than the Greater London average (4.5%).

Vol 9 Table H.3 Socio-economics – health indicators by assessment area

Health indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
Long term limiting sick	12.6%	11.4%	13.4%	15.5%
Disability living allowance	5.3%	3.3%	3.9%	4.5%

H.1.15 In the Middle Layer Super Output Area (MSOA)[iii][5] which the site falls within, levels of adult obesity are in the second lowest quintile (ie, the lowest being the best). Child obesity for the LB of Wandsworth as a whole, when compared to other London boroughs, is in the third or middle quintile.

H.1.16 Data available at a borough level reveals that the proportion of adults undertaking physical activity falls within the highest quintile (ie, the highest being the best) of all the Greater London boroughs. However, the proportion of children undertaking physical activity falls within the lowest quintile.

H.1.17 Death rates by cancer, heart disease and strokes within the MSOA are all in the lowest or second lowest quintile (ie, the lowest being the best) within

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

the borough, however death rates by circulatory disease are slightly more prevalent and fall within the second highest quintile.

H.1.18 Female life expectancy in the MSOA is in the third (middle) quintile within the borough and male life expectancy is in the second lowest quintile (ie, the lowest being the worst), with average life expectancy of female residents being 81.9 to 83.2 years old and male life expectancy at 80.3 to 81.9 years old.

Lifestyle and deprivation indicators

H.1.19 Vol 9 Table H.4 outlines lifestyle and income deprivation indicators by a relatively high proportion of households within 250m of the site do not own cars (54.1%). This is higher than within 1km (36.6%), the LB of Wandsworth (40.7%) and the Greater London level (37.5%).

H.1.20 The incidence of deprivation[iv] within 250m of the site measured by both income deprivation (72.5%) and overall deprivation (72.5%) is considerably higher than within 1km of the site (5.5% and 5.5% respectively), the LB of Wandsworth (15.4% and 10.1% respectively) and Greater London averages (21.5% and 18.3% respectively).

H.1.21 There appears to be a highly localised and substantial incidence of income deprivation and overall deprivation within 250m of the site. Within 1km of the site however, there is a lower level of deprivation than both the borough wide, and Greater London average.

Vol 9 Table H.4 Socio-economics – lifestyle and income deprivation levels by assessment area

Indicator	Assessment area			
	Immediate area (250m)	Wider local area (1km)	Borough wide (LB of Wandsworth)	Greater London
No car households	54.1%	36.6%	40.7%	37.5%
Income	72.5%	5.5%	15.4%	21.5%
Overall	72.5%	5.5%	10.1%	18.3%

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

H.2 Baseline economic profile

H.2.1 This section presents a profile of the economy local to the proposed construction site at King George's Park.

H.2.2 Data are presented for the geographical area within a radius or 'catchment' of approximately 250m from the boundary of the Limits of land to be acquired or used (LLAU) of the project site. Data are also provided at the overall borough level (which in this case is the London Borough [LB] of Wandsworth) and for Greater London.

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

Employment and businesses

H.2.4 Within 250m of the site there are approximately 3,700 jobs.[vi] Vol 9 Table H.5[vii] illustrates the breakdown of employment by sector based on the UK Standard Industrial Classification (SIC) 2007[7]. It presents data for those sectors which account for more than 5% of total employment within approximately 250m. It can be seen that:

a. Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles accounts for 26% of employment within 250m, considerably more than within the LB of Wandsworth (14%) and Greater London (16%).

b. Administrative and Support Service Activities account for 13% of employment within 250m of the site, considerably more than within the LB of Wandsworth and Greater London (both 8%).

c. Accommodation and Food Service Activities account for 8% to 9% of employment at all three geographical levels.

d. Information and Communication accounts for 8% of employment within 250m, somewhat more than within the LB of Wandsworth (5%) and similar to within Greater London (7%).

e. Public Administration and Defence / Compulsory Social Security accounts for 8% of employment within 250m, considerably greater than within the LB of Wandsworth (less than 1%) and Greater London (2%).

f. Human Health and Social Work Activities account for 5% of employment within 250m, considerably less than within the LB of

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

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

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

Wandsworth (13%) and somewhat less than within Greater London (8%).

g. Professional, Scientific and Technical Activities account for 5% of employment within 250m, considerably less than within the LB of Wandsworth (9%) and around half that within Greater London (11%).

h. Construction accounts for 4% to 5% of employment within 250m at all three geographical levels.

Vol 9 Table H.5 Socio-economics – employment by top eight sectors (2012)

	Assessment area		
Sector (Standard Industrial Code 2007)	**Immediate area (250m)**	**Borough wide (LB of Wandsworth)**	**Greater London**
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	26%	14%	16%
Administrative and Support Service Activities	13%	8%	8%
Accommodation and Food Service Activities	9%	9%	8%
Information and Communication	8%	5%	7%
Public Administration and Defence / Compulsory Social Security	8%	<1%	2%
Human Health and Social Work Activities	5%	13%	8%
Professional, Scientific and Technical Activities	5%	9%	11%
Construction	5%	4%	5%
Other (including unclassified)	20%	38%	35%

H.2.5 Within approximately 250m of the site there are approximately 430 businesses (defined here as business locations[viii]). The split of businesses by sector within 250m generally reflects the breakdown of employment by sector set out in Vol 9 Table H.5, with relatively high proportions engaged in Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles (15%), Information and Communication (11%), Administrative and Support Service Activities (11%) and Accommodation and Food Service Activities (8%).

H.2.6 Vol 9 Table H.6 illustrates the size of businesses in terms of the number of employees at each business location / unit. At all geographical levels, businesses within the smallest size band (one to nine employees) account

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

for the greatest proportion. However, there are a greater number of larger businesses within approximately 250m of the site than within the wider geographical areas. Within 250m, 80% of business units have one to nine employees, compared to 90% within the LB of Wandsworth and 88% within Greater London. Businesses with between ten to 24 employees account for 15% of businesses within 250m of the site, approximately double that within the LB of Wandsworth (7%) and Greater London (8%).

H.2.7 For the sectors accounting for the greatest proportion of jobs and businesses within approximately 250m, the size banding profile of businesses varies somewhat. Within the Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles sector, 24% of businesses employ ten to 24 employees, similar to the Administration and Support Service Activities sector (26%) and the Accommodation and Food Service Activities sector (32%). However, the proportion of businesses of this size within the Information and Communication sector is 6% and is 15% across all sectors.

Vol 9 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)	80%	15%	3%	1%	1%	0%
Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles	64%	24%	6%	3%	3%	0%
Information and Communication	89%	6%	2%	2%	0%	0%
Administrative and Support Service Activities	63%	26%	7%	4%	0%	0%
- *Accommodation and Food Service Activities*	65%	32%	0%	3%	0%	0%
Borough wide (LB of Wandsworth)	90%	7%	2%	1%	0%	0%
Greater London	88%	8%	2%	1%	1%	0%

H.3 Baseline usage surveys

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

Survey dates and times

H.3.2 Surveys were undertaken as follows.

Summer

a. Friday 19th August, 7am to 7pm (sunny, 17OC at midday)

b. Sunday 21st August 2011, 11am to 5pm (cloudy at first then sunny, 20OC to 23OC)

Autumn

a. Wednesday 5th October 2011, 7am to 10am (partly sunny, 11°C to 15°C) and 1pm to 4pm (partly sunny, 15°C)

b. Saturday 8th October 2011, 10am to 3pm (overcast, 12°C)

Survey zones

H.3.3 Vol 9 Figure H.1 (see separate volume of figures) shows the location of the survey areas listed in H.1.1.

Vol 9 Table H.7 Socio-economics – open space survey zones and duration of survey period

Name	Location	On-site survey duration	Frequency
Survey zone 1	Northern entrance to park	10 minutes	Hourly
Survey zone 2	Northern lawn area	10 minutes	Hourly
Survey zone 3	Footpath north of lake	10 minutes	Hourly
Survey zone 4	Bowling green and tennis courts	10 minutes	Hourly
Survey zone 5	Southern lawn area	10 minutes	Hourly

Key findings and observations

Survey zones 1, 2 and 3 – Northern entrance to Park, northern lawn area, footpath north of lake

H.3.4 These zones experienced generally light use, predominantly by walkers, who accounted for over 90% of users on each survey day across the three zones in total. The lawn itself was used for passive recreation on two occasions, both recorded on Friday 19th August. The seating at the pathway junction was rarely used during survey periods.

H.3.5 The majority of users (on average 80%) of the zones were White, and generally either young adults (18 to 39 years old) or older adults (40 to 59 years old), sometimes accompanied by children.

Vol 9 Table H.8 Socio-economics – average usage levels by type of use at survey zones 1, 2 and 3

Date	Survey zone	Average number of users during 10 minute observation period				
		Walkers	Joggers	Dog walkers	Cyclists	Passive recreation
Summer						
Friday 19th August	Zone 1	5	-	-	-	-
	Zone 2	2	-	-	-	1
	Zone 3	6	-	-	-	-
Sunday 21st August	Zone 1	3	1	1	-	-
	Zone 2	3	-	-	-	-
	Zone 3	7	-	1	-	-
Autumn						
Wednesday 5th October AM	Zone 1	1	-	-	1	-
	Zone 2	3	-	-	1	-
	Zone 3	12	-	-	1	-
Wednesday 5th October PM	Zone 1	4	-	-	-	
	Zone 2	1	-	1	-	-
	Zone 3	14	-	-	-	-
Saturday 8th October	Zone 1	4	-	-	-	-
	Zone 2	3	-	-	-	-
	Zone 3	6	-	-	-	-

Survey zone 4 – Bowling green and tennis courts

H.3.6 The single bowling green was used on both summer survey days, from around 12pm and for between 1 to 3 hours on each occasion. It was not seen to be used during the autumn surveys. All recorded users were White, and over 80% were aged over 40 years old.

The ten tennis courts were generally well utilised, being busiest at weekends, with up to 34 users recorded during a summer observation. In autumn, weekend user numbers were only slightly lower, though it should be noted that surveys took place during a spell of warmer than average weather.

H.3.7 The majority of users were White (averaging over 90% on all survey days), and though some children and older adults (40 to 59 years old) were recorded, young adults (18 to 39 years old) accounted for over 50% of users.

H.3.8 See Vol 9 Table H.9 for more details on the use of these spaces.

Vol 9 Table H.9 Socio-economics – usage level by type of use and demographic characteristics at survey zone 4

Date	Time of survey	Bowling green	Tennis courts	Approximate age (number of users)			Gender (approximate %)	
				0-17	18-39	40+	M	F
Summer								
Friday 19th	07:35 - 07:45	-	2	-	2	-	50	50

Date	Time of survey	Bowling green	Tennis courts	Approximate age (number of users)			Gender (approximate %)	
				0-17	18-39	40+	M	F
August (school holidays)	08:35 - 08:45	-	1	-	-	1	100	-
	09:35 - 09:45	-	7	1	6	-	57	43
	10:35 - 10:45	-	11	4	7	-	55	45
	11:35 - 11:45	2	8	3	5	2	50	50
	12:35 - 12:45	-	-	-	-	-	-	-
	13:35 - 13:45	10	10	-	10	10	75	25
	14:35 - 14:45	10	6	-	8	8	50	50
	15:35 - 15:45	10	6	1	5	10	50	50
	16:35 - 16:45	-	4	-	1	3	75	25
	17:35 - 17:45	-	2	-	2	-	50	50
	18:35 - 18:45	-	18	9	9	-	50	50
Sunday 31st August	11:35 - 11:45	-	16	-	16	-	67	33
	12:35 - 12:45	6	20	-	26	-	61	39
	13:35 - 13:45	-	24	-	24	-	63	37
	14:35 - 14:45	2	30	7	22	3	70	30
	15:35 - 15:45	-	30		30	-	47	53
	16:35 - 16:45	-	34	14	20	-	58	42
Autumn								
Wednesday 5th October AM	07:45 - 07:55	No usage observed during survey	2	-	2	-	100	-
	08:45 - 08:55		6		2	4	67	33
	09:45 - 09:55		13	-	13	-	85	15
Wednesday 5th October PM	13:35 - 13:45	No usage observed during survey	2	-	-	2	100	-
	14:35 - 14:45		2	-	-	2	100	-
	15:35 - 15:45		6	-	6	-	67	33
Saturday 8th October	10:00 - 10:10	No usage observed during survey	23	17	6	-	70	30
	11:00 - 11:10		15	-	14	1	80	20
	12:00 - 12:10		15	-	15	-	80	20
	13:00 - 13:10		28	2	26	-	72	28
	14:00 - 14:10		20	-	20	-	75	25

Survey zone 5 – Southern lawn / picnic area

H.3.9 This largely open grassed area, containing tables for passive recreation, was generally lightly used during survey periods. An exception was the summer weekend survey when a number of picnics were taking place, with a peak of 21 users being recorded.

H.3.10 The area also experienced use as a thoroughfare to and from the small playground to the north.

H.3.11 Though some usage by ethnic minorities was observed, the majority of users (over 60%) were White, and were mostly part of small family groups

of mixed ages, or, in the case of walkers, young adults (18 to 39 years old) accompanied by children.

Other findings

H.3.12 The children's play area located between survey zone 2 and 5 (surveyed using momentary observation techniques) was generally well used, particularly around late mornings and early afternoons. User numbers were highest during the weekday autumn survey when the adjacent King George's Park One O'Clock Club was open.

H.3.13 The ornamental rose garden directly to the south of the bowling green was moderately used for walking and passive recreation during summer surveys, with up to 20 users recorded. Lower levels of usage were noted during autumn surveys.

H.3.14 Seating along the park's main walkway (west of the lake) was observed to be less than 50% used during most survey periods.

H.3.15 The managed younger children's playground was used less frequently, and generally during the middle of the day and early afternoon during weekdays (in accordance with the playground opening times). The play facilities were used predominantly by 0 to 4 year olds.

H.3.16 Overall, the ethnicity of the majority of users in the areas surveyed was White, though the tennis courts were observed to have a greater ethnic diversity than other areas. See Vol 9 Table H.10 for further details.

Vol 9 Table H.10 Socio-economics – approximate ethnicity of users across all King George's Park survey zones

Date	Ethnicity (approximate %)			
	Black	E. Asian	S. Asian	White
Summer				
Friday 19th August (school holidays)	5	-	2	93
Sunday 31st August	10	3	7	80
Autumn				
Wednesday 5th October AM	15	5	-	80
Wednesday 5th October PM	20	5	5	70
Saturday 8th October	20	-	5	75

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

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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J.1 Introduction

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Appendix K: Water resources - groundwater

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Appendix K: Water resources – groundwater

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Appendix K: Water resources – groundwater

K.1 Geology

K.1.1 A summary of the anticipated geological succession at the King George's Park site is shown in Vol 9 Table K.1.

Vol 9 Table K.1 Groundwater – anticipated geological succession

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

K.1.2 The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey – BGS (BGS, 2009)[1], is shown in Vol 9 Figure 13.4.1 and Vol 9 Figure 13.4.2 respectively (see separate volume of figures).

K.1.3 The ground investigation undertaken for the Thames Tideway Tunnel project has involved drilling boreholes both on the banks and within the main river channel for the purposes of understanding the geology and hydrogeology within the assessment area. The depths and thicknesses of geological layers are based on ground investigation boreholes drilled in close proximity to the site; these are boreholes SR1109, at approximately 60m to the north and SA1110 at approximately 20m to the south. The locations of boreholes around King's George Park are shown in Vol 9 Figure 13.4.1 see separate volume of figures. The depths and thicknesses of geological layers encountered is summarised in Vol 9 Table K.2.

Vol 9 Table K.2 Groundwater – anticipated ground conditions

Formation	Top elevation* (mATD)**	Depth below ground level (m)	Thickness (m)
Made Ground	105.34	0.00	3.60
Alluvium	101.74	3.60	0.40
River Terrace Deposits	101.34	4.00	0.50
London Clay Formation			

Formation	Top elevation* (mATD)**	Depth below ground level (m)	Thickness (m)
B	100.84	4.50	27.50
A3ii	73.34	32.00	12.00
A3i	61.34	44.00	2.50
A2	58.84	46.50	11.00

** Based on an assumed ground level of 105.34mATD*
***mATD = metres above tunnel datum. A commonly used term for sub-surface construction projects, which defines height above a datum set at -100mAOD (above Ordnance Datum).*

K.1.4 The combined sewer overflow (CSO) drop shaft and base slab at King George's Park would extend down to approximately 84.9mATD and 82.9mATD respectively and would pass through the Made Ground, Alluvium, River Terrace Deposits and into the London Clay Formation, unit B.

K.1.5 The interception chamber and culvert approximately 6.56m deep, as assumed for the purpose of this assessment, would extend down to 99mATD into the London Clay Formation, unit B.

K.1.6 The invert of the Frogmore connection tunnel would also be within the London Clay Formation, unit A3.

K.1.7 The Made Ground, containing sandy gravely silt with occasional brick and concrete fragments, is expected to be 3.6m thick at the site.

K.1.8 The Alluvium, comprising silty clay and clayey silt, with occasional scattered pebbles and granules, is expected to be 0.4m thick at the site.

K.1.9 The River Terrace Deposits are formed of extensive alluvial sand and gravel deposits laid down in river terraces by a braided river system of approximately 5km width, in river terraces since the Anglian glaciation. The River Terrace Deposits at King's George Park are expected to be 0.5m thick.

K.1.10 The London Clay is comprised of firm to very stiff clay, slightly sandy and slightly gravely in places and fissured in places. The London Clay is divided into sub-units referred from oldest to youngest as A to E, with some of these sub-units dividing further, for example A1, A2, A3i-iii in decreasing age order. The London Clay formation is expected to be 53m thick at the site.

K.2 Hydrogeology

K.2.1 A summary of the anticipated hydrogeological conditions at King George's Park is shown in Vol 9 Vol 9 Table K.3.

Vol 9 Table K.3 Groundwater – anticipated hydrogeological units

Group	Formation	Hydrogeology
Superficial deposits	Made Ground Alluvium	Confining layer[i]
	River Terrace Deposits	Upper aquifer
Thames	London Clay Formation	Aquiclude[ii]

K.2.2 The Made Ground and Alluvium overlie the River Terrace Deposits or upper aquifer. The ground investigation boreholes drilled on site indicate that these superficial deposits were drilled dry and comprise of low permeability material. These superficial deposits act to confine the underlying River Terrace Deposits at this location.

K.2.3 The upper aquifer (River Terrace Deposits) is defined by the Environment Agency (EA) as a secondary A aquifer. These deposits are described as "permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers" (EA*, 2012)*[2].

K.2.4 The lower aquifer, comprising of the Upnor Formation, the Thanet Sands and the Chalk, is not expected to be encountered by the Thames Tideway Tunnel project at the King George's Park site.

K.2.5 The CSO drop shaft would pass through the upper aquifer and into the London Clay Formation (B sub division). This is generally acknowledged as an aquiclude between the upper and lower aquifers. Any groundwater present is likely to consist of localised seepages and/or minor flows. It is anticipated that below the River Terrace Deposits the shaft would be excavated in predominantly dry London Clay Formation with the exception of minor seepage at various horizons, namely silt or claystone horizons.

K.3 Groundwater level monitoring

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

K.3.2 For the *Environmental Statement* (ES), there were no groundwater level monitoring boreholes specifically dedicated to the River Terrace Deposits or upper aquifer at the King George's Park site. Information on groundwater levels for this assessment was therefore collected from two ground investigation boreholes located at the Dormay Street site (SR1108 and PR1107 at 341m and 432m respectively), these locations are shown

[i] *Confining layer – units of low permeability that bound an aquifer (Schwartz & Zhang, 2003).*

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

in Vol 9 Figure 13.4.1 (see separate volume of figures). These boreholes have response zones[iii] (EA, 2006)[3] and monitor groundwater levels in the River Terrace Deposits. The response zone depths, the monitored strata and the frequency of monitoring are detailed in Vol 9 Vol 9 Table K.4. The manual dip data collected from these monitoring boreholes is shown in Vol 9 Vol 9 Table K.5.

Vol 9 Table K.4 Groundwater – monitoring boreholes

Borehole	Response zone depths mATD	Strata	Monitoring type and frequency
PR1107	100.95-98.95	River Terrace Deposits	Fortnightly manual dips
SR1108	102.68-100.68	River Terrace Deposits	Monthly dips

Vol 9 Table K.5 Groundwater – summary level data

Borehole	Period of record	Maximum		Minimum		Average over period of record	
		Mbgl	mATD	mbgl	mATD	mbgl	mATD
PR1107	20/10/2009 – 02/08/2012	2.13 (August 2012)	102.32 (August 2012)	3.03 (Dec. 2009)	101.42 (Dec. 2009)	2.56	101.89
SR1108	28/05/2009 – 12/07/2012	2.35 (May 2012)	102.33 (May 2012)	2.79 (August 2010)	101.89 (August 2010)	2.59	102.09

K.3.3 The recorded water levels in the River Terrace Deposits at PR1107 and SR1108 range between 101.42mATD and 102.33mATD. There is a 0.6m differential between the two borehole groundwater levels; as SR1108 is located closer to site it is considered to be more representative of site conditions. The water levels consistently remain above the top of the River Terrace Deposits, which is at 100.01mATD. This suggests that these deposits are fully saturated and are confined by the overlying Made Ground and Alluvium at these locations.

K.3.4 A plot of groundwater levels within the superficial deposits in the vicinity of the site is shown in Vol 9 Figure 13.4.3 (see separate volume of figures). There are only two boreholes in the upper aquifer (PR1107 and SR1108) near the King George's Park site and as such it is difficult to determine the direction of groundwater flow. However it is likely that the direction of groundwater movement is towards the north in the general direction of the River Thames in these shallow deposits.

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

K.3.5 There are no EA monitoring boreholes sufficiently close enough to provide representative water level in the upper aquifer for the site.

K.4 Groundwater abstractions and protected rights

Groundwater licensing policy

K.4.1 The London Catchment Abstraction Management Strategy (CAMS), (EA, 2006)7 does not identify a condition status for the upper aquifer.

K.4.2 The status of the lower aquifer is not relevant to this assessment as the construction would not reach to this depth at the King George's Park site.

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

Licensed abstractions

K.4.4 The EA licenses abstractions from groundwater within London for all sources in excess of 20m^3/d. There are no licensed groundwater abstractions within 1km of the site.

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

K.4.6 There are no known unlicensed groundwater abstractions within a 1km of the King George's Park site.

Vol 9 Table K.6 Groundwater – licensed abstractions

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

K.5 Groundwater source protection zones

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

K.5.2 There are no SPZs for a Chalk source delineated within the vicinity of site. The nearest of these lies approximately 4km to the northeast.

K.6 Environmental designations

K.6.1 King George's Park is locally designated as Site of Nature Conservation Interest (SNCI).

K.6.2 The lake within the northern part of the King George's Park is understood to be a lined water body[4]. Whilst the water used to top up the lake water comes from the lower aquifer nearby, it is the case that the lake is not hydraulically in connection with the upper aquifer.

K.7 Groundwater quality and land quality assessment

K.7.1 Historical land use mapping, reviewed as part of the land quality assessment, at the King George's Park site has identified no on site potentially contaminative land uses (Vol 9 Section 8). A Colour Works plant was located 200m southeast of site which is considered a potential contaminative source. In the surrounding area there has been two recorded pollution incidents to controlled waters at the Traders Hall, directly east of the site, and by All Saints Church on Wandsworth High Street. 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 9 Vol 9 Table K.7 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tideway Tunnel project and includes data from monitoring boreholes located in close proximity to the site (SA1110) and up to 1km of the site (SR1108, PR1109 and SR1102A), these locations are listed in Vol 9 Figure 13.4.1 (see separate volume of figures). The origin of these boreholes and groundwater quality data is detailed in Vol 9 Vol 9 Table K.7. Any exceedances of the UK drinking water standards (The Water Supply Regulations, 2000)[5] or relevant Environmental Quality Standards (EQS) (River Basin Districts Typology…, 2010)[6] are shaded in blue in this table.

K.7.3 The data shows only one exceedance of the relevant standards with respect to sodium in close proximity to the site (at SA1110) and several exceedances with respect to hydrocarbons, pesticides and heavy metals at distance from the site (at PR1107 and SR1102A).

K.7.4 The EA monitors groundwater quality at a number of points across London, mainly the Chalk and Lower London Tertiaries (Lambeth Group) (EA, 2006)[7]. Although part of this network lies within King George's Park (PGWU1514), this borehole monitor water quality in the lower aquifer only and is therefore not relevant as construction would take place entirely with the superficial deposits and the London Clay.

K.7.5 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show several exceedances of the human health screening values[8] (soil guideline values designed to be protective of human health) within respect to heavy metals and hydrocarbons in the River Terrace Deposits. Further detail is provided in the land quality assessment (see Vol 9 Appendix F).

Vol 9 Table K.7 Groundwater – groundwater quality results

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT
Name				SA1110	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	PR1107	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A
Hydrogeological unit**				MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			61m	341m	341m	341m	341m	341m	341m	341m	432m	1023m	1023m	1023m	1023m	1023m	1023m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	3/11/2011	16/1/2012	16/4/2012	18/5/2012
1,1,1 - Trichloroethane	100	ug/l	SW Regs 98	-	-	<0.08	<0.08	<0.08	-	< 0.08	<0.08	-	-	<0.08	<0.08	<0.08	-	< 0.08
1,1,2 - Trichloroethane	400	ug/l	SW Regs 98	-	-	<0.2	<0.2	<0.2	-	< 0.2	<0.2	-	-	<0.2	<0.2	<0.2	-	< 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	<0.12	<0.12	-	< 0.12
2,3 - Dimethylphenol {2,3-Xylenol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	-	<0.0500	-
2,3,5,6 - Tetrachloroaminobenzene {2,...Aniline}	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	<0.00500	-
2,4 - Dichlorophenol	20	ug/l	WFD 2010	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
2,4 - Dimethylphenol {2,4-Xylenol}	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
2,4,6 - Trichlorophenol	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
2,6 - Dichlorophenol	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
2,6 - Dimethylphenol {2,6 Xylenol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	-	<0.0500	-
3,4 - Dimethylphenol {3,4 Xylenol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	-	<0.0500	-
4 - Chloro - 3- Methylphenol {P-Chloro-M-Cresol}	40	ug/l	WFD 2010	0.2	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
4-Methylphenol {para-Cresol}	-	ug/l	None	-	-	-	-	-	<0.0500	-	<0.05	-	-	-	-	-	<0.0500	-
Acenaphthene	-	ug/l	None	<0.01	<0.01	-	-	-	-	-	-	<0.01	170	-	-	-	-	-
Acenaphthylene	-	ug/l	None	<0.01	<0.01	-	-	-	-	-	-	<0.01	6.9	-	-	-	-	-
Acenapthene	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	16	-
Acenapthylene	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	0.53	-
Aliphatics >C10-C12	-	ug/l	None	-	<1	-	-	-	-	-	-	2	<0.1	-	-	-	-	-
Aliphatics >C12-C16 (Aqueous)	-	ug/l	None	-	8	-	-	-	-	-	-	4	<1	-	-	-	-	-
Aliphatics >C16-C21 (Aqueous)	-	ug/l	None	-	15	-	-	-	-	-	-	5	4	-	-	-	-	-
Aliphatics >C21-C35 (Aqueous)	-	ug/l	None	-	14	-	-	-	-	-	-	14	16	-	-	-	-	-
Aliphatics >C6-C8	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
Aliphatics >C8-C10	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
Aliphatics C5-C6	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	7.4	-	-	-	-	-
Alkalinity (Carbonate)	-	mg/l as CaCO3	None	-	-	-	<4	-	-	-	-	-	-	-	<4	-	-	-
Alkalinity Ph 4.5 - As CaCO3	-	mg/l as CaCO3	None	1900	300	234	212	<4	-	218	<4	200	490	472	490	<4	-	< 4.00
Aluminium Dissolved	200	ug/l as Al	DWS 2010	-	-	-	-	-	0.039	-	0.019	-	-	-	-	-	0.013	-
Aluminium Total	200	ug/l as Al	DWS 2010	-	-	46	26	0.025	-	0.038	0.042	-	-	<5	28	0.028	-	0.016
Ammonia - As N	0.39	mg/l as N	WS Regs 20	-	-	0.08	0.25	0.25	-	0.06	0.08	-	-	<0.05	4.2	4.3	-	4.34
Ammoniacal nitrogen	-	mg/l	None	2.4	0.42	-	-	-	-	-	-	0.76	7.9	-	-	-	-	-
Anthracene	0.1	ug/l	SW WFD	<0.01	<0.01	-	-	-	<0.01	-	<0.01	0.03	<0.01	-	-	-	0.1	-
Antimony Total	5	ug/l	DWS 2010	-	-	-	-	-	2.9	-	3.9	-	-	-	-	-	0.4	-
Aromatics >C7-C8	50	ug/l	WFD 2010	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
Aromatics >EC10-EC12	-	ug/l	None	-	4	-	-	-	-	-	-	4	<0.1	-	-	-	-	-
Aromatics >EC12-EC16 (Aqueous)	-	ug/l	None	-	7	-	-	-	-	-	-	5	2	-	-	-	-	-
Aromatics >EC16-EC21 (Aqueous)	-	ug/l	None	-	15	-	-	-	-	-	-	8	34	-	-	-	-	-
Aromatics >EC21-EC35 (Aqueous)	-	ug/l	None	-	40	-	-	-	-	-	-	14	64	-	-	-	-	-
Aromatics >EC8-EC10	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
Aromatics C6-C7	1	ug/l	DWS 2010	<0.1	<0.1	-	-	-	-	-	-	<0.1	19	-	-	-	-	-
Arsenic Total	10	ug/l as As	DWS 2010	<1	2	4.1	3	3.7	-	3.8	3.7	<1	11	41.2	36	38	-	31
Atrazine { }	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	-	<0.00800	<0.00800	-	-	<0.00300	<0.00300	<0.04000	-	<0.00800
Barium Dissolved	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	16	-	12	-	-	-	-	-	160	-

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT
Name				SA1110	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	PR1107	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A
Hydrogeological unit**				MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			61m	341m	341m	341m	341m	341m	341m	341m	432m	1023m	1023m	1023m	1023m	1023m	1023m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	3/11/2011	16/1/2012	16/4/2012	18/5/2012
Barium Total	100	ug/l as Ba	SW Regs 96	-	-	-	-	-	16	-	56	-	-	-	-	-	160	-
Bentazone	0.1	ug/l	DWS 2010	-	-	<0.00800	<0.00800	<0.00800	-	<0.00800	<0.00800	-	-	<0.08000	<0.03200	<0.00800	-	-
Benz[a]-Anthracene	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	0.04	-
Benzene	1	ug/l	DWS 2010	<1	<1	<0.07	0.08	<0.07	<0.07	< 0.07	<0.07	<1	110	0.31	<0.07	0.6	1.81	0.95
Benzene (Ethylbenzene)	20	ug/l	FW List II	-	-	-	-	-	<0.06	-	<0.06	-	-	-	-	-	<0.06	-
Benzo (a) anthracene	-	ug/l	None	<0.01	<0.01	-	-	-	-	-	-	<0.01	1.2	-	-	-	-	-
Benzo[a]Pyrene	0.01	ug/l	DWS 2010	<0.01	<0.01	<0.00500	<0.00500	<0.00500	<0.01	<0.00500	<0.00500	<0.01	0.05	0.00730	<0.00500	<0.02500	<0.01	<0.00500
Benzo[b]Fluoranthene	0.03	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.12	-	-	-	<0.01	-
Benzo[g,h,i]Perylene	0.002	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.01	-	-	-	<0.01	-
Benzo[k]Fluoranthene	0.03	ug/l	WFD D 10	0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.06	-	-	-	<0.01	-
Bifenthrin	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	<0.00500	-
Boron Dissolved	1000	ug/l as B	DWS 2010	-	-	-	-	-	170	-	150	-	-	-	-	-	420	-
Boron Total	1000	ug/l as B	DWS 2010	250	370	220	160	170	-	0.15	0.17	350	410	340	360	330	-	0.37
Bromate	10	ug/l as BrO3	DWS 2010	-	-	<0.5	<0.5	0.6	-	< 0.5	<0.5	-	-	<0.5	<0.5	<0.5	-	< 0.5
Cadmium Total	5	ug/l as Cd	DWS 2010	<2	<2	<1.5	<1.5	<1.5	<1.5	< 1.5	<1.5	<2	<2	<1.5	<1.5	<1.5	<1.5	< 1.5
Calcium Total	250	mg/l as Ca	DWS 2010	-	-	130	100	330	-	< 7.4	110	-	-	180	190	180	-	200
Carbendazim / Benomyl	0.1	ug/l	FW List II	-	-	<0.00300	<0.00300	<0.00300	-	<0.00500	<0.00500	-	-	<0.00300	<0.00300	-	-	<0.00500
Carbetamide	-	ug/l	None	-	-	<0.00600	<0.00600	<0.00600	-	<0.01000	<0.01000	-	-	<0.00600	<0.00600	-	-	<0.01000
Carbon Dioxide	-	ug/l	None	-	-	-	-	-	22400	-	16500	-	-	-	-	-	3500	-
Carbon Organic Dissolved	-	mg/l as C	None	-	-	-	-	-	3.3	-	3.2	-	-	-	-	-	4.9	-
Carbon tetrachloride	3	ug/l	DWS 2010	-	-	<0.07	<0.07	<0.07	-	< 0.070	<0.070	-	-	<0.07	<0.07	<0.07	-	< 0.070
Chlorfenvinphos	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900
Chloride	250	mg/l as Cl	DWS 2010	-	200	80.2	69.2	88.5	-	72.8	60	130	55	153	184	123	-	160
Chloroform	100	ug/l	WS Regs 20	-	-	<0.6	<0.6	<0.6	-	1.41	1.25	-	-	<0.6	<0.6	<0.6	-	< 0.600
Chlortoluron	2	ug/l	FW List II	-	-	<0.00400	<0.00400	<0.00400	-	<0.01000	<0.01000	-	-	<0.00400	<0.00400	<0.50000	-	<0.01000
Chromium Dissolved	50	ug/l as Cr	DWS 2010	-	-	-	-	-	13	-	13	-	-	-	-	-	15	-
Chromium Total	50	ug/l as Cr	DWS 2010	<5	<5	15	9	13	-	12	-	<5	<5	18	7	14	-	16
Chrysene	-	ug/l	None	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.03	-	-	-	0.03	-
Clopyralid	-	ug/l	None	-	-	<0.01900	0.04000	<0.01900	-	<0.01900	<0.01900	-	-	<0.19000	<0.07600	<0.01900	-	-
Conductivity @ 20°C	2500	uS/cm	WS Regs 20	1880	800	-	-	-	-	-	-	613	1080	-	-	-	-	-
Copper Total	2000	ug/l as Cu	DWS 2010	7	3	<5.5	<5.5	<5.5	-	< 5.5	<5.5	<2	<2	<5.5	<5.5	<5.5	-	< 5.5
Coumaphos	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	<0.00500	-
Cresols	-	ug/l	None	<0.1	<0.1	-	-	-	-	-	-	<0.1	<0.1	-	-	-	-	-
Cyanazine	0.1	ug/l	DWS 2010	-	-	<0.00700	<0.00700	<0.00700	-	<0.00800	<0.00800	-	-	<0.00700	<0.00700	<0.06000	-	<0.00800
Cyanide (Free)	50	ug/l as CN	DWS 2010	<20	<20	-	-	-	-	-	-	<20	48	-	-	-	-	-
Cyanide (Total)	50	ug/l as CN	DWS 2010	<40	<40	-	-	-	-	-	-	<40	<40	-	-	-	-	-
Cypermethrin	0.0001	ug/l	WFD 2010	-	-	<0.1	<10	<0.1	-	< 0.100	<0.100	-	-	0.13	<0.1	<0.1	-	< 0.100
Cypermethrin ID	-	Code	None	-	-	-	-	-	12	-	-	-	-	-	-	-	<5	-
Dalapon	-	ug/l	None	-	-	<0.05000	<0.05000	<0.05000	-	<0.05000	-	-	-	<0.05000	<0.05000	<0.05000	-	<0.05000
Diazinon	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900
Dibenz-[A,H]-Anthracene	-	ug/l	None	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.3	-	-	-	<0.01	-
Dichloromethane	20	ug/l	WFD 2010	-	-	<3	<3	<3	-	< 3.0	<3.0	-	-	<3	<3	<3	-	< 3.0
Dichlorprop	0.1	ug/l	DWS 2010	-	-	<0.01100	<0.01100	<0.01100	-	<0.01100	<0.01100	-	-	<0.11000	<0.04400	<0.01100	-	-
Diuron	0.1	ug/l	DWS 2010	-	-	<0.00500	<0.00500	<0.00500	-	<0.01000	<0.01000	-	-	<0.00500	<0.00500	<0.15000	-	<0.01000
Enterococci (Species)	-	Nr/100ml	None	-	-	-	-	-	0	-	0	-	-	-	-	-	0	-
Escherichia coli (Confirmed)	0	Nr/100ml	WS Regs 20	-	-	-	-	-	0	-	0	-	-	-	-	-	0	-

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT
Name				SA1110	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	PR1107	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A
Hydrogeological unit**				MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			61m	341m	341m	341m	341m	341m	341m	341m	432m	1023m	1023m	1023m	1023m	1023m	1023m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	3/11/2011	16/1/2012	16/4/2012	18/5/2012
Ethofumesate	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	<0.100	-
Ethylbenzene	-	ug/l	None	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	-
Fenuron	-	ug/l	None	-	-	-	-	-	<0.01	-	<0.01	-	-	-	-	-	<0.01	-
Fluoranthene	0.2	ug/l	EEC MAC	0.04	<0.01	-	-	-	<0.01	-	<0.01	0.04	<0.01	-	-	-	1.2	-
Fluorene	-	ug/l	None	<0.01	<0.01	-	-	-	<0.01	-	<0.01	0.06	0.43	-	-	-	1	-
Fluoride	1.5	mg/l as F	DWS 2010	-	-	0.13	0.14	0.08	-	0.165	0.212	-	-	0.32	0.34	0.33	-	0.424
Glyphosate	-	ug/l	None	-	-	<0.01400	<0.01400	<0.01400	-	-	<0.01400	-	-	<0.01400	<0.01400	0.04000	-	0.04600
Hardness Total - As CaCO3	-	mg/l as CaCO3	None	-	-	-	-	-	426	-	310	-	-	-	-	-	540	-
Indeno-[1,2,3-Cd]-Pyrene	0.002	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	0.36	-	-	-	<0.01	-
Iodide Ion	-	ug/l as I	None	-	-	-	-	-	<5	-	<5	-	-	-	-	-	7	-
Irgarol 1051	-	ug/l	None	-	-	-	-	-	0.00700	-	-	-	-	-	-	-	<0.00500	-
Iron Dissolved	200	ug/l as Fe	DWS 2010	-	-	-	-	-	0.028	-	<0.018	-	-	-	-	-	5.1	-
Iron Total	200	ug/l as Fe	DWS 2010	-	-	-	-	-	0.035	-	0.16	-	-	-	-	-	5	-
Isoproturon (Diip1,3Dithiolan-2-Ylidenemalonate)	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	-	<0.00800	<0.00800	-	-	<0.00300	<0.00300	<0.50000	-	<0.00800
Lambda Cyhalothrin	-	ug/l	None	-	-	-	-	-	6.2	-	-	-	-	-	-	-	3.9	-
Lead Total	10	ug/l	WS Regs 20	<4	<4	<5	<5	<5	-	< 5	<5	<4	<4	<5	<5	<5	-	< 5
Lithium Dissolved	-	ug/l as Li	None	-	-	-	-	-	0.003	-	<0.0006	-	-	-	-	-	0.026	-
Lithium Total	-	ug/l as Li	None	-	-	-	-	-	0.0024	-	<0.0006	-	-	-	-	-	0.025	-
Magnesium Dissolved	50	mg/l as Mg	EEC MAC	-	-	-	-	-	13	-	8.3	-	-	-	-	-	17	-
Magnesium Total	50	mg/l as Mg	EEC MAC	24	9	9.5	7.6	25	-	< 0.33	8.2	6	15	16	17	16	-	17
Manganese Dissolved	50	ug/l as Mn	DWS 2010	-	-	-	-	-	0.043	-	<0.004	-	-	-	-	-	0.84	-
Manganese Total	50	ug/l as Mn	DWS 2010	-	-	-	-	-	0.044	-	0.058	-	-	-	-	-	0.82	-
MCPA {2-methyl-4-chlorophenoxyacetic acid }	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	<0.00900	-	-	<0.09000	<0.03600	<0.00900	-	-
Mecoprop { }	0.1	ug/l	DWS 2010	-	-	<0.01000	<0.01000	<0.01000	-	<0.01000	<0.01000	-	-	<0.10000	<0.04000	<0.01000	-	-
Mercury Total	1	ug/l Hg	WS Regs 20	<0.05	<0.05	0.005	<0.002	0.003	-	0.008	0.004	<0.05	<0.05	0.015	0.006	<0.002	-	< 0.002
Metazachlor	-	ug/l	None	-	-	<0	<0	<0	-	< 0	<0.00800	-	-	<0	<0	<0	-	< 0
Methane	-	ug/l	None	-	-	-	-	-	<10.0	-	<10	-	-	-	-	-	<9	-
Molybdenum Total	0	ug/l	GW Regs 98	-	-	-	-	-	13	-	17	-	-	-	-	-	<5	-
MTBE {Methyl Tert-Butyl Ether}	-	ug/l	None	<1	<1	-	-	-	-	-	-	<1	<1	-	-	-	-	-
Multi Residual Scan	-	ug/l	None	-	-	-	-	-	-	<0.10000	-	-	-	-	-	-	-	<0.10000
Naphthalene	1.2	ug/l	WFD D 10	<0.01	<0.01	-	-	-	<0.01	-	<0.01	<0.01	<0.01	-	-	-	1.1	-
Nickel Total	20	ug/l as Ni	DWS 2010	<10	<10	<4	<4	<4	-	< 4	<4	<10	<10	5	<4	<4	-	31
Nitrate - N	11.3	mg/l as N	WS Regs 20	-	<0.1	<0.043	11.1	12.9	-	9.82	7.74	<0.1	<0.1	8.93	<0.043	<0.043	-	< 0.068
Nitrogen Total Oxidised	11.3	mg/l as N	WS Regs 20	-	-	-	-	-	15.5	-	7.91	-	-	-	-	-	16.8	-
Orthophosphate	-	mg/l as P	None	-	-	-	-	-	1.21	-	1.27	-	-	-	-	-	2.25	-
Oxamyl	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	<0.00500	-
PAHs Total	0.1	ug/l	DWS 2010	-	-	-	-	-	<0.160	-	<0.16	-	-	-	-	-	21.3	-
Permethrin (Cis + Trans)	0.01	ug/l	WFD D 10	-	-	-	<0.10000	<0.10000	-	-	<0.10000	-	-	-	<0.10000	<0.10000	-	-
Petrol range organics	-	ug/l	None	-	-	-	-	-	-	-	-	-	210	-	-	-	-	-
pH	10	pH units	DWS 2010	7.5	7.1	-	-	-	-	-	-	8.4	7.4	-	-	-	-	-
Phenanthrene	-	ug/l	None	0.02	<0.01	-	-	-	<0.01	-	<0.01	0.17	<0.01	-	-	-	0.03	-
Phenol	0.5	ug/l	EEC MAC	0.1	<0.1	-	-	-	-	-	-	0.19	<3.3	-	-	-	-	-
Phenol (Pentachlorophenol (PCP))	-	ug/l	None	-	-	<0.00900	<0.00900	<0.00900	-	<0.00900	-	-	-	<0.09000	<0.03600	<0.00900	-	-
Phenols Total For SWAD (7 Compounds)	-	ug/l	None	-	-	13.0	9.0	32.0	-	<8.0	<8.0	-	-	34.0	11.0	<80.0	-	<2,500,000.0

Source of data*				SI	SI	TT	TT	TT	TT	TT	TT	SI	SI	TT	TT	TT	TT	TT
Name				SA1110	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	SR1108	PR1107	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A	SR1102A
Hydrogeological unit**				MG	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD	RTD
Distance from site	EQS Criteria			61m	341m	341m	341m	341m	341m	341m	341m	432m	1023m	1023m	1023m	1023m	1023m	1023m
Chemical	Value	Units	Source	2009	2009	15/8/2011	4/11/2011	16/1/2012	22/3/2012	3/5/2012	14/8/2012	2009	2009	15/8/2011	3/11/2011	16/1/2012	16/4/2012	18/5/2012
Polynuclear Aromatic Hydrocarbons (Total)	0.1	ug/l	DWS 2010	<0.2	<0.2	-	-	-	-	-	-	0.36	24	-	-	-	-	-
Potassium Dissolved	-	mg/l as K	None	-	-	-	-	-	18	-	16	-	-	-	-	-	18	-
Potassium Total	-	mg/l as K	None	-	-	16	15	40	-	< 0.75	15	-	-	17	19	17	-	18
Preparation (Purge And Trap)	-	Text	None	-	-	-	-	-	-	-	Prepared	-	-	-	-	-	-	-
Propazine	0.1	ug/l	DWS 2010	-	-	<0.00400	<0.00400	<0.00400	-	<0.00500	<0.00500	-	-	<0.00400	<0.00400	<0.04000	-	<0.00500
Propetamphos	0.1	ug/l	DWS 2010	-	-	<0.00500	<0.00500	<0.00500	-	<0.00500	<0.00500	-	-	<0.00500	<0.00500	<0.00500	-	<0.00500
Pyrene	-	ug/l	None	<0.01	<0.01	-	-	-	<0.01	-	<0.01	0.06	2.3	-	-	-	1.3	-
Selenium	10	ug/l as Se	DWS 2010	<3	<3	-	-	-	4.6	-	3	<3	<3	-	-	-	<0.4	-
Silicate Reactive Dissolved - As SiO2	-	mg/l	None	-	-	-	-	-	21	-	22	-	-	-	-	-	21	-
Simazine	0.1	ug/l	DWS 2010	-	-	<0.00900	<0.00900	<0.00900	-	<0.00400	<0.00400	-	-	<0.00900	<0.00900	<0.04000	-	<0.00400
Sodium Total	200	mg/l as Na	DWS 2010	220	41	38	-	120	-	< 2.5	52	240	53	78	90	73	-	71
Strontium Dissolved	-	ug/l as Sr	None	-	-	-	-	-	0.55	-	-	-	-	-	-	-	0.8	-
Strontium Total	-	ug/l as Sr	None	-	-	-	-	-	0.56	-	0.37	-	-	-	-	-	0.8	-
Sulphate	250	mg/l as SO4	DWS 2010	-	390	100	76	111	-	117	107	230	51	70.9	65	75.5	-	946
Sulphide	-	ug/l	None	<10	<10	-	-	-	<29.0	-	<29.0	<10	<10	-	-	-	<29.0	-
Terbutryn	0.1	ug/l	DWS 2010	-	-	<0.00300	<0.00300	<0.00300	-	<0.00500	<0.00500	-	-	<0.00300	<0.00300	<0.04000	-	<0.00500
Tetrachloroethylene	-	ug/l	None	-	-	<0.09	0.14	0.3	-	0.18	0.12	-	-	<0.09	<0.09	<0.09	-	< 0.09
Tetrachlorothioanisole	-	ug/l	None	-	-	-	-	-	<0.00500	-	-	-	-	-	-	-	<0.00500	-
Tin Total	0	ug/l as Sn	GW Regs 98	-	-	-	-	-	<5	-	7	-	-	-	-	-	<5	-
Titanium	0	ug/l as Ti	GW Regs 98	-	-	-	-	-	0.054	-	0.04	-	-	-	-	-	0.072	-
Toluene (Methylbenzene)	50	ug/l	WFD 2010	<1	<1	-	-	-	<0.55	-	<0.55	<1	<1	-	-	-	0.72	-
Total Aliphatic TPH	-	ug/l	None	-	37	-	-	-	-	-	-	24	28	-	-	-	-	-
Total Aromatic TPH	-	ug/l	None	-	66	-	-	-	-	-	-	31	39	-	-	-	-	-
Total Chemical Oxygen Demand	-	mg/l	None	440	<10	-	-	-	-	-	-	<10	70	-	-	-	-	-
Total Petroleum Hydrocarbons (TPH)	-	ug/l	None	-	-	-	-	-	-	-	-	-	1700	-	-	-	-	-
Total Petroleum Hydrocarbons 10-20 (TPH)	-	ug/l	None	-	-	-	-	-	-	-	-	-	570	-	-	-	-	-
Total Petroleum Hydrocarbons 20-30 (TPH)	-	ug/l	None	-	-	-	-	-	-	-	-	-	950	-	-	-	-	-
Trichloroethene (Trichloroethylene)	10	ug/l	DWS 2010	-	-	<0.07	<0.07	<0.07	-	< 0.07	<0.07	-	-	<0.07	<0.07	<0.07	-	< 0.07
Trietazine	-	ug/l	None	-	-	<0.00600	<0.00600	<0.00600	-	<0.00800	<0.00800	-	-	<0.00600	<0.00600	0.06200	-	<0.00800
Trifluralin	0.1	ug/l	DWS 2010	-	-	<0.01000	<0.01000	<0.01000	-	<0.01000	-	-	-	<0.01000	<0.01000	<0.01000	-	<0.01000
Turbidity	1	FTU	WS Regs 20	-	-	0.24	0.2	0.26	-	0.28	0.15	-	-	22	20.6	33.6	-	31.9
Uranium	0	ug/l as U	GW Regs 98	-	-	-	-	-	0.7	-	0.4	-	-	-	-	-	0.3	-
Xylene (Meta & Para){1,3+1,4-Dimethylbenzene}	30	ug/l	WFD 2010	<1	<1	<0.09	0.21	<0.09	<0.09	0.43	<0.09	<1	12	0.27	0.1	<0.09	0.14	0.46
Xylene (ortho)	30	ug/l	SW Regs 98	-	-	-	-	-	<0.09	-	<0.09	-	-	-	-	-	<0.09	-
Zinc Total	50	ug/l as Zn	DWS 2010	6	28	8	<5	7	-	7	12	17	<1	<5	<5	<5	-	< 5

Notes:

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

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

*** Hydrogeological unit: MG – Made Ground, RTD – River Terrace Deposits*

K.8 Groundwater status

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

K.8.2 The Thames River Basin Management Plan (RBMP)[9] shows no groundwater body designation for either the upper or lower aquifers within the area in which the King George’s Park site is located; therefore no baseline assessment of quantitative or chemical status is available.

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

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

K.8.5 Only eight out of forty-six groundwater bodies within the Thames River basin district are at good status overall; this is not expected to change by 2015 (EA, 2009)[9].

K.8.6 The Thames Tideway Tunnel project would prevent deterioration of the current and predicted status of groundwater and would adhere to the key actions identified in the RBMP to achieve good status by 2021 or 2027, as follows (EA, 2009)[9]:

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

b. prevent input of nitrates to groundwater body

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

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

e. prevent direct discharges of pollutants to groundwater.

K.9 Data sources

K.9.1 A list of data used for the King George's Park assessment is given in Vol 9 Table K.8.

Vol 9 Table K.8 Groundwater – desk based baseline data sources

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

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

** LBs – London Boroughs*

References

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

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

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

[4] London Borough of Wandsworth. Personal communication.

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

[6] Defra. *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/.

[7] 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.

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park 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 Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Appendix M: Water resources - flood risk

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Creating a cleaner, healthier River Thames

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Appendix M: Water resources – flood risk

M.1 Planning policy considerations

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

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

M.1.3 General policy documents (eg, NPS) have been reviewed within Volume 2 Environmental assessment methodology. A summary of local and regional policy relevant to flood risk at the King George's Park site is provided below.

Local policy

Strategic Flood Risk Assessment

M.1.4 The King George's Park site lies within the London Borough (LB) of Wandsworth. The LB of Wandsworth has produced Level 1 and Level 2 Strategic Flood Risk Assessments (SFRA) (Scott Wilson, 2008)[2] which outline the main flood sources to the borough. The residual risk of breaches in the Thames Tideway Defences at a number of locations along the River Thames was also investigated as part of the Level 2 study.

M.1.5 According to the SFRA:

a. The site overlies London Clay.

b. The site is within the Wandsworth Tidal Flood Warning Area, the River Wandle from Colliers Wood to Wandsworth Fluvial Flood Warning Area and Environment Agency (EA) Flood Zone 3.

c. There have been less than five sewer flooding incidences recorded by Thames Water in the last 10 years in the vicinity of the site.

d. The site is situated within an area identified as having increased risk of surface water ponding based on topography, geology and historic flooding records.

M.1.6 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.1.7 The Council, in partnership with the Greater London Authority (GLA), Thames Water and the EA has produced a Surface Water Management Plan (SWMP) (GLA, 2011)[3] as part of the Drain London project. The SWMP sets out the preferred surface water management strategy for the borough.

M.1.8 According to the SWMP:

a. The site lies within the King George's Park Critical Drainage Area.

b. A section of the site lies within an area of significant (danger for most) surface water flood hazard rating for the 1% Annual Exceedance Probability (AEP[i]), including an allowance for the impact of climate change (ie, 30% increase).

c. Surface water depths of up to 1.5m occur for the 1% AEP including an allowance for the impact of climate change (ie, 30% increase).

Regional policy

Thames Estuary 2100

M.1.9 King George's Park lies within the Wandsworth to Deptford Policy Unit which has been assigned the flood risk management policy 'P5' within the Thames Estuary 2100 (TE2100) Plan (EA, 2012)[4] meaning that further action will be taken to reduce flood risk beyond that required to mitigate the impact of climate change.

M.1.10 The TE2100 Plan identifies the local sources of flood risk (relative to the King George's Park site) as including tidal flooding from the River Thames, fluvial from the River Wandle, surface water (heavy rainfall) and urban drainage sources, and a risk of groundwater flooding from superficial strata which is possibly connected to high water levels in the Thames.

M.1.11 Mitigation of flooding from these sources include:

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

b. defences along the lower reach of the River Wandle

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

d. flood forecasting and warning.

M.1.12 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.1.13 There is an acknowledgement in the TE2100 Plan that tidal defences on the River Wandle will require raising for estuary wide options.

Thames Region Catchment Flood Management Plan

M.1.14 The Thames Region Catchment Flood Management Plan (CFMP) (EA, 2007)[5] covers fluvial and non-tidal sections of the River Thames, ie, the River Thames upstream of Teddington weir and tributaries to the River Thames.

M.1.15 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

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

(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.1.16 The London Regional Flood Risk Appraisal (RFRA) (GLA, 2009)[6] states that current flood risk on the River Wandle should be sustained into the future. There is potential that some upstream areas of the River Wandle, south of Mitcham have the possibility of enabling catchment storage.

M.1.17 The RFRA indicates that developments should be designed in such a way as to take opportunities to reduce flood risk and include resilience, and that SuDS should be included within developments to reduce surface water discharge.

M.2 Hydraulic modelling technical note

Introduction

Scope

M.1.1 The EA Flood Map shows that the King George's Park site and Dormay Street site are located within Flood Zone 3a High Probability of Flooding associated with the River Wandle. In addition, the SFRA for London Borough (LB) of Wandsworth[7] identifies the part of the Dormay Street site located on the Causeway to be defined as Flood Zone 3b Functional Floodplain.

M.1.2 As a result, further modelling has been required to identify the flood risk to each of these sites and quantify the potential implications of the proposed works upon the wider flood cell in terms of floodplain storage.

M.1.3 This technical note has been prepared to summarise the methodology and conclusions of the hydraulic modelling that has been undertaken.

Software selection

M.1.4 The model simulations have been run using ISIS version 3.5 and TUFLOW build 2010-10-AF-iSP.

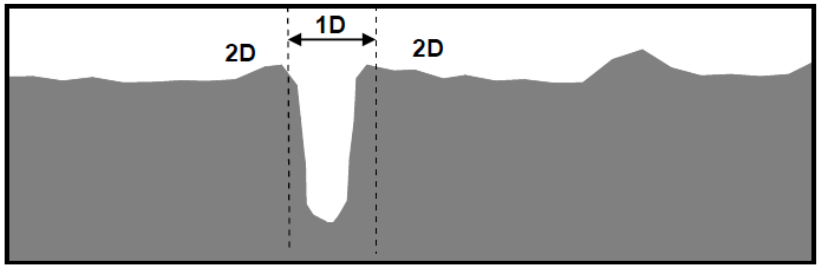
M.1.5 ISIS (www.halcrow.com/isis) is UK standard river modelling software developed by Halcrow and used extensively by the EA and its consultants. The 1D hydrodynamic module in ISIS was used for this study.

M.1.6 TUFLOW (www.tuflow.com) is a modelling package for simulating depth averaged 2D free-surface flows, and is developed by BMT WBM, Australia. TUFLOW is in widespread use in the UK and elsewhere for 2D inundation modelling.

M.1.7 An ISIS-TUFLOW link has been developed as a joint research and development project between BMT WBM and Halcrow. This link allows the ISIS 'in bank' model to be directly linked to a TUFLOW 2D domain, which allows for better representation of urban areas focussing the computational time on the most complex flow paths.. Vol 9 Plate M.1 shows an example of modelling a river channel in 1D and floodplain in 2D.

Water is transferred between the 1D and 2D domains along the line of the flood defences (or bank top if no defences are present).

Vol 9 Plate M.1 Flood risk – modelling of a river channel in 1D and floodplain in 2D



Data sources

M.1.8 The following information and data have been gathered to inform the construction and development of the hydraulic model:

a. River Wandle ISIS-TUFLOW Catchment Model files (EA);

b. 0.5m resolution LiDAR data (EA, Composite October 2010[8]);

c. Thames tidal defences joint probability extreme water level report (EA April 2008[9]);

d. Ordnance Survey 10K mapping;

e. Ordnance Survey Master Map (OSMM) data;

f. aerial photography;

g. site visits;

h. topographic survey for King George's Park and Dormay Street/The Causeway (Thames Water 2010[10]);

i. channel Survey for Bell Lane Creek (National Rivers Authority 1992[11]); and

j. proposed development drawings for the proposed temporary and permanent works at the King George's Park and Dormay Street/The Causeway sites (Thames Water 2011).

Consultation

M.1.9 Following the completion of the initial modelled outputs, meetings were held with representatives of the EA (30th November 2011; 17th January 2012) to discuss the findings of the modelling and inform further development of the hydraulic model.

M.2.1 Further meetings were held with the EA and LB Wandsworth throughout 2012 to discuss the modelling results and potential floodplain compensation storage options in the northern part of King George's Park.

M.2.2 The hydraulic modelling files were supplied to the EA for review and have been approved for use to inform the Level 3 FRA for the King George's Park and Dormay Street sites.

Model construction

Overview

M.1.10 The base of the hydraulic model prepared for the assessment of the Thames Tunnel sites is taken from the linked 1D-2D ISIS-TUFLOW hydraulic model covering the River Wandle catchment. The EA model represents the river channel using a series of cross sections and relevant structures and the floodplain is represented by a fixed grid with a resolution of 6m.

M.1.11 This section contains information on the changes that have been made to the model as part of this project. Detailed comments regarding the model construction and development are recorded in the model log.

M.1.12 The main elements in model construction are as follows:

a. the ISIS-TUFLOW River Wandle Catchment Model has been truncated at the Earlsfield railway embankment (Node 15.093D);

b. in order to better represent the area around The Causeway, the ISIS model has been extended to the north to include cross sections along the Bell Lane Creek informed by a channel survey (National Rivers Authority 1992);

c. the floodplain has been represented using a fix grid with a higher resolution of 3m which has been generated using up-to-date LiDAR data of 0.5m resolution (EA October 2010);

d. up-to-date topographic survey information (Thames Water 2010) of the area around Dormay Street and The Causeway as well as King George's Park has been used to update the representation within the model for the existing scenario including accurate representation of the Thames Tidal Flood Defences along the edge of the Bell Lane Creek; and

e. a series of proposed model scenarios have been constructed based upon the proposed designs of the Thames Tunnel sites at Dormay Street and King George's Park including assessment of proposed mitigation works and temporary works at the King George's Park site.

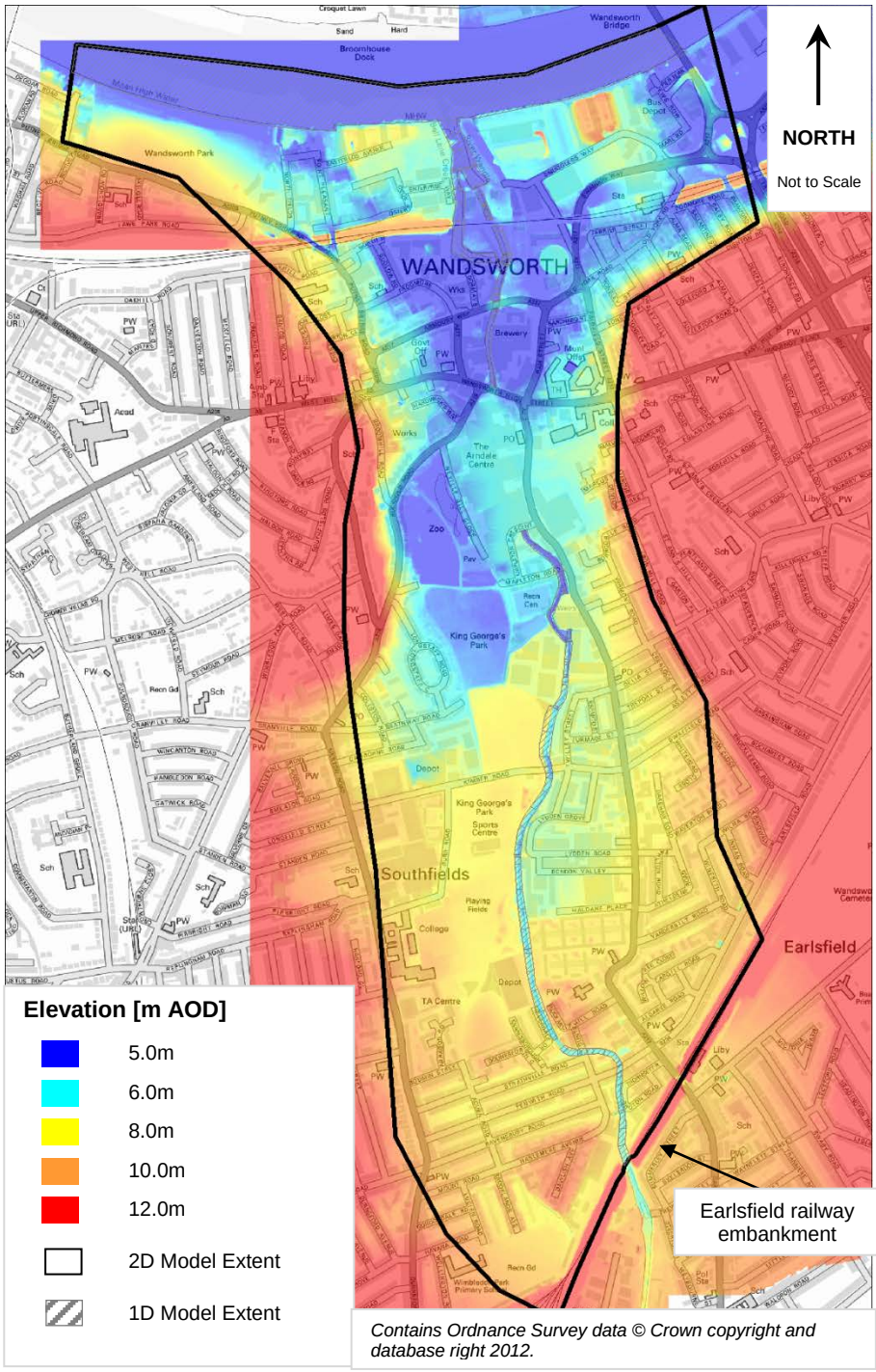
Model extent

Upstream extent

M.1.13 The existing EA River Wandle Catchment Model has been truncated at Node 15.093D to revise the upstream extent to Earlsfield railway embankment as shown in Vol 9 Plate M.2.

M.2.3 The initial TUFLOW model extents were set based on the previous flood mapping results and topography based on the DTM. These were later trimmed based on initial results from the ISIS-TUFLOW model so that the run time could be optimised.

Vol 9 Plate M.2 Flood risk – River Wandle model extent



Bell Lane Creek

M.2.4 The downstream extent of the ISIS model has been revised to include the Bell Lane Creek channel and accurate representation of the floodplain around The Causeway.

M.2.5 A channel survey (National Rivers Authority, 1992)[12] of the Bell Lane Creek provided by the EA was used to inform the representation of the Bell Lane Creek channel within the 1D domain. A narrow slot was inserted in the channel bed to prevent the channel from drying out at low tide, which had previously resulted in the model crashing

M.2.6 As the water levels in Bell Lane Creek are dominated by tidal levels in the River Thames, the additional storage provided by the narrow slots in the bed will have a negligible impact on model results

Grid size

M.2.7 It was considered that the 6m grid size of the existing EA River Wandle Catchment Model was of insufficient resolution to enable accurate analyses of floodplain storage at the two proposed sites. The existing model has therefore been modified to create a finer grid representation of the floodplain using a 3m grid size.

M.2.8 Following a series of initial runs, a 3m grid size was selected as it represented a good balance between the degree of accuracy (ie, ability to model overland flow paths along roads or around buildings) whilst maintaining reasonable model run ("simulation") times.

Topography

M.2.9 The EA River Wandle Catchment Model has been constructed using a range of different topographic data types. Channel survey data and existing model data has been used to develop the in-bank ISIS model and LiDAR and OSMM datasets have been used to build the out of bank TUFLOW model. A number of modifications and alterations have been made to the topography within the Catchment Model for the Thames Tideway Tunnel assessments. These are detailed below.

LiDAR

M.2.10 Light Detecting and Ranging Data (LiDAR) is used as the base information for the model topography. LiDAR data is an airborne survey technique that uses a laser to measure the distance between an aircraft and the ground surface.

M.2.11 As part of this project, LiDAR data was provided by the EA for the modelled area. The data was flown in February 2007 and has a resolution of 0.5m. The model's floodplain representation has been improved, and a high resolution 3m grid size has been specified which uses the 0.5m LiDAR data to determine the ground levels throughout the floodplain.

Survey data

M.2.12 Topographic survey data (Thames Water, 2010)[13] for the Dormay Street/Causeway and King George's Park sites has been used to supplement the LiDAR data and update the floodplain representation on the sites.

M.2.13 In addition, the Thames Tidal Defences along the west and south banks of the Bell Lane Creek have been included within the model representation; these flood defences were not included within the EA Catchment Model. Crest levels adjacent to the Dormay Street and Causeway sites have been determined from the topographic survey information (Thames Water 2010).

Vol 9 Plate M.2 Flood risk – Thames tidal defences along the Bell Lane Creek

M.2.14 The photograph on the left shows the flood defences adjacent to Dormay Street. The photograph on the right shows the confluence of the Bell Lane Creek and the River Wandle channels.

Bank levels

M.2.15 For the majority of the River Wandle, the 2d boundary condition lines were drawn along the extents of the ISIS cross sections. Bank levels for TUFLOW were picked based on the top of bank heights for the ISIS cross sections.

M.2.16 Bank levels for the Bell Lane Creek were established from the channel survey and topographic site survey data provided. All bank levels have been included in the model as a series of z lines.

Roughness coefficients

M.2.17 The Manning's 'n' roughness coefficients throughout the model have been set according to the land-use based on OSMM data. Vol 9 Table M.1 provides details of the values used within the model.

Vol 9 Table M.1 Flood risk – manning's values by land use classification

TUFLOW Material Code	Manning's 'n' Value	Land-use type
1	0.04	Grass
2	0.06	Dense trees
3	0.05	Fence shrubs
4	0.035	Gravel Road
5	0.025	Footpaths and paved areas and roads
6	0.05	Hard surface, standing areas, work yards
7	0.04	Open car parks
8	0.20	Multi-storey car parks
9	0.05	Fields and natural land

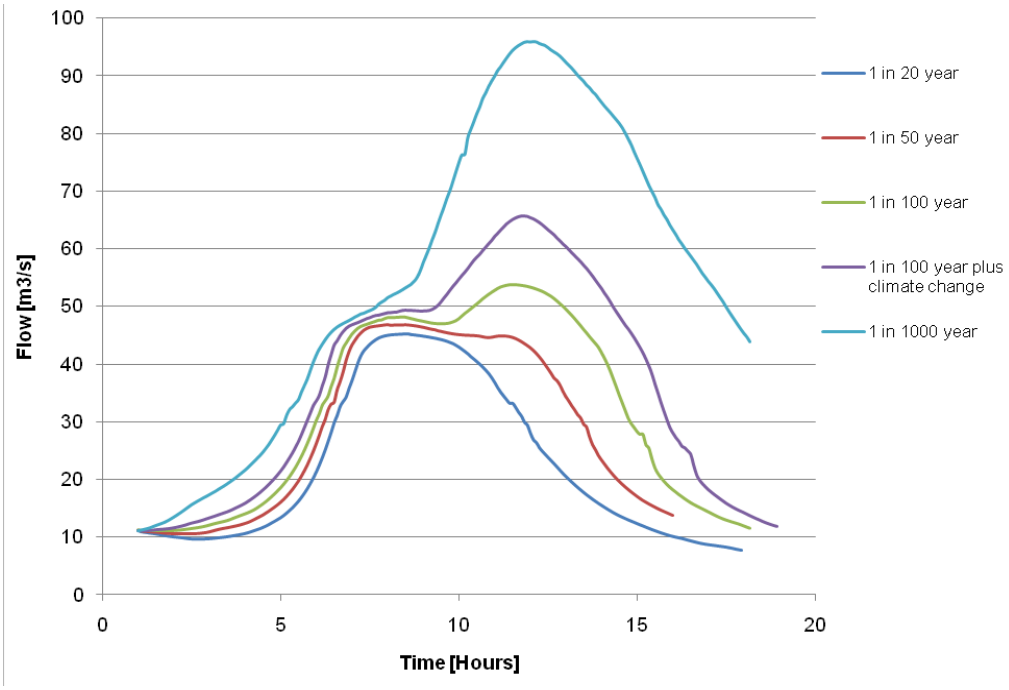
		(Default value)
10	0.1	Buildings
11	0.05	Railway
12	0.03	Water
13	0.03	Structures
14	0.03	Water
98	0.04	Default Value
99	0.25	Stability

Water level boundaries

Upstream boundary

M.2.18 The EA Catchment Model was truncated at the Earlsfield railway embankment (node 15.093D). In order to create the inflow boundaries for the truncated model, the flow at node 15.093D has been extracted from the Catchment Model results files for the five modelled annual exceedance probabilities (5%, 2%, 1% 1% plus 20% for climate change, and 0.1% AEP). These boundaries are shown in Vol 9 Plate M.3.

Vol 9 Plate M.3 Flood risk – upstream boundary conditions (node 15.093D)



Downstream tidal boundaries

M.2.19 The EA Catchment Model applied a Mean High Water Spring (MHWS) tidal water level profile as the downstream boundary. A tidal peak of 4mAOD was applied, that coincides with the fluvial peak level.

M.2.20 As part of the Thames Tideway modelling, three downstream tidal boundaries have been considered; the MHWS, 1 in 20 year (5% AEP) tidal profile and 1 in 1000 year (0.1% AEP) tidal profile.

M.2.21 In order to establish the boundaries for the 1 in 20 and 1 in 1000 year tidal events, the tidal curves from the Environment Agency Embayment Modelling and the water levels within the Environment Agency Thames Tidal Defences Joint Probability Extreme Water Levels 2008 Report have been used.

M.2.22 The Joint Probability Extreme Water Level Report details the water levels throughout the Thames created from a 2D joint-probability computer hydraulic model. The study, which was completed in 2008, modelled water levels for 7 different annual exceedance probabilities (10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1%). Each of these probabilities has been modelled for present day (2005) and future years (2055 and 2017), taking into account Defra's climate change allowances as set out in the NPPF**Error! Bookmark not defined.**. These values have been xtrapolated to determine a level for the year 2011.

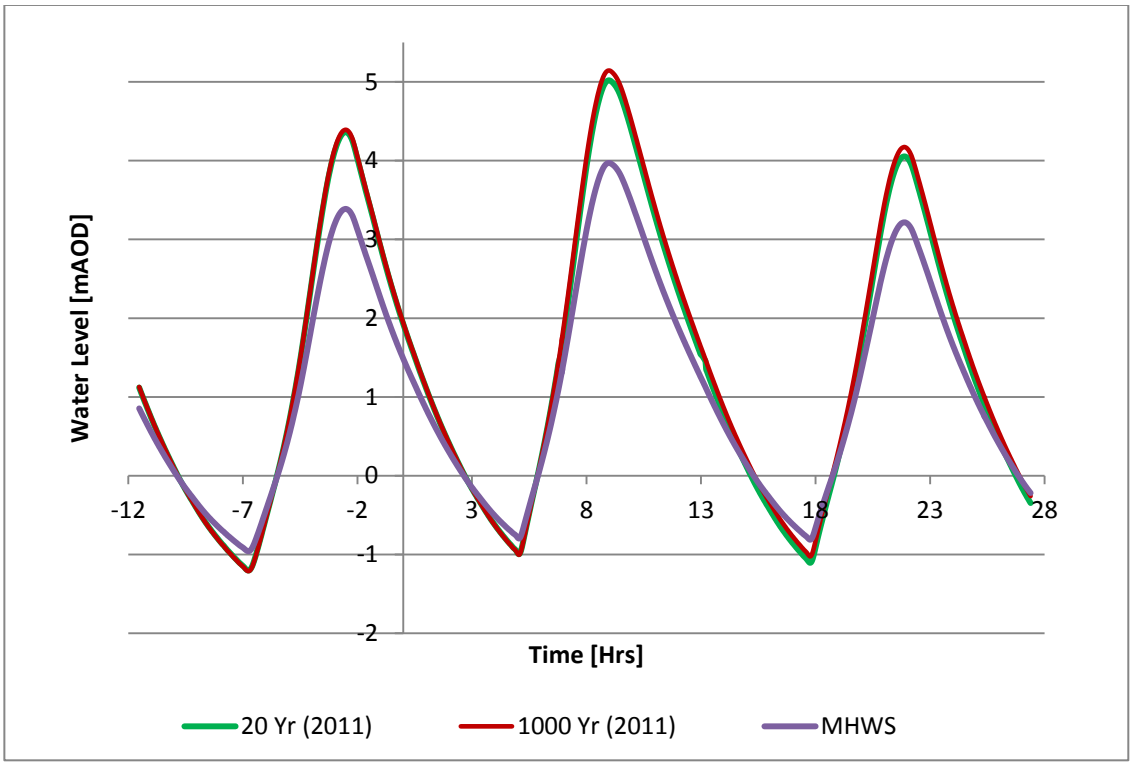
M.2.23 The confluence of the River Wandle and Bell Lane Creek with the River Thames is approximately half way between node 2.23 and node 2.25 from the Joint Probability Extreme Water Levels modelling, and therefore an average water level from these two nodes has been assumed, as shown in Vol 9 Table M.2 below.

Vol 9 Table M.2 Flood risk – thames tidal water levels (2011)

X	Y	Node	Water Level (mAOD)						
			Annual Exceedance Probability (AEP) 2011						
			10%	5%	2%	1%	0.5%	0.2%	0.1%
524453	175620	2.23	4.99	5.03	5.07	5.10	5.12	5.14	5.15
525470	175310	Wandle	4.98	5.02	5.06	5.09	5.11	5.13	5.14
526164	175610	2.25	4.97	5.01	5.05	5.07	5.09	5.11	5.13

M.2.24 The tidal curves obtained from EA Embayment Modelling have been scaled to the peak water levels in the Thames shown in the table above and were then shifted to ensure that the tidal peak aligned with the fluvial peak in the River Wandle. The resulting tidal boundaries are shown in Vol 9 Plate M.4.

Vol 9 Plate M.4 Flood risk – downstream boundary conditions



Design model runs

M.2.25 The design model simulations listed below were run on a fixed timestep of 0.75s and 1.5s for the 1D and 2D domains respectively. The runs were completed using ISIS version 3.5 and TUFLOW build 2010-10-AF-iSP.

a. 1 in 100 year (1% AEP) fluvial event with MHWS tidal boundary

b. 1 in 100 year (1% AEP) including 20% climate change fluvial event with MHWS tidal boundary

c. 1 in 1000 year (0.1% AEP) fluvial event with MHWS tidal boundary

d. 1 in 20 year (5% AEP) fluvial event with 1 in 20 year (5% AEP) tidal boundary

e. 1 in 20 year (5% AEP) fluvial event with 1 in 1000 year (0.1% AEP) tidal boundary

f. 1 in 100 year (1% AEP) including 20% climate change fluvial event with 1 in 20 year (5% AEP) tidal boundary

Model development – baseline scenario

M.2.26 The model set-up files included within the EA Catchment Model have been used as the basis for representation of the baseline scenario.

M.2.27 As the ground levels within the Baseline Model were based on LiDAR data, some 'scouring out' of buildings had occurred (during the automatic LiDAR filtering process) resulting in very low ground levels within the building outline.

M.2.28 In order to better represent the existing building thresholds in the Dormay Street area, topographic survey has been reviewed and z-shapes were inserted to apply a uniform level across the building thresholds of the existing buildings in that area.

Water level lines

M.2.29 Water level lines were added to the model set-up in order to ensure that the channels of the River Wandle and Bell Lane Creek watercourses are shown as flooding in the modelled outputs.

Results – baseline scenario

M.2.30 The following figures are provided to show the comparison between the Catchment Model and the Baseline Model:

a. Vol 9 Figure M.2.1 Catchment model maximum flood depth 1% AEP fluvial event with MHWS tidal boundary (see separate volume of figures)

b. Vol 9 Figure M.2.2 Catchment model maximum flood depth 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

c. Vol 9 Figure M.2.3 Baseline model maximum flood depth 1% AEP fluvial event with MHWS tidal boundary (see separate volume of figures)

d. Vol 9 Figure M.2.4 Baseline model maximum flood depth 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

e. Vol 9 Figure M.2.5 Baseline model maximum flood depth 5% AEP fluvial event with 5% AEP tidal boundary (see separate volume of figures)

f. Vol 9 Figure M.2.6 Baseline model maximum flood depth 5% AEP fluvial event with 0.1% AEP tidal boundary (see separate volume of figures)

M.2.31 The results demonstrate that at the King George's Park site, the flood depths are very similar to those experienced in the EA Catchment Model. The flow capacity of the twin culvert beneath Southside Shopping Centre is not sufficient to convey the 1 in 100 year (1% AEP) fluvial flood event. This causes the channel upstream to back up and water to come out of bank adjacent to the recreation ground located to the south of Mapleton Road and to the east of King George's Park. The predominant flowpath is west into King George's Park where water ponds until it reaches a sufficient level to spill over into the northern part of the park and propagate northwards to the location of the proposed site. A peak flood level of 6.0mAOD is experienced on the King George's Park site during the 1 in 100 year (1% AEP) with climate change fluvial event and MHWS tidal boundary.

M.2.32 On reaching the northern part of King George's Park, floodwaters continue northwards along Buckhold Road, across Wandsworth High Street and Armoury Way and down Dormay Street and Frogmore Street. The railway

embankment and tidal defences adjacent to the Bell Lane Creek present a barrier to further propagation of the flowpath and therefore floodwaters accumulate to significant depths in the topographic depression.

M.2.33 It is noted that modelled flood depths adjacent to Hardwick's Way are shown to be particularly deep. A review of the topography in the model set up files shows that this is due to a minor error in the LiDAR data. This is likely to have occurred during the automatic LiDAR filtering process resulting in the ground levels in this area being much lower than the actual levels.

M.2.34 At the Dormay Street site, the results from the Baseline Model are different to those shown by the Catchment Model. This is due to the improved representation of the tidal flood defences along Bell Lane Creek which prevent overland flows from discharging straight into Bell Lane Creek. The tidal flood defences form a barrier and lead to increased ponding of floodwaters in this area. As a result, peak flood levels on the Dormay Street site are higher than those experienced in the Catchment Model. The peak flood level on the Dormay Street site during the 1 in 100 year (1% AEP) including an allowance for climate change fluvial event and MHWS tidal boundary is 5.77mAOD.

M.2.35 The modelling shows that floodwaters do spread northwards along the Causeway (road), however flow does not reach the area proposed for temporary works required to support the construction of the Dormay Street site. These modelled scenarios therefore confirm that The Causeway site is not located within the fluvial floodplain.

M.2.36 To summarise;

a. the Causeway site is not located within Flood Zone 3b Functional Floodplain;

b. the Dormay Street site is not located within Flood Zone 3a associated with the River Wandle;

c. the Dormay Street site is located within Flood Zone 2 associated with the River Wandle as well as Flood Zone 3a including an allowance for climate change (ie, 1% AEP including climate change); and,

d. the King George's Park site is located in Flood Zone 3a associated with the River Wandle.

Model development – proposed scenario (without mitigation)

M.2.37 Detailed drawings of the proposed works at King George's Park have been used to inform modifications to the model topography for the proposed scenario. A review of all construction, permanent and demolition phases has been undertaken and a representation of the worst case scenario from these phases has been included within the model.

M.2.38 At the King George's Park site, the shaft has been represented as a topographic change within the model. Changes in the roughness coefficients have also been applied to represent the temporary office, welfare facilities, workshops, material handling area and access route.

The changes that have been made with the ground levels in the model are shown in Vol 9 Figure M.2.7 and Vol 9 Figure M.2.8. Changes to the roughness coefficients in the model are shown in Vol 9 Figure M.2.9 and Vol 9 Figure 2.10 (see separate volume of figures).

Results – proposed scenario (without mitigation)

M.2.39 The following figures are provided to show the comparison between the Baseline and Proposed Scenarios:

a. Vol 9 Figure M.2.11 Proposed model maximum flood depth 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

b. Vol 9 Figure M.2.12 Proposed model flood level difference 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

c. Vol 9 Figure M.2.13 Proposed model flood outline difference 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

M.2.40 At the King George's Park site, the proposed works are located across the primary flowpath of floodwater from the northern part of the park onto Buckhold Road. As a result, the proposed works result in a reduction in the conveyance of floodwater from the northern part of the park and a subsequent increase in the flood levels in the park of 13mm during the 1 in 100 year (1% AEP) including an allowance for climate change fluvial event and MHWS tidal boundary. This increase also has a minor impact on the flood extents throughout the surrounding area as shown in Vol 9 Figure M.2.13 (see separate volume of figures).

Flood hazard rating

M.2.41 Flood hazard rating is a method of understand the risk of flooding based upon both the flood depth and flow velocity. The derivation of flood hazard categories is based on the formulae presented in the Defra publication 'Flood Risks to People FD2320' (Defra & Environment Agency, 200514).

M.2.42 The following figures show the maximum flood hazard rating for the baseline and proposed scenarios:

a. Vol 9 Figure M.2.14 Baseline model flood hazard rating 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

b. Vol 9 Figure M.2.15 Proposed model flood hazard rating 1% AEP plus climate change fluvial event with MHWS tidal boundary (see separate volume of figures)

M.2.43 A comparison of these figures confirms that the proposed works do not impact on the hazard rating in the surrounding area.

Sensitivity analysis

M.2.44 Additional model runs have been undertaken to determine the impact of varying roughness coefficients on the model results and to enable an appreciation of the impact of the proposed works in the context of the

general sensitivity of the model. The sensitivity analysis has been undertaken on the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary for both the baseline and proposed scenarios.

M.2.45 Global changes were made to the roughness values and applied either solely to the floodplain, or the floodplain and the channel. The following list summarises the scenarios that were undertaken as part of the sensitivity analysis:

a. Baseline model. Roughness values -20% applied to the floodplain.

b. Baseline model. Roughness values +20% applied to the floodplain.

c. Baseline model. Roughness values -20% applied to the floodplain and channel.

d. Baseline model. Roughness values +20% applied to the floodplain and channel.

e. Proposed model (without mitigation). Roughness values -20% applied to the floodplain.

f. Proposed model (without mitigation). Roughness values +20% applied to the floodplain.

g. Proposed model (without mitigation). Roughness values -20% applied to the floodplain and channel.

h. Proposed model (without mitigation). Roughness values +20% applied to the floodplain and channel.

M.2.46 A summary of the results from the sensitivity analysis is provided on Vol 9 Figure M.2.16 and Vol 9 Figure M.2.17 (see separate volume of figures).

Model development – proposed scenario with mitigation

M.2.47 As discussed, the proposed works are located across the primary flowpath out of the northern part of King George's Park and therefore reduce the capacity to convey floodwaters northwards onto Buckhold Road during extreme flood events.

M.2.48 In order to reduce the impact that the proposed works would have on the flooding mechanism in the area, additional measures have been incorporated into the design to improve the conveyance of floodwater from the park onto Buckhold Road.

M.2.49 Given the location of the site, there were a number of constraints upon the development of a suitable measure including the aesthetics of the park entrance and the presence of established mature trees. In addition, the presence of the sewer that passes across this part of the park limits the area in which alteration of ground levels can be undertaken.

As shown in Vol 9 Figure M.2.18 (see separate volume of figures), a landscaped depression area has been incorporated along the north western edge of the site to improve the conveyance of floodwater around the shaft site and maintain a pathway for the floodwater. A more detailed plan showing the proposed ground levels is shown in Vol 9 Figure M.2.27 (see separate volume of figures). Changes in roughness coefficient used

to represent the mitigation are also shown in Vol 9 Figure M.2.19 (see separate volume of figures).

Results – proposed scenario with mitigation

M.2.50 Following inclusion of the landscaped depression area into the site design, the modelling demonstrates that the proposed works have a reduced impact on the flood levels in King George's Park.

M.2.51 Vol 9 Figure M.2.21 (see separate volume of figures) shows that during the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary, the proposed works at the King George's Park site result in a 2-3mm increase in the flood level in the park. Vol 9 Figure M.2.26 (see separate volume of figures) also shows that the proposed works results in a slight reduction in the maximum flood level further north of King George's Park in Wandsworth of –24mm.

M.2.52 Vol 9 Figure M.2.20 (see separate volume of figures) shows the modelled flood depths during the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary for the proposed works at the King George's Park site (with mitigation). Vol 9 Figure M.2.28 (see separate volume of figures) shows that during the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary, the proposed scenario with mitigation results in a negligible difference in the flood extents.

M.2.53 Vol 9 Figure M.2.29 and Vol 9 Figure M.2.30 (see separate volume of figures) show the maximum flood hazard for the baseline model and the proposed scenario with mitigation respectively, during the 1 in 100 year (1% AEP) with climate change with MHWS tidal boundary flood event.

M.2.54 As shown in Vol 9 Figure M.2.31 (see separate volume of figures), the slight increase in flood level which results from the proposed works, does not result in any increase in the flood hazard rating.

M.2.55 The conveyance areas of the proposed landscaped depression which is included within the proposed scenario as mitigation, has been maximised as much as possible, taking into account the constraints of the site. The results demonstrate that the works still result in a minor increase in the peak flood level, however the corresponding increase in flood extent and flood hazard is negligible. It is therefore considered that no further mitigation measures are necessary.

Model development – temporary works

M.2.56 An additional model build has been developed to quantify the impact of the temporary works at King George's Park on flood levels within the park.

M.2.57 This modelled scenario includes increased roughness due to construction activities and the increased ground levels resulting from the construction works, but does not include the conveyance route.

M.2.58 Vol 9 Figure M.2.22 and Vol 9 Figure M.2.23 (see separate volume of figures) show how the temporary works have been represented within the model through changes to the ground topography and roughness coefficients respectively.

M.2.59 Given the lifespan of the temporary works, it has not been necessary to include an allowance for climate change within this modelled scenario. Therefore the flood event that has been modelled for this scenario is the 1 in 100 year (1% AEP) fluvial event with MHWS tidal boundary.

Results – temporary works

M.2.60 As shown in Vol 9 Figure M.2.25 (see separate volume of figures), during the 1 in 100 year (1% AEP) fluvial event with MHWS tidal boundary, the proposed temporary works at the King George's Park site result in a 4mm increase in the flood level in the park.

M.2.61 Modelled flood depths for the temporary scenario are shown in Vol 9 Figure M.2.24 (see separate volume of figures). Given the temporary nature of this impact it has not been considered necessary to provide mitigation for this minor increase in flood level.

Conclusions

M.2.62 Hydraulic modelling of the River Wandle has been undertaken to inform the Level 3 FRA for King George's Park. This modelling confirms that the King George's Park site is located in Flood Zone 3a associated with the River Wandle. Flood Zone 3a is land assessed as having a 1 in 100 or greater annual probability of flooding from the fluvial River Wandle in any given year (1% AEP).

M.2.63 The proposed works at King George's Park are located across the primary flowpath from the northern part of the park towards Wandsworth High Street. As a result, prior to the incorporation of mitigation measures, the proposed shaft and associated landscaping results in an increase in the flood levels in the park during the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary.

M.2.64 As a result, the design of the King George's Park site has been revised to include a landscaped depression area around the north western part of the site to ensure that the flowpath from the park to Buckhold Road is retained and the impact of the proposed development on the flooding mechanisms is reduced. The incorporation of these design measures ensures that the proposed works do not result in a significant increase in the flood levels in the park or surrounding area during the 1 in 100 year (1% AEP) including climate change fluvial event with MHWS tidal boundary.

M.2.65 The flow conveyance area of the landscaped depression has been maximised whilst taking into account the constraints of the site, in order to reduce the impact of the proposed works as much as possible. The results demonstrate that the permanent works with mitigation do result in a minor increase in the flood levels in the park during the 1 in 100 year (1% AEP) including climate change fluvial event. However the landscaped depression minimises the impact as far as is reasonably practical, and there is a negligible increase in flood extent and flood hazard associated with the minor increase in flood level, therefore no further mitigation is necessary.

M.2.66 An additional model run was undertaken to assess the impact of the temporary works on flood levels in the park during the 1 in 100 year (1%

AEP) fluvial event with MHWS tidal boundary (ie, with no allowance for climate change). The results show that the temporary works do result in a minor increase in the flood level in the park, however given the temporary nature of this impact it has not been considered necessary to provide mitigation for this minor increase in flood level.

M.2.67 The design and analysis of the landscaped depression area has required significant collaborative working between the Thames Tunnel team, the Environment Agency and LB Wandsworth. The following pages present a Technical Note submitted in July 2012 to clarify the conclusions of the modelling and a subsequent email from the Environment Agency confirming their approval of the proposals

337-TN-ENV-PWH3X-000001-AB.docx

TECHNICAL MEMORANDUM

KING GEORGES PARK-FLOODPLAIN COMPENSATION

Prepared by:	Elizabeth Gent		
Prepared for:	Environment Agency		
Copy:	John Sweetnam, James Mabin, Alan Lewis, Elisabetta Torricelli, Isobel Bain, Ruth Letourneour, Tom Sly		
Doc ref no:	337-TN-ENV-PWH3X-000001_AB	**Date:**	2nd August 2012

1 Introduction

This technical note has been prepared as supporting information to inform the proposed construction works and landscape design at the King George's Park site in light of the flood risk posed to the site from the River Wandle.

This report seeks to:

1. provide a brief overview of the factors at the site that present constraints to the design of the proposed CSO interception and connection tunnel receptor site,
2. present the preferred design and landscaping option, and,
3. provide an assessment of the preferred design option on the risk of flooding associated with the River Wandle on the surrounding area.

2 Background

It is proposed to construct a CSO interception and connection tunnel receptor site in the northern part of King George's Park, close to the junction between Buckhold Road and Neville Gill Close.

Initial model simulations undertaken for the proposed permanent works (without the inclusion of any mitigation measures or details of landscape proposals) identified that the proposed works are located across the primary flowpath of floodwater from the northern part of the park onto Buckhold Road. As a result, the raising of ground levels in this area as part of the proposed works result in a reduction in the capacity to convey floodwater from the northern part of the park and a subsequent increase in the flood levels in the park of 13mm during the 1 in 100 year (1% AEP) including an allowance for climate change fluvial event and MHWS tidal boundary. This increase in flood level also has a minor impact on the extent of flooding in the local area.

The temporary works were also modelled (without the inclusion of any landscape mitigation measures which aren't practical during construction), which allowed for construction materials/hoarding etc. and a conservative footprint during the temporary construction period. The temporary works are anticipated to remain for a period of 2.5 years and have been modelled against the 1 in 100 year return period without an allowance for climate change. The results of the temporary case were identified as 4mm and were not considered a significant change in flood risk during the temporary construction period of 2.5 years therefore no mitigation is proposed for the temporary works scenario.

As a result of the findings for the permanent works scenario (without mitigation), it became necessary to explore options to revise the design and seek measures to reduce the impact of the proposed permanent works on the extent and level of flooding across the local area.

During the process of revising the design a number of constraints at this location were identified which place restrictions on the design and configuration of the CSO interception and connection tunnel receptor site.

The Frogmore Relief Sewer is a high level sewer which passes across the northern part of the park, as shown in Figure 1PL03-FL-20205. The position of this infrastructure prevents the modification of ground levels within at least 5m either side of this feature.

In addition, there are several established mature trees and the existing lake which limit the potential to significantly alter the location and configuration of the shaft site.

3 Proposed design

Following consultation between the design team, London Borough of Wandsworth and the Environment Agency, a revised landscape plan has been developed which seeks to reinstate the conveyance capacity in the northern part of the park and enable floodwater to continue to adopt its original route north onto Buckhold Road.

The proposed design is shown in Figure 1PL03-FL-20205 and includes the following elements:

1. raised shaft structure, set at between 5.5mAOD and 5.6mAOD,
2. a 17m long footpath ramp extending from the southern end of the hard-standing at an elevation of 5.5mAOD to existing ground levels,
3. a landscaped depression area located to the north west of the shaft and to the north of the line of the Frogmore Relief Sewer. The central part of this landscaped depression area has been set at 4.7mAOD, with a width of approximately 4 to 5m around the edge to grade down from the existing levels.

Details of the revised design, including the landscaped depression area, were incorporated into the hydraulic modelling and an additional model simulation was undertaken to assess the impacts of the proposed design on the flood mechanisms in the area. The results are presented in the following section.

4 Results

The results from the hydraulic modelling demonstrate that the proposed permanent works, including the landscaped depression area, serve to improve the conveyance capacity around the west of the shaft and successfully mitigate the impact of the shaft on increasing the extent and level of flooding in the park.

The following figures have been produced to show the comparison between the Baseline Model and the Proposed Scenario (including the improved conveyance route):

1. Figure 1PL03-FL-20204: Peak flood level difference 1% AEP including climate change fluvial event with MHWS tidal boundary
2. Figure 1PL03-FL-20205: Proposed landscape plan including site constraints.
3. Figure 1PL03-FL-20206: Flood extent difference 1% AEP including climate change fluvial event with MHWS tidal boundary
4. Figure 1PL03-FL-20207: Baseline model flood hazard 1% AEP including climate change fluvial event with MHWS tidal boundary
5. Figure 1PL03-FL-20208: Proposed model flood hazard 1% AEP including climate change fluvial event with MHWS tidal boundary
6. Figure 1PL03-FL-20209: Flood hazard difference 1% AEP including climate change fluvial event with MHWS tidal boundary
7. Figure 1PL03-FL-20206 presents the difference in peak flood level across the study area and shows that the proposed landscape design results in a minor increase in flood level in the park of between +2 to 3mm. This provides a 10mm betterment from the initial scenario which did not include the landscaped depression area.

THAMES TUNNEL

8. Figure 1PL03-FL-20206 also demonstrates that the proposed landscape design including the landscaped depression area results in a reduction in flood levels in the downstream part of the catchment by up to as much as -24mm.

The figures showing the changes in flood extent and flood hazard confirm that the 2 to 3mm increase can be viewed as insignificant with no significant increase in flood extent or flood hazard as a result of the proposed landscape works.

Therefore the +2 to 3mm increase, identified for the 1 in 100 year event including climate change as a result of the proposed works including landscaped depression, is not considered a significant change in flood risk.

Tom Edwards

From: Elisabetta Torricelli [Elisabetta.Torricelli@tidewaytunnels.co.uk]
Sent: 26 October 2012 09:39
To: Alan Lewis; Elizabeth Gent
Cc: Tom Edwards
Subject: FW: King George's Park Updated Conveyance Option

From: Letourneur, Ruth [mailto:ruth.letourneur@environment-agency.gov.uk]
Sent: 26 October 2012 09:34
To: Elisabetta Torricelli
Cc: John Sweetnam; Bain, Isobel
Subject: King George's Park Updated Conveyance Option

Dear Elisabetta,

First of all let me apologise for the delay in our comments on the newly proposed conveyance solution in KGP. As you are aware we have been in discussions with the modelling team at URS over the actual way that the model works, as this was not clear in the note given to us. We now have the following comments:

The initial proposed permanent works (without the inclusion of any mitigation measures or details of landscape proposals were modelled by TTT team (URS). This identified that the works are located within the primary flow path of fluvial floodwater from the northern part of King George's Park on Buckhold Road.

The associated raising of ground levels in this area as part of the proposed works would result in a reduction in the conveyance of floodwater from the northern part of the park and therefore in a subsequent increase in upstream levels of 13mm during the 1 in 100 year (1%AEP) including an allowance for climate change fluvial event combined with a Mean High Water Springs tidal boundary. This 13mm increase in flood level would affect the park and also increase the extent and number of properties subject to flooding in the local areas. This would be unacceptable.

To mitigate this flood risk impact, TTThas produced a revised landscape plan with a "scrape". We understand that this seeks to compensate for the loss of conveyance capacity in the northern part of the park and to enable flood water to continue to adopt its original route north on Buckhold Road. The "scrape" depression area is located to the northwest of the shaft and to the north line of the Frogmore Relief Sewer. The central part of the "scrape" has been set at a reduced level of 4.7mAOD, with a width of approximately 4 to 5m around the edge to grade down from the existing levels.

Modelling shows that the "scrape" results in a maximum of 2/3mm increase upstreamto the park and to some areas outside of the park, although with no increase in flood extent affecting properties. Downstream of the park, this has reduced flood levels to the Wandsworth Town area by 24mm from existing.

As there are no additional properties affected, and there is no increase in the flood extent, as demonstrated by the modelling, the Environment Agency accepts this proposal. We understand that this will be included within the forthcoming DCO application in January. Please note that this is the position of the Environment Agency, and we will be sharing this with LB Wandsworth. The proposed works are subject to Wandsworth's agreement, and we would ask to be notified as to Wandsworth's agreement. Should the design of the "scrape" alter, our comments here are no longer valid. We are reliant on the accuracy of the information given to us.

We were first presented the idea of the "scrape" in KGP in a meeting on 19th July where we also discussed possible overlaps with the Wandsworth Flood Alleviation Scheme. We issued a note to John Sweetnam on 25th July 2012 covering what was discussed in that meeting. I understand that TTT were not willing to agree to that note for issue to LB Wandsworth, but was advised that you were going to come back with comments on that note. We have yet to receive these comments.

I hope that is all clear, if you have any questions, please do not hesitate to come back to me.

Kind regards,
Ruth

1

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.09**

Volume 9: King George's Park appendices

Appendix N: Development schedule

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

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January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 9 King George's Park appendices

Appendix N: Development schedule

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Appendix N: Development schedule

N.1 Summary

N.1.1 The assessments undertaken for this site take account of other relevant development projects within the vicinity of the site which are under construction, permitted but not yet implemented or submitted but not yet determined. In order to identify the relevant developments for consideration, the Planning Inspectorate, local planning authorities and the Greater London Authority have been consulted on the methodology (see Volume 2) and asked to assist in identifying and verifying the development projects included in the assessment. A schedule is provided in Vol 9 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 9 Table N.1 Development schedule for King George's Park

Category types:

a. Under construction

b. Permitted but not yet implemented

c. Submitted but not yet determined

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions		Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2017 (Site Year 1 of construction & peak construction traffic year)	2023 (Year 1 of operation)		
Southside Shopping Centre, Garratt Lane	Adjacent to site boundary on Neville Gill Close (at closest point of dev)	2011/5534	Metro Shopping Fund LP	Demolition of Block B and erection of replacement building of up to four-storeys; erection of front extensions and formation of mezzanine floors to Block A to provide up to 3 levels of accommodation including existing basement; proposed floor space to accommodate retail, financial and professional services, restaurants, pubs and bars and a gym (Classes A1, A2, A3, A4 and D2) together with improvements to existing facade and service yard E, landscaping, public art, signage, advertising and associated works.	B	100% complete & operational	100% complete & operational	Planning application held on the LBW online database, no information that indicates that the development would be built in phases.	Base case (all years)
The Business Village, Broomhill Road	15m north	2007/2999	Workspace Glebe Ltd	Demolition of existing buildings. Erection of buildings between four and sixteen-storeys in height to provide 10,500 sq.m. of B1 floorspace (office, research and development, and light industry), 209 residential units, retail, cafe+/restaurant and crèche/nursery uses with 120 parking spaces within the basement and provision of new public routes/spaces.	A	100% complete & operational	100% complete & operational	ES not available online Site visit conducted December 2011 As it is currently under construction, it is assumed it will be complete and operational by Site Year 1 of construction.	Base case (all years)
Cockpen House, Buckhold Road	60m north	2008/0960	Minerva (Wandsworth) Ltd	Demolition of all existing buildings. Erection of 5 to16-storey buildings plus basement made up of a 5-storey building to the rear, stepping up to a 10-storey building along Buckhold Road with the 4-storey element and 16-storey tower facing King George's Park along the new pedestrian route to Hardwicks Square. Provision of 207 flats. 1010sq. m of commercial space including shops, community uses, offices, bars and restaurants. Underground parking for 78 vehicles and 206 cycles.	A	100% complete & operational	100% complete & operational	Environmental Statement Non Technical Study (Section 6 Development Programme and Construction) Site visit conducted December 2011	Base case (all years)
Osiers Road	Approx 550m north	2011/5207	Boyer Planning	Demolition of existing buildings. Erection of buildings up to 8-storeys high plus basement to provide 158 flats (including 48 affordable units), 2,228sq.m. of commercial accommodation for retail, food and drink, business and community	B	100% complete & operational	100% complete & operational	Planning application information held on the LBW online database, no information indicates that the development would be	Base case (all years)

Development within 1km (IPC or Mayoral referral unless otherwise noted)	Dist from site (closest point)	Development description			Category type (based on 'current' status)	Year specific assumptions		Source of assumption information / Notes	Base case or cumulative dev?
		Appl. No.	Developer	Description		2017 (Site Year 1 of construction & peak construction traffic year)	2023 (Year 1 of operation)		
				uses (Class A1, A2, A3, B1, D1) with associated parking, private amenity space and public realm with access through the site.				built in phases.	
Units 1 -20 Enterprise Way	Approx 580m north	2009/3017	Barratt Homes Ltd	Demolition of existing buildings. Erection of 8 buildings ranging in height from 2 to 21 storeys comprising 275 flats of which 89 would be affordable; 3,587sq.m. of commercial floor space to include shops, financial and professional services (Class A1).	A	100% complete & operational	100% complete & operational	Chapter 6 of ES - development programme, demolition and construction	Base case (all years)
Western Riverside Transfer Station	Approx 670m northeast	2009/1239	Cory Environmental Ltd	Replacement of existing Civic Amenity facility with a building with open sides to south and west elevations for use as a Civic Amenity facility including revised public access/queuing arrangements to the east of the proposed building. Revised staff car park.	A	100% complete & operational	100% complete & operational	Planning application information held on the LBW online database and site visit conducted December 2011.	Base case (all years)
Wandsworth Riverside Quarter, Point Pleasant/Osiers Road	Approx 670m north	2009/3372	Frasers Riverside Quarter Ltd	Erection of six buildings ranging in height up to fifteen-storeys and two single-storey commercial pavilions to provide approximately 8,712sq.m. of commercial floorspace (including community and leisure uses) and 504 residential units (308 private/196 affordable). Provision of open space, new vehicular and pedestrian access points and associated parking.	A	Phase A (Buildings 5A, 5B, 5C and 5D) complete & operational. Phase B (Buildings 6A & 6B) under construction.	100% complete & operational	Planning application information held on the LBW online database and site visit conducted December 2011. Planning Statement states the development will be constructed in two phases but does not indicate over what time period. As construction has commenced, it is assumed that Phase A (Buildings 5A, 5B, 5C & 5D) will be complete and occupied by 2016 and Phase B (Buildings 6A & 6B) by 2019/20.	**2017:** Base case = Buildings 5A, 5B, 5C & 5D Cumulative = Buildings 6A & 6B **2023:** Base case = all buildings No cumulative

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

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