Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

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

Lindsay Speed   Sarah Fairbrother

September 2014

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

List of contents

Environmental Statement glossary and abbreviations

Volume 1	Introduction to the Environmental Statement
Volume 2	Environmental assessment methodology
Volume 3	Project-wide effects assessment
Volume 4	Acton Storm Tanks site assessment
Volume 5	Hammersmith Pumping Station site assessment
Volume 6	Barn Elms site assessment
Volume 7	Putney Embankment Foreshore site assessment
Volume 8	Dormay Street site assessment
Volume 9	King George's Park site assessment
Volume 10	Carnwath Road Riverside site assessment
Volume 11	Falconbrook Pumping Station site assessment
Volume 12	Cremorne Wharf Depot site assessment
Volume 13	Chelsea Embankment Foreshore site assessment
Volume 14	Kirtling Street site assessment
Volume 15	Heathwall Pumping Station site assessment
Volume 16	Albert Embankment Foreshore site assessment
Volume 17	Victoria Embankment Foreshore site assessment
Volume 18	Blackfriars Bridge Foreshore site assessment
Volume 19	Shad Thames Pumping Station site assessment
Volume 20	Chambers Wharf site assessment
Volume 21	King Edward Memorial Park Foreshore site assessment
Volume 22	Earl Pumping Station site assessment
Volume 23	Deptford Church Street site assessment
Volume 24	Greenwich Pumping Station site assessment
Volume 25	Abbey Mills Pumping Station site assessment
Volume 26	Beckton Sewage Treatment Works site assessment
Volume 27	Minor works sites assessment

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

List of contents

Section 1	Introduction
Section 2	Site context
Section 3	Proposed development
Section 4	Air quality and odour
Section 5	Ecology – aquatic
Section 6	Ecology – terrestrial
Section 7	Historic environment
Section 8	Land quality
Section 9	Noise and vibration
Section 10	Socio-economics
Section 11	Townscape and visual
Section 12	Transport
Section 13	Water resources – groundwater
Section 14	Water resources – surface water
Section 15	Water resources – flood risk

Volume 17: Victoria Embankment Foreshore figures

Section 1	Plans from the *Book of Plans*
Section 2	Environmental impact assessment figures

Volume 17: Victoria Embankment Foreshore appendices

Appendix A	Introduction
Appendix B	Air quality and odour
Appendix C	Ecology – aquatic
Appendix D	Ecology – terrestrial
Appendix E	Historic environment
Appendix F	Land quality
Appendix G	Noise and vibration
Appendix H	Socio-economics

Appendix I	Townscape and visual
Appendix J	Transport
Appendix K	Water resources – groundwater
Appendix L	Water resources – surface water
Appendix M	Water resources – flood risk
Appendix N	Development schedule

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Sections 1 to 3: Introduction, site context and proposed development

List of contents

Page number

1 Introduction 1

2 Site context.. 3

3 Proposed development 7

3.1 Overview.. 7

3.2 Defined project 7

3.3 Construction assumptions 14

3.4 Operational assumptions... 22

3.5 Base case and cumulative development 24

3.6 On-site alternatives.. 25

List of plates

Page number

Vol 17 Plate 2.1.1 Victoria Embankment Foreshore – aerial photograph 4

Vol 17 Plate 2.1.2 Victoria Embankment Foreshore – view from the Embankment... 4

Vol 17 Plate 2.1.3 Victoria Embankment Foreshore – view from the River Thames.. 5

List of tables

Page number

Vol 17 Table 3.2.1 Victoria Embankment Foreshore - plans and documents defining the proposed development 8

Vol 17 Table 3.3.1 Victoria Embankment Foreshore − construction phase plans.... 15

Vol 17 Table 3.6.1 Victoria Embankment Foreshore − on-site alternatives 25

This page is intentionally blank.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 1: Introduction

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

1 Introduction

1.1.1 This volume of the *Environmental Statement* of the Thames Tideway Tunnel project presents the results of the environmental impact assessment (EIA) of the proposed development at the Victoria Embankment Foreshore site.

1.1.2 The proposal at this site is to control flows from the existing Regent Street combined sewer overflow (CSO), which currently discharges approximately five times in a typical year. The total volume is approximately 22,300m^3 each year. The CSO would be controlled by connecting the northern Low Level Sewer No.1 to the main tunnel.

1.1.3 The site and environmental context are described in Section 2. The proposed development at the site, comprising both the construction and operational phases, is described in Section 3. Those elements of the proposal for which development consent is sought are described followed by a description of the assumptions applied to the assessment of construction and operational effects. Finally in Section 3.6, the main alternatives which have been considered for this site are presented.

1.1.4 Sections 4 to 15 present the environmental assessments for each topic, which are presented alphabetically. The order of these topics and the structure of each assessment remains the same across different sites.

1.1.5 Figures and appendices for this site are appended separately (see Vol 17 Victoria Embankment Foreshore figures and Vol 17 Victoria Embankment Foreshore appendices). In addition, there is a separate glossary and abbreviations document which explains technical terms used within this assessment.

This page is intentionally blank.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 2: Site context

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

Hard copy available in

Box **31** Folder **A**
January 2013

Creating a cleaner, healthier River Thames

This page is intentionally blank

2 Site context

2.1.1 The proposed development site is located within the City of Westminster on the northern bank of the River Thames. It would comprise a section of the River Thames foreshore, and a section of pavement and roadway of the Victoria Embankment (A3211). The Regent Street CSO discharges into the River Thames at the site and the Northumberland Avenue CSO discharges into the river approximately 40m north of the site. A permanently moored vessel, The Tattershall Castle (a floating bar and restaurant) is located within the site area.

2.1.2 The site extent is defined by the limits of land to be acquired or used (LLAU) and covers an area of approximately 1.6 hectares. The site context and location is indicated in Vol. 17 Figure 2.1.1 (see separate volume of figures).

2.1.3 The site is bounded to the north, east and south by the River Thames and to the west by the Victoria Embankment (A3211). To the north of the site, there is the bar/restaurant ship, Hispaniola, and beyond that the Hungerford Bridge, the Golden Jubilee footbridges and the Embankment Pier. The London Eye, a sightseeing attraction for tourists, is located to the southeast of the site on the opposite river bank. Three moorings lie to the south of the site as well as the Whitehall Stairs which project into the river and contain the Royal Air Force memorial. The closest buildings to the site are those along Whitehall Court to the west of Whitehall Gardens, which include some residential properties. Vol 17 Plate 2.1.1 below provides an aerial view of the site. Photos of the site are also provided in Vol 17 Plate 2.1.2 and Vol 17 Plate 2.1.3.

Vol 17 Plate 2.1.1 Victoria Embankment Foreshore – aerial photograph

Vol 17 Plate 2.1.2 Victoria Embankment Foreshore – view from the Embankment

Vol 17 Plate 2.1.3 Victoria Embankment Foreshore – view from the River Thames

2.1.4 The general existing land uses within and around the site are shown in Vol 17 Figure 2.1.2 (see separate volume of figures).

2.1.5 The closest train station is the Embankment Underground Station located approximately 200m walk to the north of the site. The Thames Path National Trail and public right of way (PRoW) runs along the footpath of Victoria Embankment.

2.1.6 There are a number of receptors in close proximity to the site and these include residential, commercial and recreational receptors as follows (approximate closest distance to the proposed main site hoarding is given). There are no educational establishments within 250m of the site hoarding:

a. residential:
    i Whitehall Court – 68m west of the hoarding
b. commercial:
    i Tattershall Castle bar/restaurant vessel – 20m south of the hoarding
    ii Hispaniola bar/restaurant – 32m north of the hoarding
    iii National Liberal Club – 68m west of the hoarding
c. recreational:
    i River Thames – within cofferdam area
    ii Thames Path National Trail – within the site hoarding
    iii Whitehall Gardens/Victoria Embankment Gardens – 25m west of the hoarding.

2.1.7 Environmental designations for the site and immediate surrounds are shown in Vol 17 Figure 2.1.3 (see separate volume of figures).

2.1.8 The site is located within the City of Westminster air quality management area (AQMA) which is a borough-wide designation declared for nitrogen dioxide (NO_2) and particulate matter (PM_{10}).

2.1.9 The site is located within the river Thames and Tidal Tributaries Site of Importance for Nature Conservation (SINC) (Grade III Metropolitan importance). Additionally, the site is adjacent (across the A3211 Victoria Embankment) to the Victoria Embankment Gardens: Whitehall Garden SINC (Local level)

2.1.10 There are a number of Grade II listed features within the site including seven catenary lamp standards along the riverfront, the river wall and ten ‘sturgeon’ lamp standards with festoon lighting , and four listed decorative benches. There are several listed statues and memorials along Victoria Embankment and within the Victoria Embankment Gardens however none are located within the site boundary.

2.1.11 The site lies within both the Whitehall Conservation Area and the Lundenwic and Thorney Island Area of Special Archaeological Priority.

2.1.12 There are no tree preservation orders (TPOs) within, or adjacent, to the site. Victoria Embankment is characterised by an avenue of mature London plane trees. These trees are indirectly protected by being located within the Conservation Area.

2.1.13 The site is considered unlikely to have significant sources of contamination as it has not been subject to major contaminative land uses in the past. Local geology comprises of superficial deposits and made ground, London Clay, Lambeth Group and Thanet Sand.

2.1.14 Being located on the River Thames foreshore the site is considered to be functional floodplain (Flood Zone 3b), ie, where water must flow or be stored during times of flooding.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 3: Proposed development

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

3 Proposed development

3.1 Overview

3.1.1 The proposed development at Victoria Embankment Foreshore would control the existing Regent Street combined sewer overflow by making a connection to the northern Low Level Sewer No. 1[i]. The works would comprise construction of a CSO drop shaft. An overflow weir chamber would be constructed in the northern Low Level Sewer No. 1 and a connection culvert would link the overflow weir chamber to the drop shaft. The drop shaft would connect to the main tunnel via a short connection tunnel under the river.

3.1.2 The geographic extent of the proposals for which development consent is sought, is defined by the LLAU.

3.1.3 This section of the assessment provides a description of the proposed development. The defined project for which consent is sought is described in Section 3.2. In Section 3.3, assumptions are presented on how the development at this site is likely to be constructed and includes the assumed programme and typical construction activities. Section 3.4 sets out operational assumptions in terms of operational structures and the typical maintenance regime. These construction and operational assumptions underpin the assessment.

3.1.4 Other development may take place and become operational in advance of or during the Thames Tideway Tunnel project thereby changing baseline conditions. In order to undertake an accurate assessment it is necessary to compare the predicted situation with the Thames Tideway Tunnel project in place with this future baseline conditions ('base case') (rather than comparing it with the current conditions). In addition, other development may be under construction at the same time as construction or operation of the Thames Tideway Tunnel project and this could lead to cumulative effects. Information regarding schemes included in the base case and in the cumulative assessment is presented in Section 3.5 with details included in Vol 17 Appendix N. The methodology for identifying these schemes is explained in Volume 2 Section 3.8. Finally, Section 3.6 describes any on-site alternatives considered.

3.2 Defined project

3.2.1 This section identifies the proposals for which consent is sought and so those which can be regarded, subject to approval, as being 'certain' or nearly so (eg, indicative locations).

[i] By diverting the flow from the Low Level Sewer No. 1 at Chelsea Embankment Foreshore, Victoria Embankment Foreshore and Blackfriars Bridge Foreshore, the flows from ten other CSOs along the north bank of the river would be controlled. This avoids the need for additional sites at or near the ten CSOs from Church Street in Chelsea to Essex Street in the City of Westminster

3.2.2 Vol 17 Table 3.2.1 below sets out documents and plans for which consent is sought and which have been assessed.

Vol 17 Table 3.2.1 Victoria Embankment Foreshore - plans and documents defining the proposed development

Document /Plan Title	Status	Location
Proposed schedule of works	For approval	Schedule 1 of *The Draft Thames Water Utilities Limited (Thames Tideway Tunnel) Development Consent Order 201[ ] (Draft DCO)* (and extracts below)
Site works parameter plan	For approval	Vol 17 Victoria Embankment Foreshore figures – Section 1
Demolition and site clearance plans	For approval	Vol 17 Victoria Embankment Foreshore figures – Section 1
Access plan	For approval	Vol 17 Victoria Embankment Foreshore figures - Section 1
Proposed landscape plan (Plan 1 of 2)	Indicative– but layout of above ground structures is illustrative	Vol 17 Victoria Embankment Foreshore figures – Section 1
Proposed landscape plan (Plan 2 of 2)	For approval	Vol 17 Victoria Embankment Foreshore figures – Section 1
Proposed site features plan	Indicative– but layout of above ground structures is illustrative	Vol 17 Victoria Embankment Foreshore figures – Section 1
Design intent plans for kiosk and river wall	Indicative	Vol 17 Victoria Embankment Foreshore figures – Section 1
Proposed listed structure interface plan – foreshore structure	Indicative	Vol 17 Victoria Embankment Foreshore figures –

Document /Plan Title	Status	Location
		Section 1
As existing and proposed listed structure interface plan - weir structure	Indicative	Vol 17 Victoria Embankment Foreshore figures – Section 1
As existing and proposed detailed river elevation - impact on listed structure	Illustrative - but maximum extent of loss of listed structures is for approval	Vol 17 Victoria Embankment Foreshore figures – Section 1
Design principles: Generic	For approval	*Design Principles* report Section 3 (see Vol 1 Appendix B)
Design principles: Site-specific principles (Victoria Embankment Foreshore)	For approval	*Design Principles* report Section 4.14 (see Vol 1 Appendix B)
Code of Construction Practice (CoCP) Part A: General Requirements	For approval	*CoCP* Part A (see Vol 1 Appendix A)
Code of Construction Practice (CoCP) Part B: Site-specific Requirements Victoria Embankment Foreshore	For approval	*CoCP* Part B Victoria Embankment Foreshore (see Vol 1 Appendix A)

Description of the proposed works

3.2.1 Schedule 1 to the *Draft DCO* describes the proposed works for which development consent is sought. The schedule describes the main tunnel, connection tunnels and also the works which would be required at each of the proposed sites within the project. This includes the works comprising the nationally significant infrastructure project (NSIP) and associated development (which are described in Part 1 of Schedule 1) and ancillary works (which are described in Part 2 of Schedule 1).

3.2.2 The following sections provide a description of the proposed works at this site under three headings: Nationally significant infrastructure project, Associated development and Ancillary works. The description of the proposed works has been extracted verbatim from Schedule 1 to the *Draft DCO* and the codes given for the works are those given within that schedule.

3.2.3 In accordance with the *Draft DCO*, all distances, directions and lengths referred to are approximate. All distances for scheduled linear works referred to are measured along the centre line of the limit of deviation for that work. Internal diameters for tunnels and shafts are the approximate internal dimensions after the construction of a tunnel lining. Unless otherwise stated, depths are specified to invert level and are measured from the proposed final ground level.

Nationally significant infrastructure project

3.2.4 The proposed structures and works required at this site which comprise the nationally significant infrastructure project are as follows:

a. **Work No. 16a**: Victoria Embankment Foreshore CSO drop shaft – A shaft with an internal diameter of 13 metres and a depth (to invert level) of 51 metres.

b. **Work No. 16b**: Regent Street connection tunnel – A tunnel between Victoria Embankment Foreshore CSO drop shaft (Work No. 16a) and the main tunnel (east central) (Work No. 1c).

Associated development

3.2.5 The proposed structures and works required at this site, which comprise associated development are as follows:

a. **Work No. 16c:** Victoria Embankment Foreshore associated development - Works to control and divert flow from the northern Low Level Sewer No.1 to the Victoria Embankment Foreshore CSO drop shaft (Work No. 16a) and into the Regent Street connection tunnel (Work No. 16b) including the following above and below ground works:

   i dredging and construction of cofferdam, including the placement of fill material, connection to the existing river wall and construction of campsheds

   ii partial demolition of existing listed river wall and construction of new river wall including connection to and alteration of the existing river wall to reclaim land and to enclose Work Nos. 16a and 16c(iii), (v), (vi) and (vii) and scour protection works, new [Regent Street B] CSO, and new CSO outfall apron

   iii construction of an overflow weir chamber, hydraulic structures, chambers with access covers and other structures including culverts, pipes and ducts to modify, connect, control, ventilate, de-aerate, and intercept flow

   iv removal and subsequent reinstatement of existing listed features including lamp standards and benches

   v construction of structures for air management plant and equipment including filters and ventilation columns and associated below ground ducts and chambers

   vi construction of electrical and control kiosks

   vii construction of pits, chambers, ducts and pipes for cables, hydraulic pipelines, utility connections, utility diversions and drainage including reinstatement of pipe subway

   viii provision of construction access from Victoria Embankment and subsequent reinstatement to original layout

   ix provision of permanent access from Victoria Embankment;

x removal of a section of central reservation and its subsequent re-instatement

xi removal of existing mooring for the Tattershall Castle attached to listed wall (and associated access ramps), temporary relocation of the existing mooring (ramped over listed wall) to the south and use of the temporary mooring, and the construction and use of a new permanent mooring for a permanently moored vessel ramped over listed wall to the south of Work No. 16c(ii) and means of access including access brows, bank seats and gangways

xii temporary removal and then reinstatement of the service mooring / service pontoon to the south of the junction of Victoria Embankment and Horse Guards Avenue

xiii permanent removal of service mooring / service pontoon to the north of the junction of Victoria Embankment and Horse Guards Avenue

xiv construction of amenity building.

3.2.6 The maximum heights of above-ground structures, which are for approval, and shown on the Site works parameter plan (see separate volume of figures – Section 1) are as follows:

a. ventilation column(s) serving the drop shaft = 8m (with minimum 4.0m)

b. ventilation column(s) serving the interception chamber = 6.0m

c. electrical and control kiosk(s) = 6.0m

d. electrical and control kiosk serving the interception chamber = 2.0m

3.2.7 In addition, further works are required at this site that constitute associated development within the meaning of section 115(2) of the Planning Act 2008. These comprise:

a. establishment of temporary construction areas at each works site to include, as necessary, site hoardings/means of enclosure, demolition (including of existing walls, fences, planters, and other buildings and other above and below ground structures), provision of services, including telecommunications, water and power supplies (including substations) including means of enclosure, and ground preparation works including land remediation and groundwater de-watering

b. provision of welfare/office accommodation, workshops and stores, storage and handling areas, facilities for and equipment for processing of excavated materials, treatment enclosures and other temporary facilities, plant, cranes, machinery, temporary bridges and accesses, and any other temporary works required

c. in connection with Work Nos. 5, 6, [8] , 11, 12, 13, 14, 15, 16, 17, 19, [23], 24 [and 26] the provision of temporary moorings (including dolphins) and other equipment and facilities for temporary use by barges, pontoons and other floating structures and apparatus (including as necessary piling for support of such structures) for use in construction of those works, and works for the strengthening of river walls and other flood protection defences

d. temporary removal of coach and car parking bays and creation of temporary replacement coach and car-parking as required and temporary footpath diversions

e. restoration of temporary construction areas, works to restore and make safe temporary work sites and work areas, including (as necessary) removal of hardstanding areas, temporary structures and other temporary works and works to re-establish original ground levels

f. works to trees

g. works to create temporary or permanent landscaping, including drainage and flood compensation, means of enclosure, and reinstatement / replacement of, or construction of, boundary walls and fences including gates

h. formation of construction vehicle accesses and provision of temporary gated or other site accesses and other works to streets

i. diversions (both temporary and permanent) of existing traffic and pedestrian access routes and subsequent reinstatement of existing routes, and works to create permissive rights of way

j. modifications of existing accesses, railings and pedestrian accesses

k. provision of construction traffic signage

l. relocation of existing bus stops and provision of temporary bus lay-bys

m. construction of new permanent moorings and piers, including access brows, bank seats, gangways and means of access

n. permanent and temporary works for the benefit or protection of land or structures affected by the authorised project (including protective works to buildings and other structures, and works for the monitoring of buildings and structures)

o. temporary landing places, moorings or other means of accommodating vessels in the construction and/or maintenance of the authorised project

p. provision of buoys, beacons, fenders and other navigational warning or ship impact protection works

q. such other works as may be necessary or expedient for the purposes of or in connection with the construction of the authorised project which do not give rise to any materially new or materially different environmental effects from those assessed in the Environmental Statement.

3.2.8 The works defined by bullets k, l and n (in the list above) are not considered likely to be applicable to the works proposed at this site.

Ancillary works

3.2.9 These works are not “development” as defined in section 32 of the Planning Act 2008, they do however form part of the Thames Tideway Tunnel project for which development consent will be sought and are included within Schedule 1 to the *Draft DCO*.

3.2.10 The following ancillary works are set out in Schedule 1 to the *Draft DCO*:

a. works within the existing sewers, chambers and culverts and other structures that comprise the existing sewerage network for the purposes of enabling the authorised project, including reconfiguring, modifying, altering, repairing, strengthening or reinstating the existing network

b. works within existing pumping stations including structural alterations to the interior fabric of the pumping station(s), works to reconfigure existing pipework, provision of new pipework, new penstock valves and associated equipment, modification of existing electrical, mechanical and control equipment, and installation or provision of new electrical, mechanical and control equipment

c. installation of electrical, mechanical and control equipment in other buildings and kiosks and modification to existing electrical, mechanical and control equipment in such buildings and kiosks

d. installation of pumps in chambers and buildings

e. works to trees and landscaping works not comprising development

f. works associated with monitoring of buildings and structures

g. provision of construction traffic signage

h. the relocation of boats/vessels.

Design principles

3.2.11 The design principles for the project have been developed with stakeholders and set the parameters that must be met in the final detailed design of the above-ground structures and spaces associated with the project. The principles apply only to the operational phase of the project (ie, the permanent structures).

3.2.12 The generic principles include principles for the integration of functional components and also principles for heritage, in-river structures, landscape, lighting and site drainage.

3.2.13 The design principles form an integral part of the project and are assumed to be implemented within the design of the operational development. Where individual principles are relevant to a particular topic, this is indicated within the relevant assessments.

3.2.14 The *Design Principles* report is provided in Vol 1 Appendix B.

Site features and landscaping

3.2.15 The above-ground structures are shown at an indicative scale on the Proposed landscape plan (see separate volume of figures – Section 1) and the scales of these structures (in addition to the defined heights) have been considered within the assessments as appropriate. The possible locations of these above-ground structures, as well as the CSO drop shaft, are defined by the zones on the Site works parameter plan (see separate volume of figures – Section 1).

3.2.16 All other features on the landscape plan are illustrative only and have not been assessed. The landscaping proposals for approval for this site are provided in the site-specific design principles for this site (see *Design Principles* report Section 4.14).

Code of Construction Practice

3.2.17 All works would be undertaken in accordance with the *Code of Construction Practice (CoCP)*. The *CoCP* sets out a series of measures to protect the environment and limit disturbance from construction activities as far as reasonably practicable. These measures would be applied throughout the construction process at this site, and would be the responsibility of the contractor to implement. The *CoCP* is provided in Vol 1 Appendix A and comprises two parts, Part A and Part B. Part A presents measures which are applicable at all sites across the project and Part B defines measures which are only applicable at individual sites.

3.2.18 The *CoCP* forms an integral part of the project and all of the measures contained therein are assumed to be in place during the construction process described in Section 3.3 below. The measures are not described within Section 3.3 although further details on the measures within the *CoCP* Part B Chambers Wharf are given within the relevant assessments.

3.3 Construction assumptions

3.3.1 This section describes the approach to construction which has been assumed for the purposes of the EIA. The construction programme, layouts and working methods are illustrative and do not form part of the project for which consent is sought. However, although the programme, layouts and working methods described are illustrative, they represent what is considered to be the likely approach, given the existing site constraints, the adjacent land uses and the construction requirements. This section describes only the main activities with the focus on those that are relevant for the assessment of environmental effects.

3.3.2 The assumed construction programme is described first, followed by typical construction activities and concluding with other assumptions associated with the construction phase.

3.3.3 It is also assumed that, where the appropriate powers do not form part of the Development Consent Order, further consents may be required before certain construction activities are progressed. These could include various consents issued by the Environment Agency (EA) (including Flood Defence Consents, Abstraction Licenses and Discharge Consents) and the Port of London Authority (PLA) (including River Works Licenses) as appropriate.

Assumed construction programme and working hours

3.3.4 Construction at this site would be likely to commence in 2016 (Site Year 1) and would be completed in 2021 (Site Year 5). The infrastructure at the site would only become operational in 2023 when the Thames Tideway Tunnel project as a whole becomes operational.

3.3.5 Construction at this site is anticipated to take approximately four and a half years and would involve the following main works (with some overlaps):

a. Site Year 1 – Site set up (approximately 12 months)

b. Site Year 2 – CSO drop shaft construction (approximately eight months)

c. Site Year 2 – Tunnelling (approximately four months)

d. Site Years 3 to 4 – Construction of other structures (approximately 24 months)

e. Site Years 4 to 5 – Completion of works and site reinstatement (approximately 8 months).

3.3.6 This site would operate to the standard and continuous working hours for various phases and activities as set out in the *CoCP* Part A and B (Section 4). Standard working hours would be applied to all of the above phases of construction work apart from elements of drop shaft construction and connection tunnel construction as described below.

3.3.7 It has been assumed that continuous hours would be required during construction of the connection tunnel for a duration of approximately four months. However, it is noted that there would be periods of activity within this phase where continuous 24 hour working would not be required. During these periods only those activities directly connected with the task would be permitted within the varied hours.

Typical construction activities

3.3.8 Vol 17 Table 3.3.1 identifies the construction phasing plans used for the assessment of construction effects. These plans have been prepared to illustrate possible site layouts for the principle construction phases and relevant activities.

Vol 17 Table 3.3.1 Victoria Embankment Foreshore – construction phase plans

Document/Plan title	Activities	Status	Location
Construction phases – phase 1	Site setup	Illustrative	Vol 17 Victoria Embankment Foreshore figures – Section 1
Construction phases – phase 2	CSO drop shaft construction Tunnelling	Illustrative	Vol 17 Victoria Embankment Foreshore figures – Section 1
Construction phases – phase 3	Construction of other structures	Illustrative	Vol 17 Victoria Embankment Foreshore

Document/Plan title	Activities	Status	Location
			figures – Section 1
Construction phases – phase 4	Completion of works and reinstatement	Illustrative	Vol 17 Victoria Embankment Foreshore figures – Section 1

3.3.9 The methods, order and timing of the construction work outlined herewith are illustrative, but representative of a practical method to construct the works and suitable upon which to base the assessment.

3.3.10 The following physical construction works are described:

a. site setup
b. shaft construction
c. tunnel construction
d. tunnel and shaft secondary lining
e. construction of other structures
f. completion of works and site restoration
g. excavated materials and waste
h. access and movement.

Site setup

3.3.11 Prior to any works commencing the site boundary would be established and secured. The hoarding at this site would be 3.6m in height. Welfare and office facilities would also be set up. Telecommunications, water and power supplies to the site would be established by connecting to local services on Victoria Embankment. Service diversions, including two major gas mains and 40 fibre optic cables, would be carried out in the carriageway and pavement of Victoria Embankment.

3.3.12 Seven trees to the west of the site on Victoria Embankment would require removal in advance of the works.

3.3.13 Parts of the site are currently occupied by the Tattershall Castle floating bar and restaurant and an associated mooring which would be first temporarily relocated upriver to a position currently occupied by a City Cruises pontoon, and then, post-construction, permanently relocated closer to the permanent site to a position currently occupied by a service mooring. Both pontoons would themselves require removal during the works.

3.3.14 The extent of demolition and site clearance works are shown on the Demolition and site clearance plans (see separate volume of figures – Section 1). It is assumed that demolition would take approximately 10 months. The approach to any land remediation that might be required cannot be defined at this stage. However it is assumed that any remediation that is required would occur within this earliest phase of construction and that any associated lorry movements would be substantially lower than the subsequent peak during the main construction phases.

3.3.15 Other site works would include the setting up of the required site access from Victoria Embankment, introduction of the required traffic management activities, and modifications to the Thames Path.

3.3.16 It has been assumed that a temporary works cofferdam would extend out from the land from the existing river wall to create a working platform during construction. The maximum extent of the temporary works in the river is defined on the Site parameter plan (see Section 3.2 and separate volume of figures – Section 1). The top level of the outer wall of the cofferdam would be set to existing flood defence level to maintain the level of defence during construction.

3.3.17 The piles used to form the temporary cofferdam would be driven into the impermeable clays from a jack-up barge. The top level of the outer wall of the cofferdam would be set to existing flood defence level to maintain the level of defence during construction.

3.3.18 For the purpose of this assessment it is assumed that the piles would be driven using vibration piling techniques although the intention would be to seek to utilise silent piling techniques where reasonably practical.

3.3.19 A concrete campshed would be constructed along the eastern face of the temporary cofferdam for barges to sit safely on the river bed. The area of the campshed has been assumed to be approximately 400m^2. It is assumed that no dredging would be required at this site, although it is likely that there would be some disturbance to the riverbed during construction of the cofferdam and campshed.

3.3.20 It is assumed for the assessment that the majority of foreshore material within the temporary cofferdams would remain in situ. For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdams and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. Removal of this material would ensure that any settlement of the cofferdam fill material does not adversely affect the ties between the walls of the twin walled temporary cofferdam leading to structural difficulties. All soft material within permanent cofferdams would be removed to ensure sound foundations for permanent construction.

3.3.21 The exact extent and depth of the foreshore deposits to be removed at each site would be informed by geotechnical investigations. Areas of removed material would be filled with gravel similar to the existing bed material. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore. A drain sump would be maintained within the filled cofferdam to enable any water entering the cofferdam to be pumped back to river. The CSO drop shaft construction (see below) would commence once the cofferdam is in place as described.

3.3.22 Monitoring of potential scour would be undertaken during the temporary construction works. The need for scour protection to the cofferdam would be identified using the approach set out in the *Scour Monitoring and Mitigation Strategy* (see Vol 3 Appendix L.4).

3.3.23 Internal site roads, plant and material storage areas, offices, welfare and workshops would be established on the cofferdam.

Shaft construction

3.3.24 Major plant required for the CSO drop shaft construction would include cranes, excavators and dumpers.

3.3.25 The CSO drop shaft would be constructed with a primary lining of precast concrete segmental shaft linings. Initially the drop shaft would be constructed as a wet caisson until London Clay is encountered and the ground water cut off. Pumps would discharge groundwater to the River Thames after being treated through a settlement system. From then on the drop shaft would be constructed using underpinning techniques.

3.3.26 As the drop shaft enters the water bearing Lambeth Group dewatering wells would be drilled outside the periphery of the shaft to control water ingress. Pumps would be placed in the drill casings and ground water extracted. Approval would be sought from the EA so that extracted ground water can be discharged directly into the River Thames. Extracted water would be sampled on a regular basis to check water quality.

3.3.27 Once the excavation is complete, a steel reinforced concrete base plug would be formed at the base of the drop shaft. The size of the concrete base slab would require an extended working day to enable the concrete pour to be completed. This would be agreed with Westminster City Council in advance.

3.3.28 The drop shaft would be finished above flood defence level. The rest of the permanent cofferdam area would be finished at various levels, some above flood defence level and some below flood defence level but protected by a parapet wall.

Tunnel construction

3.3.29 To connect the drop shaft to the main tunnel, an approximately 3m internal diameter connection tunnel approximately 30m long would be constructed using Sprayed Concrete Lining (SCL) techniques. The tunnel is progressively excavated and the SCL tunnel lining is built up in even layers until the required profile is achieved. The concrete would be batched on the surface and pumped to the connection tunnel.

3.3.30 The excavated material would be transported along the connection tunnel to a temporary stockpile on the surface prior to loading to barge for onward disposal.

3.3.31 A tunnel portal would be formed in the drop shaft lining. The portal would consist of a cast *in situ* concrete portal tied to the shaft lining.

3.3.32 Dewatering and ground treatment would be required for the connection tunnel works and to facilitate connection tunnel break-in to the main tunnel.

Secondary lining of shaft and connection tunnel

3.3.33 Secondary lining is an additional layer of concrete placed against the inside of a tunnel's primary concrete segmental lining for watertightness and to improve the overall structural durability. For the purposes of assessment, it has been assumed that the drop shaft and connection tunnel would have a reinforced concrete secondary lining.

3.3.34 It is assumed that the lining of the CSO drop shaft would be made of reinforced concrete placed inside the shaft's primary support. The CSO drop shaft secondary lining is likely to be constructed after the connection tunnel construction. It would be formed with a continuous slip form formwork system or fixed shutters. The shutter would be assembled at the bottom of the drop shaft, slowly and continuously winched up the shaft whilst setting steel reinforcement from a working platform and continuously pumping concrete.

3.3.35 When the secondary lining is complete the internal structures including the vortex and drop tube would be shuttered and concreted.

Construction of other structures

3.3.36 An overflow weir chamber, connection culvert and valve chamber would connect to the existing northern Low Level Sewer No.1 inside the Victoria Embankment wall to the CSO drop shaft.

3.3.37 To construct the overflow weir chamber on the Low Level Sewer No.1, the services above the sewer would be diverted or supported and protected where possible. It is anticipated that traffic management would be required for both the utility diversions and the overflow weir chamber construction.

3.3.38 The Low Level Sewer No.1 would be lined before the overflow weir chamber is constructed. The overflow weir chamber would be constructed using secant or sheet piles and excavated exposing the low level sewer. The base slab and internal walls would then be constructed. Flow would be temporarily diverted from the Low Level Sewer No.1 to allow the existing sewer to be broken out on completion of the weir chamber.

3.3.39 Sheet pile walls would be used to provide support within which the underground chambers would be constructed. Walls would be constructed to a depth to minimise ground water ingress into the excavation, but small pumps would be utilised to manage any ground water that does seep through. The pumps would discharge ground water to the River Thames after being treated through a settlement system.

3.3.40 Ground treatment would be required during the interception and CSO works, to the base of the existing river wall.

3.3.41 The walls, bases and roofs of the chambers and shallow foundations for above-ground structures would be formed by in-situ reinforced concrete techniques. Concrete would be pumped or skipped to the chamber. The piled walls would be extended to the CSO drop shaft to allow the connection culvert to be constructed in a similar manner to the chambers.

3.3.42 It is assumed that piles would be used to support the underground chambers, and would be bored reinforced concrete piles. The diameter, depth and spacing would depend on the structure design and ground conditions.

3.3.43 Air management structures comprising an underground air treatment chamber and associated ducts and ventilation columns and the electrical and control kiosks would also be built and commissioned.

3.3.44 On completion of the main construction (outlined above) the new realigned river wall would be installed prior to removal of the temporary cofferdam to ensure flood protection.

Completion of works and site restoration

3.3.45 On completion of the main construction (outlined above) the new river wall would be finished prior to removal of the temporary cofferdam to ensure flood protection.

3.3.46 Once the cofferdam fill is removed, the geotextile layer would be removed and the area of the foreshore where permanent scour protection is required would be excavated by approximately 1.5m by an excavator.

3.3.47 It is assumed for the assessment that permanent scour protection and new outfall apron would consist of loose large stone placed just below foreshore level. The size and type of the stone is to be defined. It is assumed therefore that a 1m depth of stone would be placed up to approximately 0.5m below the existing foreshore level within the zone indicated on the Site works parameter plan (see separate volume of figures – Section 1). This permanent protection would be within the area of the temporary cofferdam.

3.3.48 Once the permanent scour protection is in place, the bed would be reinstated to match the existing river bed conditions as required and the sheet piling forming the temporary cofferdam would then be removed by pulling. Material excavated would be disposed of in accordance with the project’s waste management procedure.

3.3.49 Once the main elements of construction are completed, the final landscaping works would be undertaken including final treatments and surfaces, planting and installation of street furniture. Final treatments to the river wall would be completed prior to removal of the temporary cofferdam.

Excavated materials and waste

3.3.50 The construction activities described above and in particular the construction of the CSO drop shaft would generate a large volume of excavated material which would require removal. This is estimated at 62,500 tonnes, the main elements of which would comprise approximately 43,500 tonnes of imported fill (which would require later removal), 750 tonnes of made ground, 13,500 tonnes of London Clay, and 5,000 tonnes of Lambeth group.

3.3.51 In addition, it is estimated that approximately 2,000 tonnes of construction waste would be generated including 1,500 tonnes of imported fill and 350 tonnes of concrete.

3.3.52 Excavated materials and construction wastes would be exported from the site in accordance with the *Transport Strategy* which accompanies the application for development consent (the ‘application’) (see Access and movement below).

Access and movement

3.3.53 For the purposes of the assessment a single trip to or from the site is referred to as a ‘movement’, while two trips, one to and one from the site, are referred to as a ‘lorry’ or ‘barge’.

3.3.54 The transport strategy requires that the importation of granular fill for the formation of the temporary working area, and the subsequent removal of fill would be by barge. It is also anticipated that the removal of drop shaft and ‘other’ excavated material would be by barge. The assessment assumes 90% of these materials would be taken by river, with the residual 10% transported by road to account for periods where river transport is not available or the material is unsuitable for transport by barge.

3.3.55 The highest barge movements (peak barge movements) would occur during cofferdam construction. Peak daily barge numbers, averaged over a one month period, would be two barges per day, equivalent to four barge movements. It is estimated that total barge numbers for this site would be 144, equivalent to 288 barge movements over the construction period. Barge numbers are based upon an assessed barge size of 800T.

3.3.56 Barges would sit on campsheds adjacent to the temporary cofferdam during periods of low tide and it is assumed that they would be moved by tugs at this site. It is estimated that tugs would be present at this site for approximately 20 minutes when delivering / collecting barges.

3.3.57 The highest lorry movements (peak vehicle movements) at the site would also occur during cofferdam construction. The peak daily vehicle numbers at this time, averaged over a one month period, are estimated to be 14 heavy goods vehicle (HGV) lorries, equivalent to 28 movements per day. It is estimated that total vehicle numbers for this site would be in the order of 5,800 HGV lorries, equivalent to 11,600 movements over the construction period.

3.3.58 The site access point would be via a left turn into the site from Victoria Embankment (A3211) and the egress is a left turn back out onto Victoria Embankment which forms part of the Transport for London Route Network (TLRN).

3.3.59 The pedestrian footpath and Thames Path running along the river embankment would be diverted to the northern footpath of Victoria Embankment utilising existing crossing facilities. Appropriate diversion signage would be deployed.

3.3.60 A *Traffic management plan* would be developed for the site, produced, coordinated and implemented by the contractor.

3.3.61 A *Draft Project Framework Travel Plan,* which accompanies the application, has been produced setting out the requirements and guidelines for the site-specific *Travel plans* to be developed by the contractor.

3.4 Operational assumptions

3.4.1 This section provides details of the assumptions which have been made for the operational phase for the purposes of the EIA. Unless otherwise also listed in Section 3.2, the details given are illustrative and do not form part of the project for which consent is sought.

3.4.2 The details given are considered likely to represent the likely approach, given the site constraints, the adjacent land uses and the operational requirements. This section describes only the main operational structures and activities with the focus on those that are relevant for the assessment of environmental effects.

3.4.3 The operational structures are described first, followed by the assumed maintenance regime.

3.4.4 Once operational the project would divert the majority of current CSO discharges via the CSO shaft and connection tunnel to the main tunnel for treatment at Beckton Sewage Treatment Works. The number of CSO discharges from the Regent St CSO would be reduced from five spill events in a typical year to zero. The connection to the northern Low Level Sewer No. 1 at this site and at two other sites (Chelsea Embankment Foreshore and Blackfriars Bridge Foreshore) would control the discharge from ten CSOs along the northern embankment.

Operational structures

3.4.5 For the purposes of the application, each of the main operational structures is shown as being located within a defined zone, in which the structure would be located. The operational structures listed within the proposed schedule of work description in Section 3.2 along with the relevant plans, form part of the proposed development for consent. The defined zones for the structures are shown on the Site works parameter plan (see separate volume of figures – Section 1).

3.4.6 The heights of the main ventilation columns are defined and also form part of the project for consent (see Section 3.2). The following text provides additional clarification on the assumed form, purpose, function and working of these structures where this is considered helpful to the reader.

3.4.7 The assessment for each of the environmental topics has been based on the most appropriate dimensions and siting of the structures to ensure the assessment is robust. For example, the lower height for the ventilation column would typically generate higher odour impacts than a higher height and so the lower height limit has been modelled in the assessment. For other topics such as townscape, the upper height may be more important and has been assessed. The approach that has been adopted in this regard is explained within each topic assessment section, where necessary.

3.4.8 The approximate dimensions provided for underground structures are internal dimensions which are determined by the hydraulic requirements at particular sites.

3.4.9 Once constructed and operational the structures listed in the following sections would remain on site.

Shaft

3.4.10 The location, diameter and depth of the CSO drop shaft are described in Section 3.2. Ground level access covers on the drop shaft would be used for access/egress by maintenance vehicles and personnel during planned inspections of the shaft.

Chambers and culverts

3.4.11 The overflow weir chamber, valve and outfall chambers and connection culvert would be below ground, built around the existing northern Low Level Sewer No. 1 and within a new extension to the embankment. There would be covers on top of the chambers to allow access and inspection. The new foreshore structure would be finished to existing embankment level with a flood wall about 1m high at the roadside with a raised platform at the riverside protecting the covers from tidal/fluvial flooding.

River wall

3.4.12 The location of the new river wall is defined in Section 3.2. River wall parapets would be provided around the foreshore structure at current flood defence levels. The main public space on top of the structure would be at the same height as the flood defences. The stepped terraces around the front sides of the structure would sit below the defence level and would occasionally be flooded, although all are above highest astronomical tide level (HAT).

Air management structures

3.4.13 The heights and locations of above-ground air management structures, which comprise the ventilation columns, are defined in Section 3.2. In addition to these structures, an underground air treatment chamber would contain an air management filter and would be connected to the ventilation columns. The air treatment chamber would have ground level covers to allow access and inspection.

Electrical and control kiosk

3.4.14 The height and location of the above ground electrical and control kiosk and a small local control pillar are defined in Section 3.2. The electrical and control kiosk would contain gas monitors, electrical and control panels and metering equipment.

Permanent restoration and landscaping

3.4.15 The Proposed landscape plan (see separate volume of figures – Section 1) and generic and site-specific design principles (see Section 3.2) should be referred to for information on landscaping principles.

3.4.16 The area above the structures would be finished with hardstanding to allow maintenance vehicle and crane access to the covers on top of the drop shaft. This hardstanding would form an extension to the Thames Path and would usually be publicly accessible, but Thames Water would retain a right of access over it and would install temporary security and safety barriers on occasions when the area is used for drop shaft access. Parts of the drop shaft structure would be raised to approximately flood defence level to provide a viewing platform looking over the river towards the Palace of Westminster.

3.4.17 Access to the Victoria Embankment Foreshore site would be via a reinforced vehicle crossing across the footpath from Victoria Embankment. The site would be accessible to the public by foot. The existing coach parking on Victoria Embankment would be reinstated.

3.4.18 The Tattershall Castle mooring would be moved from its temporary position (during construction) to a new permanent position to the south (upstream) of its original location. One of the two service moorings would be reinstated. Access ramps to relocated moorings would be like for like. They would bridge over the river wall with minimum physical and visual impact on the listed structure.

Typical maintenance regime

3.4.19 A light commercial vehicle would undertake three to six monthly maintenance works. This would be carried out during normal working hours and would take approximately half a day. There would be no aerial lighting. A coach parking space on Victoria Embankment in front of the vehicular access would be used to allow the maintenance workers to park without having to access the site where this is possible. Additionally, once every ten years, more significant maintenance work would be carried out. This would also be carried out in normal working hours. Vehicular requirements for these visits would include two mobile cranes and associated support vehicles and equipment.

3.5 Base case and cumulative development

3.5.1 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, Greater London Authority and Transport for London 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 20 Appendix N 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.

3.5.2 The development projects which have been included under base case, cumulative or both for the assessment of the proposed development at Victoria Embankment Foreshore are listed below. A map showing their location is included in Vol 17 Figure 3.5.1 (see separate volume of figures).

a. London Eye Pier Extension

b. Elizabeth House, 39 York Road

c. Land bounded by Upper Ground and Doon St - east part of site (adjacent to Cornwall Rd)

d. York House

e. Odeon West End - land bounded by Leicester Square, Panton Street, Whitcomb Street, Orange Street and St. Martin's Street London

f. St James's Market redevelopment.

3.6 On-site alternatives

3.6.1 Project-wide and site selection alternatives are addressed in Volume 1 Section 3. This section describes on-site alternatives that have been considered and provides the main reasons why these alternatives (to the proposed approach) have not been adopted.

3.6.2 Vol 17 Table 3.6.1 below identifies those items for which alternatives have been considered, the alternatives and provides the main reasons why the alternatives were not taken forward.

Vol 17 Table 3.6.1 Victoria Embankment Foreshore – on-site alternatives

Item	Alternatives considered	Reason not progressed
Shape of the foreshore structure	Symmetrical orthogonal design and an 'island' style shaft foreshore structure	Stakeholder concerns over scale of the structures, impact on the character of the area of a more informal design, and accessibility of the 'island' structure.
Location of foreshore structure	A location slightly further downstream, in closer proximity to Hungerford Bridge	To increase the distance between and reduce effects on Hungerford Bridge and the London Underground Bakerloo Line infrastructure.
Sewer interception methodology	Direct interception of Regent St CSO with smaller overflow weir on	More efficient to intercept Regent St CSO indirectly (reduction in culverts, vortex, etc.) with a longer overflow weir on the Low Level Sewer.

Item	Alternatives considered	Reason not progressed
	northern Low Level Sewer No.1	

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 4: Air quality and odour

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 4: Air quality and odour assessment

List of contents

Page number

4 Air quality and odour ... 1

4.1 Introduction ... 1

4.2 Proposed development relevant to air quality and odour ... 2

4.3 Assessment methodology ... 4

4.4 Baseline conditions ... 8

4.5 Construction effects assessment ... 17

4.6 Operational effects assessment ... 26

4.7 Cumulative effects assessment ... 27

4.8 Mitigation ... 28

4.9 Residual effects assessment ... 28

4.10 Assessment summary ... 29

References ... 32

List of tables

Page number

Vol 17 Table 4.3.1 Air quality and odour – stakeholder engagement ... 4

Vol 17 Table 4.4.1 Air quality – measured NO_2 concentrations ... 9

Vol 17 Table 4.4.2 Air quality – additional monitoring locations ... 10

Vol 17 Table 4.4.3 Air quality – 2010 background pollutant concentrations ... 11

Vol 17 Table 4.4.4 Odour – measured H_2S concentrations ... 11

Vol 17 Table 4.4.5 Air quality and odour – receptors ... 15

Vol 17 Table 4.4.6 Air quality – annual mean background pollutant concentrations. 17

Vol 17 Table 4.5.1 Air quality – predicted annual mean NO_2 concentrations ... 19

Vol 17 Table 4.5.2 Air quality – predicted annual mean PM_{10} concentrations ... 21

Vol 17 Table 4.5.3 Air quality – predicted exceedances of the daily PM_{10} standard. 23
Vol 17 Table 4.5.4 Air quality – numbers of dust sensitive receptors 24
Vol 17 Table 4.5.5 Air quality – summary of construction dust risks......................... 25
Vol 17 Table 4.5.6 Air quality – significance of construction dust effects.................. 26
Vol 17 Table 4.6.1 Odour – impacts and magnitude - operation............................... 27
Vol 17 Table 4.10.1 Air quality – summary of construction assessment................... 29
Vol 17 Table 4.10.2 Odour – summary of operational assessment 31

4 Air quality and odour

4.1 Introduction

4.1.1 This section presents the findings of the assessment of the likely significant air quality and odour effects of the proposed development at the Victoria Embankment Foreshore site. The project-wide air quality effects are described in Volume 3 Project-wide effects assessment.

4.1.2 The proposed development has the potential to affect air quality and odour due to:

a. construction traffic on the roads leading to an increase in vehicle emissions (air quality)

b. temporary closure of lanes during construction, which can lead to an increase in vehicle emissions through worsened congestion or through vehicles being routed onto other roads (air quality)

c. emissions from tugs pulling river barges (air quality)

d. emissions from construction plant (air quality)

e. construction-generated dust (air quality)

f. operation of the tunnel, resulting in air emissions (odour).

4.1.3 Each of these impacts is considered within the assessment. As a result the construction assessment for Victoria Embankment Foreshore site comprises four separate components: effects on local air quality from construction road traffic (taking account of temporary lane closures); effects on local air quality from tugs (for river barges); effects on local air quality from construction plant; and effects from construction dust. The effects on local air quality from construction road traffic, tugs (for river barges) and construction plant are assessed together (within the same model) while construction dust is assessed separately. The operational assessment considers the potential for nuisance odour emissions from the operation of the tunnel. As set out in the *Scoping Report*, local air quality effects are not assessed during operation on the basis that the only relevant operational source of air pollutants would be from the infrequent visits of maintenance vehicles which would not result in a likely significant effect.

4.1.4 The assessment of air quality and odour presented in this section has considered the requirements of the National Policy Statement for Waste Water sections 4.3 (odour), 4.11 (air quality and emissions) and 4.12 (dust). Further details of these requirements can be found in Vol 2 Section 4.3.

4.1.5 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore figures). Appendices supporting this site assessment are contained in Vol 17 Appendix B.

4.2 Proposed development relevant to air quality and odour

4.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to air quality and odour are set out below.

Construction

Construction road traffic

4.2.2 During the proposed construction period there would be construction traffic movements[i] in and out of the site.

4.2.3 The highest number of annual lorry movements at the Victoria Embankment Foreshore site would occur during the sewer connection works / fitout straddling over Site Year 3 and Site Year 4 of construction. The average daily number of vehicle movements during the peak month would be approximately 26 movements per day.

4.2.4 The construction traffic routes, traffic management and access to the site are detailed in Section 12 of this volume.

4.2.5 Construction traffic is likely to affect local air quality as a result of increasing traffic and therefore emissions on the road network

Tugs for river barges

4.2.6 River barges may affect local air quality through direct emissions from the tugs pulling them.

4.2.7 The highest number of barge movements in any one year is in Site Year 3 of construction when there would be four barge movements a day averaged over a one month period. The emissions associated with the tugs are presented in Vol 17 Appendix B.3.

Construction plant

4.2.8 Construction plant is likely to affect local air quality from direct exhaust emissions associated with the use and movement of the plant around the site.

4.2.9 There are a number of items of plant to be used on site that may produce emissions that could affect local air quality. Examples of such plant are excavators, generators and dumper trucks.

4.2.10 Typical construction plant which would be used at the Victoria Embankment Foreshore site in the peak construction year and associated emissions data are presented in Vol 17 Appendix B.4.

Construction dust

4.2.11 Activities with the potential to give rise to dust emissions from the proposed development during construction are as follows:

[i] A movement is a construction vehicle moving either to or from the site.

a. site preparation and establishment

b. demolition of existing infrastructure and buildings

c. materials handling and earthworks including the batching of concrete and grout

d. construction traffic – from moving over unpaved ground and then tracking out mud and dirt onto the public highway (termed 'trackout' hereafter).

4.2.12 At the Victoria Embankment Foreshore site there would be approximately $92m^3$ of demolition material generated while the amount of amount of material moved during the earthworks would be approximately 115,000 tonnes. The volume of building material used during construction would be approximately $7,000m^3$.

Code of construction practice

4.2.13 Appropriate dust and emission control measures are included in the *Code of construction practice (CoCP)*[ii] *Part A* (Section 7) in accordance with the London Councils Best Practice Guidance (GLA, 2006)[1]. Measures incorporated into the *CoCP* to reduce air quality impacts include measures in relation to vehicle and plant emissions, measures to reduce dust formation and re-suspension, measures to control dust present and measures to reduce particulate emissions. These would be observed across all construction and demolition activities at the Victoria Embankment Foreshore site.

4.2.14 The effective implementation of the *CoCP Part A* measures is assumed within the assessment.

4.2.15 There are no site-specific air quality measures contained in the *CoCP Part B*.

Operation

4.2.16 A ventilation structure would treat air released from the tunnel. The air would be treated by passing air through two carbon filters housed in a below ground air treatment chamber. Natural pressure during tunnel filling would allow air to pass passively without the need for fans. The capacity of each passive filter would be $0.5m^3/s$. The maximum air release rate from each filter during a typical year is expected to be $0.2m^3/s$ therefore all air in a typical year would be treated through the passive filter. No nuisance odours are therefore expected.

4.2.17 Air would be released from the ventilation columns for about 20 hours in a typical year, all of which would have passed through the passive filter. For the remaining hours, no air would be released although air intake would occur as the tunnel is emptied.

[ii] The *Code of construction practice* (CoCP) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

Environmental design measures

4.2.18 A carbon filter would be included as part of the ventilation structure design and construction. The passive filter would remove odours by adsorption onto the filter. Full details of the Thames Tideway Tunnel ventilation system can be found in the *Air Management Plan*.

4.3 Assessment methodology

Engagement

4.3.1 Volume 2 Environmental assessment methodology (Section 4.2) documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of air quality and odour are presented here (Vol 17 Table 4.3.1).

Vol 17 Table 4.3.1 Air quality and odour – stakeholder engagement

Organisation	Comment	Response
Westminster City Council, Position Paper, January 2011	It should be ensured that the engines of all vehicles and plant on site are not left running unnecessarily to prevent exhaust emissions.	This is noted. Appropriate mitigation measures are included in the *CoCP Part A*.
Westminster City Council, scoping response, May 2011	The impact of utility and traffic diversions should be considered as part of the construction activities and their effects assessed in relation to traffic flow, air quality, odour and dust, noise and vibration.	Utility and traffic diversions have been taken into account in the assessment where appropriate.
Westminster City Council, scoping response, May 2011	The construction impact of the connecting tunnel should be considered as part of the assessment.	This assessment has considered the effects of the construction works with the potential to give rise to air quality and odour impacts. This work has included the construction of the connection tunnel.
Westminster City Council, scoping response, May 2011	An assessment of the use of river transport for access, construction and post construction works and activities compared to alternative modes of transport should be included in the ES.	This assessment has considered the use of river transport of 90% of cofferdam fill in and out of the site and 90% of shaft and other excavated material out of the site.
Westminster City Council	Agree monitoring locations with Westminster City Council	Locations agreed with City of Westminster Project

Organisation	Comment	Response
(June 2011)		Manager - Air Quality.
Westminster City Council (June 2011 and July 2012)	Odour complaints in the area should be considered	No relevant complaints have been identified in the vicinity of the site.
Westminster City Council, Phase two Consultation, February 2012	A number of the monitoring sites identified in Figure 4.4.1 for PEIR Victoria Embankment Foreshore are no longer in use and we would suggest reviewing data for air quality and odour monitoring in this area. Any adverse effects should be mitigated by minimising land based transport to the proposed worksite and maximising use of river transport for materials to and from the worksite.	The monitoring has been reviewed and updated in Section 4.4. River transport has been maximised in order to minimise the effects on local air quality in the vicinity of Victoria Embankment Foreshore site.
English Heritage, Phase two Consultation, February 2012	English Heritage advises that the National Liberal Club is both a distinct building and distinct business from Whitehall Court and consequently we recommend that it is identified as a distinct receptor in para. 4.4.11 on page 18. Furthermore, we recommend the National Liberal Club's inclusion in Table 4.4.4 on page 19, Table 4.8.1 (air quality – construction) and Table 4.8.2 (odour).	The National Liberal Club has been assessed as a sensitive receptor for both air quality and odour.

Baseline

4.3.2 The baseline methodology follows the methodology described in Volume 2. There are no site specific variations for identifying baseline conditions for this site.

Construction

4.3.3 The assessment methodology for the construction phase follows that described in Volume 2. There are no site specific variations for undertaking the construction assessment of this site.

4.3.4 Section 4.5 details the likely significant effects arising from the construction at the Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel sites which could elevate construction dust nuisance effects within the assessment area (see para. 4.3.5 below). With regard to local air quality, the effect of all relevant traffic associated with Thames Tideway Tunnel sites using the highway network in the vicinity of the site is taken into account in the assessment as traffic data used for the assessment includes traffic associated with all Thames Tideway Tunnel sites.

Construction assessment area

4.3.5 The assessment area for the local air quality assessment during construction covers a square area of 600m by 600m centred on the Victoria Embankment Foreshore site. This assessment area has been used for the assessment of road transport, tugs for river barges, construction plant and construction dust and has been selected on the basis of professional judgement to ensure that the effects of the Victoria Embankment Foreshore site are fully assessed. A distance of 200m is generally considered sufficient (Highways Agency, 2007)[2] to ensure that any significant effects are considered. The selected assessment area exceeds this considerably.

Construction assessment year

4.3.6 The peak construction year in terms of construction traffic movements (Site Year 3/Site Year 4 of construction) has been used as the year of assessment for construction effects (construction road and river transport, construction plant and construction dust) in which the development case (with the Thames Tideway Tunnel project) has been assessed against the base case (without the Thames Tideway Tunnel project) to identify likely significant effects of the Thames Tideway Tunnel project.

4.3.7 The assessment of construction effects also considers the extent to which the effects on local air quality would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Other developments

4.3.8 As indicated in the site development schedule (see Vol 17 Appendix N), there is one development (London Eye Pier Extension) identified within a 300m radius of the Victoria Embankment Foreshore site (construction assessment area). Due to its nature (new floating pontoon), this development is not however relevant to the air quality assessment as it does not represent a new receptor for consideration in the assessment. Also, as the development would be complete and operational by Site Year 3/Site Year 4 of construction, there are no cumulative construction effects to assess.

Operation

4.3.9 The odour assessment methodology for the operational phase follows that described in Volume 2. There are no site specific variations for undertaking the operational assessment of this site.

4.3.10 Section 4.6 details the likely significant effects arising from the operation at the Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel sites which could give rise to additional effects on odour within the assessment area for this site, and therefore no other Thames Tideway Tunnel sites are considered in this assessment.

Operational assessment area

4.3.11 Odour dispersion modelling has been carried out over an area of 700m by 700m centred on the Victoria Embankment Foreshore site. The assessment area has been selected on professional judgement on the basis of it being considered the potential maximum extent of the impact area.

Operational assessment year

4.3.12 The assessment undertaken for a typical use year (as described in Volume 2) applies equally to all operational years. Therefore no specific year of operation has been assessed.

Other developments

4.3.13 Regarding other new developments, there are none that are relevant to the odour assessment as none are within 50m of the ventilation columns.

Assumptions and limitations

Assumptions

4.3.14 The general assumptions associated with this assessment are presented in Volume 2.

Construction

4.3.15 The site specific assumptions in terms of model input are set out in Vol 17 Appendix B.

Operation

4.3.16 The site specific assumptions in terms of the assumed capacity of the carbon filter and air release rate used for the odour dispersion modelling are described in paras. 4.2.16 to 4.2.18.

4.3.17 Odour dispersion modelling only includes emissions from the ventilation structure and does not take account of background concentrations due to other sources. Background odour concentrations in the area are assumed to be low as there has been only one complaint in the surrounding area over recent years (see para. 4.4.12) and seasonal spot measurements of hydrogen sulphide (H_2S) carried out in 2011/12 indicate that concentrations are typical of urban areas (Michigan Environmental Science Board, 2000)[3].

4.3.18 Following dispersion modelling, the maximum concentration predicted at any location was reported whether this was at a building where people could be exposed or on open land. As a worst case assumption, it was assumed that this is a relevant receptor. This means that should the ventilation structure be moved within the identified parameter plan (see Site Parameter Plan, separate volume of figures – Section 1), the impact would not be worse than that reported in Section 4.6.

Limitations

4.3.19 The general limitations associated with this assessment are presented in Volume 2.

Construction

4.3.20 As there are no appropriate particulate matter (PM_1) monitoring data located within the vicinity of the Victoria Embankment Foreshore site, it has not been possible to verify PM_{10} modelling results[iii]. The adjustment factor derived for oxides of nitrogen (NO_X) (from a comparison of modelled and monitored NO_X data) has therefore been applied to the PM_{10} modelling results.

Operation

4.3.21 There are no limitations specific to the odour assessment of this site.

4.4 Baseline conditions

4.4.1 The following section sets out the baseline conditions for air quality and odour within and around the site. Future baseline conditions (base case) are also described.

Current baseline

Local air quality

4.4.2 The current conditions with regard to local air quality are best established through long-term air quality monitoring.

4.4.3 As part of their duties under Part IV of the Environment Act 1995 (UK Government)[4], local authorities, especially in urban areas where air quality is a significant issue, undertake long-term air quality monitoring within their administrative areas.

4.4.4 There are three continuous monitoring stations and two diffusion tubes which collect data pertinent to the Victoria Embankment Foreshore site and associated construction traffic routes operated by Westminster City Council. The location of these is shown in Vol 17 Figure 4.4.1 (see separate volume of figures). Monitoring data for these monitoring sites in the City of Westminster for the period 2007-2011 are contained in Vol 17 Table 4.4.1 (NO_2 concentrations). No data are available for the Covent Garden (WM5) site in 2007, 2008 or 2009 as monitoring commenced in July 2009.

4.4.5 There are no PM_{10} monitoring data that meets Defra guidelines available within 1.1km of the Victoria Embankment Foreshore site.

[iii] Model verification refers to checks that are carried out on model performance at a local level. This involves the comparison of predicted (modelled) versus measured concentrations. Where there is a disparity between the predicted and the measured concentrations, the first step should always be to check the input data and model parameters in order to minimise the errors. If required, the second step would be to determine an appropriate adjustment factor that can be applied to the modelled traffic contribution.

Vol 17 Table 4.4.1 Air quality – measured NO_2 concentrations

Monitoring site	Site type	Annual mean (µg/m^3)					Number of exceedances of hourly standard				
		2011	2010	2009	2008	2007	2011	2010	2009	2008	2007
Continuous monitoring sites											
Horseferry Road (WM0)	Urban background	**41**	**49**	**44**	**40**	37*	0	3	0	1	0*
Charing Cross Library (WM4)	Roadside	NM**	**89**	**83**	**78**	**86**	NM	**34**	**22**	**24**	**71**
Covent Garden (WM5)	Urban background	NM**	**52**	NM			NM	0	NM		
Diffusion tube monitoring sites											
Covent Garden (WM58)	Urban background	NM***	**49**	**48**	**51**	**50**	NM				
Air Street (WM39)	Roadside	NM***	**92**	**81**	**75**	**92**	NM				

*Note: NM indicates not measured. Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean and 200µg/m^3 for the hourly mean which can be exceeded 18 times per year. Codes in brackets represent monitoring site identifiers used in Vol 17 Figure 4.4.1. * Based on 77% data capture. ** Sites closed in January 2011. *** Sites closed March 2011.*

4.4.6 The monitoring data at these sites show that the annual mean NO_2 objective / limit value (40µg/m^3) has been exceeded at both roadside and background sites in nearly all years when monitoring was undertaken. The hourly mean NO_2 objective / limit value has been exceeded in all years that monitoring was undertaken at the Charing Cross Library roadside site, but not at the background sites at Covent Garden and Horseferry Road.

4.4.7 As a result of previous exceedances of air quality objectives, the Westminster City Council has declared the whole borough an Air Quality Management Area (AQMA) for both NO_2 and PM_{10}.

4.4.8 Diffusion tube monitoring has also been undertaken as part of the EIA to monitor NO_2 concentrations in the vicinity of the Victoria Embankment Foreshore site. This monitoring comprises five diffusion tubes based at the locations identified in Vol 17 Table 4.4.2. The table shows a 2010 annual mean concentration (baseline year), which has been calculated from the measurements made between April 2011 and April 2012 at each of the sites. To calculate the 2010 annual mean NO_2 concentrations, the 2011/12 measurements are adjusted for bias using the co-located diffusion tubes and are then seasonally adjusted. Annual mean NO_2 concentrations, for the period covered by the diffusion tubes, and for the year 2010 have been collated from four nearby background continuous monitoring sites measuring NO_2 and with data capture rates greater than 90%. The average of the ratios between the period and annual means has been used to calculate the seasonal adjustment factor. To enable any bias to be corrected a triplicate site (comprising three diffusion tubes) was established at a continuous monitoring site in Putney (site PEFM4 – see Vol 7); for additional precision, a triplicate site was established at one of the monitoring sites (VEFM5) near the Victoria Embankment Foreshore site; otherwise all the monitoring locations have single tubes.

Vol 17 Table 4.4.2 Air quality – additional monitoring locations

Monitoring site	Grid reference	Site type	2010 NO_2 annual mean (µg/m^3)
Victoria Embankment north (VEFM1)	530480, 180477	Roadside	**142.3**
Northumberland Avenue (VEFM2)	530258, 180347	Roadside	**113.3**
Whitehall (VEFM3)	530069, 180245	Roadside	**129.4**
Horse Guards Avenue (VEFM4)	530228, 180102	Roadside	**86.9**
Victoria Embankment south (VEFM5)	530330, 180004	Roadside	**92.1**

Note: Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean.

4.4.9 All five sites recorded concentrations above the NO_2 annual mean standard of (40µg/m^3). The concentrations recorded during the monitoring are similar to those recorded during local authority monitoring at roadside sites and are typical of the high levels in central London.

4.4.10 This monitoring has been used in conjunction with existing Westminster City Council monitoring to define the baseline situation and also to provide input to model verification.

4.4.11 In addition to monitoring data, an indication of baseline pollutant concentrations in the vicinity of the site has been obtained from the background data on the air quality section of the Defra website[5]. Mapped background pollutant concentrations are available for each 1km by 1km grid square within every local authority's administrative area for the years 2008 to 2020. The background data relating to the Victoria Embankment Foreshore site are given in Vol 17 Table 4.4.3 for 2010 (baseline year).

Vol 17 Table 4.4.3 Air quality – 2010 background pollutant concentrations

Pollutant*	2010
NO_2 (µg/m^3)	62.6
PM_{10} (µg/m^3)	24.9

** Annual mean for 1km grid square centred on 530500, 180500.*

Odour

4.4.12 Westminster City Council has not received any odour complaints for the local area over recent years[6]. The Thames Water complaints database was reviewed for an area within a 500m radius of the zones identified for the proposed ventilation columns. Over the last five years (2007-2011), the only identified complaint was in 2010, which related to odour from the general sewerage system.

4.4.13 Data gathering for the EIA included spot measurements of H_2S made near the site, the results of which are summarised in Vol 17 Table 4.4.4 and the monitoring locations shown in Vol 17 Figure 4.4.2 (see separate volume of figures).. The highest concentrations, up to 36.6µg/m^3, were measured on 28 February 2012 during easterly wind conditions. These levels are typical of urban areas when a faint odour may be detectable on occasions (World Health Organisation)[7] [iv].

Vol 17 Table 4.4.4 Odour – measured H_2S concentrations

Location	Grid reference	Date	Time	H_2S concentration (µg/m^3)
Hispaniola (VEFS1)	530404, 180248	28/08/2011	09:30:08	0.0
		28/08/2011	09:30:53	0.0

[iv] The H_2S odour detection threshold is 7ug/m^3 which is the level at which 50% of the people on an odour panel who have been proven to have a good sense of smell can just detect the gas in laboratory controlled conditions.

Location	Grid reference	Date	Time	H_2S concentration (µg/m^3)
		06/10/2011	15:54:28	11.6
		06/10/2011	15:55:41	9.0
		30/10/2011	09:49:14	0.0
		30/10/2011	09:49:42	4.7
		22/02/2012	09:42:14	32.7
		22/02/2012	09:43:24	10.3
		28/02/2012	12:55:29	36.6
		28/02/2012	12:56:47	10.0
		21/05/2012	09:26:56	34.8
		21/05/2012	09:28:10	11.2
Bazalgette (VEFS2)	530416, 180273	28/08/2011	09:31:48	0.0
		28/08/2011	09:32:22	0.0
		06/10/2011	15:58:01	10.2
		06/10/2011	15:59:42	7.2
		30/10/2011	09:50:37	5.4
		30/10/2011	09:50:37	5.0
		22/02/2012	09:44:27	9.3
		22/02/2012	09:45:25	8.1
		28/02/2012	12:58:32	10.0
		28/02/2012	12:59:39	9.2
		21/05/2012	09:29:21	13.7
		21/05/2012	09:30:24	11.9
Tattershall (VEFS3)	530391, 180192	28/08/2011	09:34:20	0.0
		28/08/2011	09:34:54	0.0
		06/10/2011	16:01:33	6.9
		06/10/2011	16:02:55	6.4
		30/10/2011	09:52:27	4.2
		30/10/2011	09:52:56	0.0
		22/02/2012	09:46:36	7.8
		22/02/2012	09:47:47	9.0
		28/02/2012	13:00:55	9.0
		28/02/2012	13:02:01	7.7

Location	Grid reference	Date	Time	H_2S concentration ($\mu g/m^3$)
		21/05/2012	09:31:41	10.7
		21/05/2012	09:32:27	8.3
End of Gardens (VEFS4)	530373, 180107	28/08/2011	09:36:01	0.0
		28/08/2011	09:36:32	0.0
		06/10/2011	16:05:06	8.4
		06/10/2011	16:06:49	6.9
		30/10/2011	09:53:49	6.8
		30/10/2011	09:54:17	6.4
		22/02/2012	09:49:06	7.8
		22/02/2012	09:50:08	6.1
		28/02/2012	13:03:20	7.8
		28/02/2012	13:04:26	8.5
		21/05/2012	09:33:52	8.6
		21/05/2012	09:34:55	8.3
Hungerford Bridge (VEFS5)	530449, 180279	28/08/2011	09:40:42	0.0
		28/08/2011	09:41:13	0.0
		06/10/2011	16:10:47	8.0
		06/10/2011	16:11:51	6.4
		22/02/2012	09:54:32	29.0
		22/02/2012	09:55:52	8.1
		28/02/2012	13:10:11	10.2
		28/02/2012	13:11:32	7.1
		21/05/2012	09:40:39	29.4
		21/05/2012	09:42:02	9.8
Meteorological conditions: 28/08/2011 SW wind up to 2m/s, partially cloudy, rain on previous day. 06/10/2011 W wind up to 4m/s, occasional clouds. 30/10/2011 SW wind at 0.5m/s, cloudy, last rain on 27/10/2011. 22/02/2012 W wind up to 4.2m/s, partially cloudy. 28/02/2012 E wind up to 3.1m/s, partially cloudy. 21/05/2012 E wind, average speed 1.2m/s.				

Receptors

4.4.14 As set out in Section 4.1 and Volume 2, the air quality assessment involves the selection of appropriate receptors, which are shown in Vol 17 Figure 4.4.3 (see separate volume of figures) and the table below (Vol 17 Table 4.4.5) for the Victoria Embankment Foreshore site. All of these receptors are relevant, albeit with different levels of sensitivity to each of the elements of the air quality assessment. The sensitivity of identified receptors has been determined using the criteria detailed in Volume 2.

Vol 17 Table 4.4.5 Air quality and odour – receptors

Receptors (relating to all identified emissions sources)	Approximate distance of modelled receptor from site boundary and direction from site	Receptor sensitivity		
		Air quality (construction traffic, river tugs for barges and construction plant)	Construction dust (on-site demolition and construction processes)	Odour (ventilation column)
Residential - Whitehall Court (VEFR3)	65m west	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Residential - Trafalgar Buildings (VEFR4)	240m west	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Hotel - The Royal Horseguards Hotel (VEFR2)	70m west	Medium (exposure relevant to daily mean and hourly mean standards).	Medium	High
Restaurant/bar - Tattershall Castle (Existing) (VEFR9)	Within site boundary	Medium (exposure is relevant for the hourly mean standard only).	Medium	High
Restaurant/bar - Tattershall Castle (Relocated) (VEFR10)*	20m south	Medium (exposure is relevant for the hourly mean standard only).	Medium	High
Restaurant/bar - Hispaniola (VEFR8)	40m north	Medium (exposure is relevant for the hourly mean standard only).	Medium	High
Restaurant/bar/hotel - National Liberal Club (VEFR1)	65m northwest	Medium (exposure relevant to daily mean and hourly mean standards).	Medium	High
Recreational – Thames Path (VEFR7)	5m north	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium

Receptors (relating to all identified emissions sources)	Approximate distance of modelled receptor from site boundary and direction from site	Receptor sensitivity		
		Air quality (construction traffic, river tugs for barges and construction plant)	Construction dust (on-site demolition and construction processes)	Odour (ventilation column)
Recreational - Whitehall Gardens (VEFR5)	25m northwest	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Recreational – River Thames (VEFR11)	35m east	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Recreational - Victoria Embankment Gardens (VEFR6)	175m north	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium

** Denotes receptor that is altered or constructed after the baseline year.*

Construction base case

4.4.15 The base case conditions for the construction assessment year would be expected to change from the baseline conditions due to modifications to the sources of the air pollution in the intervening period.

4.4.16 For road vehicles, there would be an increase in the penetration of new Euro emissions standards (Defra)[8] to the London vehicle fleet between the current situation and Site Year 3 / Site Year 4 of construction. Euro standards define the acceptable exhaust emission limits for new vehicles sold in the EU. These standards are defined through a series of European Union directives staging the progressive introduction of increasingly stringent standards over time. The uptake of newer vehicles with improved emission controls should lead to a reduction in NO_2 and PM_{10} concentrations over time. These changes in fleet composition and the emissions are covered in this assessment.

4.4.17 Other emissions sources should also reduce due to local and national policies. Therefore, the non-road sources of the background concentrations used in the modelling have been reduced in line with Defra guidance LAQM.TG(09)[9]. Background pollutant concentrations for Site Year 3/Site Year 4 of construction (peak construction year) used in the modelling are shown in Vol 17 Table 4.4.6.

4.4.18 The background NO_2 concentration has been derived from the 2010 annual mean measured at the background site in Horseferry Road (WM0) while the background PM_{10} concentration has been taken from the Defra mapped background data5. The Defra map has been used for the PM_{10} background, as there are no suitable PM_{10} monitors within the relevant assessment area.

Vol 17 Table 4.4.6 Air quality – annual mean background pollutant concentrations

Pollutant	Baseline (2010)	Peak construction year
NO_2 (µg/m^3)*	49.0	36.8
PM_{10} (µg/m^3)**	24.3	21.7

** Derived from WM0 2010 monitoring. ** Taken from Defra mapped 1km grid square centred on 530500, 180500. Adjusted to ensure local A roads are not double counted.*

Operational base case

4.4.19 Base case conditions have been assumed to be the same as baseline conditions with respect to background odour concentrations as no change in background odour concentrations is anticipated.

4.5 Construction effects assessment

Local air quality assessment

4.5.1 Construction effects on local air quality (comprising emissions from construction road traffic, tugs for river barges and construction plant) have been assessed following the modelling methodology set out in Volume 2. This involves predicting NO_2 and PM_{10} concentrations in the baseline year (2010), and in the peak construction year (Site Year 3/Site Year 4 of construction), without the proposed development (base case) and with the proposed development (development case). Predicted pollutant concentrations for the base case and development case can then be compared to determine the air quality impacts associated with the project and considering these in the context of statutory air quality objectives/limit values to determine the significance of effects at specified receptors (listed in Vol 17 Table 4.4.5).

4.5.2 The assessment has focussed on NO_2 and PM_{10} concentrations as these are the only pollutants whose air quality standards may be exceeded. From professional experience, emissions of other pollutants (eg, volatile organic compounds (VOCs)) are very unlikely to be significant and therefore do not need to be assessed.

4.5.3 A model verification exercise has been undertaken at the Victoria Embankment Foreshore site in line with the Defra guidance LAQM.TG(09)9. This checks the model performance against measured concentrations, using the five monitoring sites established for this assessment (VEFM1 – VEFM5 – see Vol 17 Table 4.4.2). Further details regarding the verification process are included in Vol 17 Appendix B.1. The model adjustment factor derived from the verification process was applied to all model results.

4.5.4 The model inputs for the local air quality assessment for the Victoria Embankment Foreshore site are also detailed in Vol 17 Appendix B (B.2, B.3 and B.4). This includes road traffic data (comprising annual average daily traffic flows, heavy good vehicle proportions and speeds for each road link) and data pertaining to the tugs for river barges and construction plant.

NO_2 concentrations

4.5.5 Predicted annual mean NO_2 concentrations for the modelled scenarios are shown in Vol 17 Table 4.5.1. This table details the forecast NO_2 concentrations at specific sensitive receptors. Annual mean results are shown for all of the sensitive receptors but the receptors are divided into two groups depending on whether the annual mean objective/limit value applies or not. The annual mean criteria only apply at those receptors which could be occupied continually for a year (eg, residential properties). Exceedances of the hourly objective / limit value are inferred from the annual mean concentration. Additionally, contour plots are provided (Vol 17 Figures 4.5.1 to Vol 17 Figure 4.5.3, see separate volume of figures) showing modelled concentrations for the baseline, base case and development case scenarios over the construction assessment area. A plot showing the change in NO_2 annual mean concentrations between the base and development cases (in the peak construction year) is also presented at Vol 17 Figure 4.5.4 (see separate volume of figures).

4.5.6 The modelled concentrations in Vol 17 Table 4.5.1 show that annual mean NO_2 levels are predicted to decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project.

This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The results for the development case show small increases over the base case at all modelled receptors due to the construction works at the Victoria Embankment Foreshore site except at the Tattershall Castle (VEFR9 and VEFR10). The large decrease in the concentration predicted at the Tattershall Castle is due to its relocation to the south of the Victoria Embankment Foreshore site, further from the busy junction at Northumberland Avenue and The Embankment rather than due to an improvement in air quality.

4.5.7 Exceedances of the annual mean objective / limit value (40µg/m^3) are predicted for all receptors in all scenarios. In line with LAQM.TG(09)9, as all modelled concentrations in the peak construction year are above 60µg/m^3, exceedances of the hourly NO_2 air quality objective / limit value are considered likely in both the base case and development case at all receptors.

Vol 17 Table 4.5.1 Air quality – predicted annual mean NO_2 concentrations

Receptor	Predicted annual mean NO_2 concentration (µg/m^3)			Change between base and dev cases (µg/m^3)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the annual mean objective / limit value applies					
Whitehall Court residential (VEFR3)	**95.6**	**72.4**	**72.6**	0.2	Negligible
Trafalgar Buildings residential (VEFR4)	**195.6**	**139.6**	**139.7**	0.1	Negligible
Receptors where the annual mean objective / limit value does not apply					
The Royal Horseguards Hotel (VEFR2)	**87.9**	**66.1**	**66.2**	0.1	Negligible
Tattershall Castle (existing) (VEFR9) / (relocated) restaurant/bar (VEFR10)*	**109.1**	**82.5**	**74.8**	-7.7	Large
Hispaniola restaurant/bar (VEFR8)	**122.7**	**92.5**	**92.8**	0.2	Negligible

Receptor	Predicted annual mean NO_2 concentration ($\mu g/m^3$)			Change between base and dev cases ($\mu g/m^3$)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
National Liberal Club (VEFR1)	**107.9**	**81.0**	**81.2**	0.2	Negligible
Thames Path (VEFR7)	**207.0**	**152.1**	**153.0**	0.9	Small
Whitehall Gardens (VEFR5)	**153.4**	**114.0**	**114.3**	0.3	Negligible
River Thames (VEFR11)	**83.8**	**63.5**	**64.6**	1.1	Small
Victoria Embankment Gardens (VEFR6)	**152.2**	**114.5**	**114.6**	0.2	Negligible

*Notes: Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean. * Denotes receptor that is altered or constructed after the baseline year. Changes in concentration at each receptor have been rounded to one decimal place.*

4.5.8 The highest predicted increase in annual mean concentration as a result of the construction works at the Victoria Embankment Foreshore site is 1.1µg/m^3 which is predicted at receptor VEFR11 which represents the River Thames, however the annual mean objective / limit value (40µg/m^3) does not apply here. The largest increase at a receptor of relevant exposure to the annual mean concentration is 0.2µg/m^3 at the residential properties at Whitehall Court (VEFR3). This increase is described as being of negligible magnitude according to the criteria detailed in Volume 2.

4.5.9 The significance of the effect at residential properties in Whitehall Court and Trafalgar Buildings, which have a high sensitivity to local air quality, is **negligible** (according to the criteria detailed in Volume 2). At the Royal Horseguards Hotel, the National Liberal Club and Hispaniola restaurant/bar, which have a medium sensitivity to local air quality and at which the hourly objective / limit value applies, the significance of the effect would also be **negligible**. The significance of effects would be **minor adverse** at the River Thames and the Thames Path, which have a low sensitivity to local air quality and at which the hourly objective / limit value applies. The Tattershall Castle restaurant/bar is predicted to experience a **major beneficial** effect but that is due to the relocation of the boat. The other sensitive receptors (Victoria Embankment Gardens and Whitehall Gardens) are predicted to have a **negligible** effect from NO_2.

PM_{10} concentrations

4.5.10 Predicted annual mean PM_{10} concentrations for the modelled scenarios, taking account of emissions from construction road traffic, tugs for river barges and construction plant, are shown in Vol 17 Table 4.5.2. This table details the forecast PM_{10} concentrations at specific sensitive receptors. Additionally, contour plots are provided (Vol 17 Figures 4.5.5 to Vol 17 Figure 4.5.7, see separate volume of figures) showing modelled concentrations for the baseline, base case and development case scenarios over the construction assessment area. A plot showing the change in annual mean PM_{10} concentrations between the base and development cases (in the peak construction year) is also presented at Vol 17 Figure 4.5.8 (see separate volume of figures).

4.5.11 The modelled concentrations in Vol 17 Table 4.5.2 show that annual mean concentrations of PM_{10} are predicted to achieve the annual mean objective / limit value (40µg/m^3) at all but five receptors in 2010 and decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project to below the annual mean objective / limit value at all but three receptors. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The predicted results for the development case show small increases over the base case at all modelled receptors due to construction activities at the Victoria Embankment Foreshore site.

Vol 17 Table 4.5.2 Air quality – predicted annual mean PM_{10} concentrations

Receptor	Predicted annual mean PM_{10} concentration (µg/m^3)			Change between base and dev cases (µg/m^3)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the annual mean objective / limit value applies					
Whitehall Court residential (VEFR3)	35.1	28.5	28.6	0.0	Negligible
Trafalgar Buildings residential (VEFR4)	**59.4**	**41.9**	**41.9**	0.0	Negligible
Receptors where the annual mean objective / limit value does not apply					
The Royal Horseguards Hotel (VEFR2)	32.4	26.8	26.9	0.0	Negligible

Receptor	Predicted annual mean PM_{10} concentration (µg/m^3)			Change between base and dev cases (µg/m^3)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Tattershall Castle (existing) (VEFR9) / (relocated) restaurant/bar (VEFR10)*	39.8	31.7	30.2	-1.5	Small
Hispaniola restaurant/bar (VEFR8)	**44.4**	34.2	34.3	0.1	Negligible
National Liberal Club (VEFR1)	38.1	30.3	30.3	0.0	Negligible
Thames Path (VEFR7)	**73.1**	**51.8**	**51.9**	0.1	Negligible
Whitehall Gardens (VEFR5)	**53.1**	39.4	39.5	0.1	Negligible
River Thames (VEFR11)	32.0	26.9	27.1	0.3	Negligible
Victoria Embankment Gardens (VEFR6)	**55.3**	**40.8**	**40.8**	0.0	Negligible

*Notes: Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean. * Denotes receptor that is altered or constructed after the baseline year. Changes in concentration at each receptor have been rounded to one decimal place.*

4.5.12 The largest predicted increase in the annual mean concentration as a result of construction at the Victoria Embankment Foreshore site is 0.3µg/m^3, predicted at the receptor on the River Thames (VEFR11). This change is described as negligible according to the criteria detailed in Volume 2. There are no predicted increases at receptors of relevant exposure to the annual mean concentration.

4.5.13 With no exceedances of the annual mean PM_{10} standard (40µg/m^3), the significance of the effects is **negligible** at all receptors.

4.5.14 With regard to daily mean PM_{10} concentrations, Vol 17 Table 4.5.3shows the predicted number exceedances of the daily PM_{10} standard (50µg/m^3) for each modelled scenario. The objective / limit value allows no more than 35 exceedances in a year.

4.5.15 The results in Vol 17 Table 4.5.3 show that the number of daily exceedances of PM_{10} is predicted to decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The predicted results for the development case show a maximum increase of one day per year with concentrations above 50µg/m^3 compared with the base case at the modelled receptors due to construction works at the Victoria Embankment Foreshore site. No increase in the number of days per year with PM_{10} concentrations above 50µg/m^3 is however predicted at a receptor of relevant exposure to the daily mean air quality objective / EU limit value.

4.5.16 With no significant impacts with regard to the daily mean PM_{10} standard in the peak construction year at locations of relevant exposure, the significance of the predicted effect is **negligible** at all receptors.

Vol 17 Table 4.5.3 Air quality – predicted exceedances of the daily PM_{10} standard

Receptor	Predicted number of exceedances of the daily PM_{10} standard			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the objective / limit value does apply					
Whitehall Court residential (VEFR3)	**50**	22	23	0	Negligible
Trafalgar Buildings residential (VEFR4)	**288**	**93**	**93**	0	Negligible
The Royal Horseguards Hotel (VEFR2)	**37**	17	17	0	Negligible
National Liberal Club (VEFR1)	**67**	29	29	0	Negligible
Receptors where the objective / limit value does not apply					
Tattershall Castle (existing) (VEFR9) / (relocated) restaurant/bar (VEFR10)*	**78**	34	28	-6	Large
Hispaniola restaurant/bar (VEFR8)	**113**	**46**	**46**	0	Negligible

Receptor	Predicted number of exceedances of the daily PM_{10} standard			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Thames Path (VEFR7)	365	187	188	1	Small
Whitehall Gardens (VEFR5)	**203**	**75**	**76**	1	Small
River Thames (VEFR11)	35	17	18	1	Small
Victoria Embankment Gardens (VEFR6)	**230**	**85**	**85**	0	Negligible

Notes: Emboldened figures indicate an exceedance of the objective / limit value which is 35 days.
** Denotes receptor that is altered or constructed after the baseline year. Changes at each receptor have been rounded to the nearest whole number.*

Sensitivity test for programme delay

4.5.17 For the assessment of local air quality effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing receptors. Based on the development schedule (Vol 17 Appendix N), there would be no new receptors requiring assessment as a result of a one year delay.

Construction dust

4.5.18 Construction dust would be generated from both on-site activities and from road vehicles accessing and servicing the site.

4.5.19 Dust sensitive receptors have been identified in the vicinity of the Victoria Embankment Foreshore site in accordance with the criteria in Volume 2, as described in Vol 17 Table 4.4.5. A summary of the approximate numbers of receptors in distance bands from the Victoria Embankment Foreshore site is listed in Vol 17 Table 4.5.4.

Vol 17 Table 4.5.4 Air quality – numbers of dust sensitive receptors

Buffer distance (m)	Number of receptors*	Receptor type
<20	0	Hispaniola and Tattershall Castle
20-50	2	Gardens
50-100	10-100	Hotels, residential properties, gardens
100-350	100-500	Hotels, residential properties, gardens, offices

** Buildings or locations that could be affected by nuisance dust.*

4.5.20 In line with the Institute of Air Quality Management (IAQM) guidance (2012)[10], the site has been categorised using the criteria given in Volume 2 to assess the likely impacts from demolition, earthworks, construction and trackout activities during construction and the likely effects of these activities on sensitive receptors close to the development.

4.5.21 The demolition for the Victoria Embankment Foreshore site is classified as a 'small' dust emission class. This classification is based on the small size of the demolition volumes, which is less than 20,000m^3. As the nearest receptor is less than 20m from the construction site, this makes the risk category for demolition activities medium risk.

4.5.22 The earthworks have been assessed to be a 'large' dust emission class as the size of the construction site is greater than 10,000m^2 and the total material to be moved is more than 100,000 tonnes. With the nearest receptor less than 20m away, the site is assessed to be high risk for earthworks.

4.5.23 The construction proposed for the Victoria Embankment Foreshore site has a 'medium' dust emission class. This classification is based on the medium size of the building volumes, the use of piling for the cofferdam and the use of on-site concrete batching. The risk category for construction activities is therefore assessed to be high risk.

4.5.24 There would be 50-100m of unpaved haul roads on site and the number of construction lorries per day would be between 25-100, so the trackout dust emission class is classified as 'medium'. The closest receptor is within 20m of the affected roads. The risk category from trackout is therefore assessed to be medium risk.

4.5.25 The risk categories for the four activities are summarised in Vol 17 Table 4.5.5. This summary of these risks does not take into account the measures outlined in the *CoCP* (*Part A*).

Vol 17 Table 4.5.5 Air quality – summary of construction dust risks

Source	Dust soiling / PM10 effects
Demolition	Medium risk site
Earthworks	High risk site
Construction	High risk site
Trackout	Medium risk site

Note: without CoCP measures

4.5.26 On this basis, the development at the Victoria Embankment Foreshore site is classified as a high risk site overall.

4.5.27 Although the receptor sensitivity (with respect to construction dust nuisance) is identified as medium for all receptors (as identified in Vol 17 Table 4.4.5), due to the duration of the works and the high PM_{10} background concentrations in the locality, the sensitivity of the area has been defined as 'high'.

4.5.28 With regard to the significance of effects, a high risk site with a high sensitivity of the area would result in a moderate adverse effect without mitigation. When the measures outlined in the *CoCP* are applied, the significance of the effect would be reduced to **minor adverse** for receptors within 20m of construction area and **negligible** for receptors beyond 20m (in accordance with IAQM guidance). The significance of the effect for each receptor is summarised in Vol 17 Table 4.5.6.

Vol 17 Table 4.5.6 Air quality – significance of construction dust effects

Receptor	Significance of effect
Whitehall Court residential (VEFR3)	Negligible
Trafalgar Buildings residential (VEFR4)	Negligible
The Royal Horseguards Hotel (VEFR2)	Negligible
Tattershall Castle (relocated) restaurant/bar (VEFR10)*	Minor adverse
Hispaniola restaurant/bar (VEFR8)	Minor adverse
National Liberal Club (VEFR1)	Negligible
Thames Path (VEFR7)	Minor adverse
Whitehall Gardens (VEFR5)	Negligible
River Thames (VEFR11)	Negligible
Victoria Embankment Gardens (VEFR6)	Negligible

*Notes: * Denotes receptor that is altered or constructed after the baseline year.*

4.6 Operational effects assessment

4.6.1 The operational assessment has been undertaken in accordance with the modelling methodology set out in Vol 2. Vol 17 Table 4.6.1 shows the predicted maximum ground level odour concentrations at the Victoria Embankment Foreshore site. These are the highest concentrations that could occur at the worst affected ground level receptor at or near the site in a typical year. In accordance with the odour benchmark set by the Environment Agency, results are presented for the 98th percentile of hourly average concentrations in the year (or the 176th highest hourly concentration in the year) and the number of hours in a year with concentrations above $1.5ou_E/m^3$. Achieving the 98th percentile is considered to prevent nuisance and protect amenity. The number of hours with concentrations above $1.5ou_E/m^3$ gives an indication of the number of hours in a year that an odour might be detectable at the worst affected receptor. The Environment Agency benchmark permits 175 hours above $1.5ou_E/m^3$. The table also identifies the magnitude of the identified impacts in accordance with the criteria detailed in Volume 2.

Vol 17 Table 4.6.1 Odour – impacts and magnitude - operation

Year	Maximum at ground level locations		Impact magnitude and justification
Typical	98th percentile (ou_E/m^3)	0	Negligible 98th percentile concentration is less than $1ou_E/m^3$
	No. of hours > $1.5ou_E/m^3$	3	

4.6.2 In Vol 17 Table 4.6.1 above, the 98th percentile is shown as zero as air would be released from the ventilation columns for less than 2% (176 hours) of the year. This means that the odour benchmark would be achieved at all locations. This represents an impact of negligible magnitude.

4.6.3 The highest odour concentrations would occur within 10m of the ventilation columns with concentrations reducing rapidly away from this area. There would be a maximum of three hours in a year with an odour concentration greater than $1.5ou_E/m^3$ so there could be a detectable odour on an hourly basis within 10m of the ventilation columns. Odour would not be detectable at any buildings or at the Hispaniola or Tattershall Castle. With a frequent use year (ie, a more rainy year than average), the situation would be similar with no detectable odour beyond 10m of the columns.

4.6.4 With regard to the significance of effects at ground level and building locations, given that the predicted odour concentrations at all locations and at buildings would not exceed the 98th percentile criterion of $1.5ou_E/m^3$, it is considered that overall significance would be **negligible**. No significant effects are therefore predicted in relation to odour.

4.7 Cumulative effects assessment

Construction effects

4.7.1 As described in Section 4.3, there would not be any cumulative construction effects. Therefore the effects on air quality would remain as described in Section 4.5 above. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

Operational effects

4.7.2 As described in Section 4.3, there would not be any cumulative operational effects. Therefore the effects on odour would remain as described in Section 4.6 above.

4.8 Mitigation

Construction

4.8.1 Control measures of relevance to air quality are embedded in the *CoCP* as summarised in Section 4.2. No mitigation is required because effects are not significant.

Operation

4.8.2 Based on the assessment results (which includes the environmental design measures detailed in para. 4.2.18) indicating that all effects would be negligible, no mitigation is required because effects are not significant.

Monitoring

4.8.3 It is envisaged that an appropriate particulate monitoring regime would be agreed with the Westminster City Council prior to commencement of construction at the Victoria Embankment Foreshore site.

4.9 Residual effects assessment

Construction effects

4.9.1 As no mitigation measures are required, the residual construction effects remain as described in Section 4.5. All residual effects are presented in Section 4.10.

Operational effects

4.9.2 As no mitigation measures are required, the residual operational effects remain as described in Section 4.6. All residual effects are presented in Section 4.10.

4.10 Assessment summary

Vol 17 Table 4.10.1 Air quality – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential - Whitehall Court (VEFR3)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential - Trafalgar Buildings (VEFR4)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Hotel - The Royal Horseguards Hotel (VEFR2)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Restaurant/bar - Tattershall Castle* (existing) (VEFR9) / (relocated) (VEFR10)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Major beneficial	None	Major beneficial
	Effects from construction dust	Minor adverse	None	Minor adverse
Restaurant/bar - Hispaniola (VEFR8)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Minor adverse	None	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Restaurant/bar/hotel - National Liberal Club (VEFR1)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Recreational - Thames Path (VEFR7)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Minor adverse	None	Minor adverse
Recreational - Whitehall Gardens (VEFR5)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Recreational - River Thames (VEFR11)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Recreational - Victoria Embankment Gardens (VEFR6)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible

** Denotes receptor that is altered or constructed after the baseline year.*

Vol 17 Table 4.10.2 Odour – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential - Whitehall Court (VEFR3)	Odour	Negligible	None	Negligible
Residential - Trafalgar Buildings (VEFR4)		Negligible	None	Negligible
Hotel - The Royal Horseguards Hotel (VEFR2)		Negligible	None	Negligible
Restaurant/bar - Tattershall Castle* (existing) (VEFR9) / (relocated) (VEFR10)		Negligible	None	Negligible
Restaurant/bar - Hispaniola (VEFR8)		Negligible	None	Negligible
Restaurant/bar/hotel - National Liberal Club (VEFR1)		Negligible	None	Negligible
Recreational - Thames Path (VEFR7)		Negligible	None	Negligible
Recreational - Whitehall Gardens (VEFR5)		Negligible	None	Negligible
Recreational - River Thames (VEFR11)		Negligible	None	Negligible
Recreational - Victoria Embankment Gardens (VEFR6)		Negligible	None	Negligible

** Denotes receptor that is altered or constructed after the baseline year.*

References

[1] Greater London Authority and London Councils, *Best Practice Guidance: The Control of Dust and Emissions from Construction and Demolition* (November 2006).

[2] Highways Agency. *Design Manual for Roads and Bridges*, Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 1 pg D-1 HA207/07 Air Quality. (May 2007).

[3] Michigan Environmental Science Board, *Health Effects of Low-Level Hydrogen Sulfide in Ambient Air* (2000).

[4] UK Government. *Environment Act 1995*. Available at: http://www.legislation.gov.uk/ukpga/1995/25/contents. Accessed June 2012.

[5] Defra, *Local air quality management background maps*. Available at: http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html. Accessed June 2012.

[6] City of Westminster, Personal Communication with Environmental Health Officer (July 2012).

[7] World Health Organization, *Air Quality Guidelines for Europe* Second Edition (2000). Available at: http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf Chapter 6.6, last accessed 16 August 2012.

[8] Defra. *Local air quality management emissions. Available at:* http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft. Accessed June 2012.

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

[10] Institute of Air Quality Management, *Guidance on the Assessment of the Impacts of Construction on Air Quality and the Determination of their Significance* (January 2012).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 5: Ecology - aquatic

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 5: Ecology – aquatic

List of contents

Page number

5 Ecology – aquatic 1
5.1 Introduction 1
5.2 Proposed development relevant to aquatic ecology 1
5.3 Assessment methodology 6
5.4 Baseline conditions 10
5.5 Construction effects assessment 26
5.6 Operational effects assessment 34
5.7 Cumulative effects assessment 43
5.8 Mitigation and compensation 43
5.9 Residual effects assessment 44
5.10 Assessment summary 45
References 51

List of plates

Page number

Vol 17 Plate 5.4.1 Aquatic ecology – long term EA total fish catches from Battersea site 16

List of tables

Page number

Vol 17 Table 5.3.1 Aquatic ecology – stakeholder engagement for Victoria Embankment Foreshore 6
Vol 17 Table 5.4.1 Aquatic ecology – principal habitat, substrate and other features of interest at Victoria Embankment Foreshore 12

Vol 17 Table 5.4.2 Aquatic ecology – results of fish surveys at Victoria Embankment Foreshore 14

Vol 17 Table 5.4.3 Aquatic ecology – results of 2011 juvenile fish surveys at Blackfriars Bridge........ 15

Vol 17 Table 5.4.4 Aquatic ecology – invertebrate fauna sampled at Victoria Embankment Foreshore 18

Vol 17 Table 5.4.5 Aquatic ecology – marine algae sampled at Victoria Embankment Foreshore during 2012 22

Vol 17 Table 5.4.6 Aquatic ecology – marine algae sampled at Cleopatra's Needle between early 1970s and 1999........ 23

Vol 17 Table 5.4.7 Aquatic ecology – summary of receptors and their values/sensitivities at Victoria Embankment Foreshore........ 24

Vol 17 Table 5.10.1 Aquatic ecology – summary of construction assessment 45

Vol 17 Table 5.10.2 Aquatic ecology – summary of operational assessment........ 46

5 Ecology – aquatic

5.1 Introduction

5.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on aquatic ecology at the Victoria Embankment Foreshore site.

5.1.2 The proposed development has the potential to affect aquatic ecology due to both the physical works in-river during construction and the operation of the tunnel. During operation the interception of the combined sewer overflow (CSO) would result in substantially reduced discharges of untreated sewage into the Tidal Thames at this location. There would also be permanent in-river structures at this site. Significant construction and operational effects are therefore considered likely, and an assessment of effects on aquatic ecology for both phases is presented.

5.1.3 The presence of sewage in the aquatic environment has adverse effects on aquatic ecology receptors (habitats, mammals, fish, invertebrates and algae). In particular, discharges of untreated sewage effluent can result in low levels of dissolved oxygen (DO), which can cause mass fish mortalities known as hypoxia events. There are CSOs discharging at locations throughout the Tidal Thames, including the reach upstream and downstream of the Regents Street CSO.

5.1.4 The tidal Thames comprises a dynamic environment, in which tidal action leads to dispersal of discharges. Therefore the effects of the operational Thames Tideway Tunnel, which is designed to intercept the most problematic CSOs would be most evident at a project-wide level. These effects are therefore reported in Volume 3 Project-wide assessment. This section assesses the localised effects at a site-specific level for Victoria Embankment Foreshore.

5.1.5 The assessment of the likely significant effects of the project on aquatic ecology has considered the requirements of the National Policy Statement (NPS) for Waste Water[1]. In line with these requirements, designations, species and habitats relevant to aquatic ecology are identified and measures incorporated into the proposed development described. Based on assessment findings, measures to address likely significant adverse effects are identified. Vol 2 Section 5 provides further details on the methodology.

5.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

5.2 Proposed development relevant to aquatic ecology

5.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to aquatic ecology are set out below.

Construction

5.2.2 The construction maximum extent of working at Victoria Embankment Foreshore would be located predominantly on the foreshore. Construction activities would occur over four and a half years, with structures in place for approximately four years. The key elements of the construction of the proposed development of relevance to aquatic ecology would be as follows:

a. The installation of temporary and permanent sheet piling to create cofferdams on the foreshore for the CSO interception works as shown in the illustrative Construction Phases – Phase 1 Site Setup figure (see separate volume of figures – section 1). The installation of cofferdams would be accomplished using a jack-up barge or similar equipment.

b. It is assumed for the assessment that the majority of foreshore material within the temporary cofferdams would remain in situ. For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdams and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. Removal of this material would ensure that any settlement of the cofferdam fill material does not adversely affect the ties between the walls of the twin walled temporary cofferdam leading to structural difficulties. All soft material within permanent cofferdams would be removed to ensure sound foundations for permanent construction.

c. The exact extent and depth of the foreshore deposits to be removed at each site would be informed by geotechnical investigations. Areas of removed material would be filled with gravel similar to the existing bed material. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore. Upon removal of the temporary cofferdam, the fill and geotextile layer would be removed and the bed would be reinstated to match the existing river bed conditions. Material excavated would be disposed of in accordance with the project’s Waste Management procedure.

d. The placement and removal of a temporary campshed of approximately 400m^2 the foreshore outside the cofferdam for the CSO works suitable for up to an 800 tonne barge.

e. Regular barge movements and resting on the campshed (with a peak monthly average of four barge movements per day).

5.2.3 The construction of in-river structures, and in particular the temporary works cofferdams would affect the river regime. There is potential for localised increases in flow velocity to cause scour of the river bed and foreshore, or deposition of sediments. The scour could occur around the face of the cofferdam or at the adjacent bridge supports (abutment scour) or across the channel width (contraction scour). Any potential scour development during construction would be monitored and if relevant trigger levels are reached, appropriate protection measures would be provided. Further details are provided in *Scour and Accretion Monitoring* *and Mitigation Plan for Temporary Works in the Foreshore* (Vol 3 Appendix L.4).

Code of construction practice

5.2.4 The *Code of construction practice* (*CoCP*) context sets out the standards, procedures and measures for managing and reducing construction effects. These measures would be implemented through a *Construction environment management plan* (*CEMP*) prepared by the contractor to control site operations and works.

5.2.5 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (*Part A*), and site specific requirements for this site (*Part B*). The *CoCP Part A* includes the following measures, which are an integral part of the project and relevant for the purposes of this assessment:

a. The location of barges resting on the foreshore and river bed would be controlled to reduce extent of potential environmental impacts. The design of facilities such as campsheds would consider the need to minimise environmental impacts and should consider the use of lattice structure barge grids where appropriate. In-river structures, including campsheds, would be removed on completion of the works unless otherwise agreed. Where concrete is used, such as campsheds, a membrane is required to protect the underlying riverbed. The method for reinstatement of the temporary works area would be subject to a method statement that would consider requirements for impact on aquatic ecology (*CoCP Part A* Section 11).

b. Avoiding piling at night, to ensure noise free periods when fish can undertake migrations passed the site within each 24-hour period (*CoCP Part A* Section 6).

c. Undertaking noise measurements at prescribed points and intervals to ensure compliance with the *CoCP* (*CoCP Part A* Section 6).

d. Limiting allowable noise and vibration levels to leave part of the river cross-section passable at all times (*CoCP Part A* Section 6).

e. Where technically feasible, utilising low noise/vibration cofferdam or pile/pier installation techniques such as pressing or vibro-piling rather than impact/percussive piling. In the event that in-river percussive piling is needed, prior approval from the EA would be required (*CoCP Part A* Section 6).

f. Where vibro-piling is undertaken, slowly increasing the power of the driving to enable fish to swim away before the full power of the pile driver is felt through the river (*CoCP Part A* Section 6).

g. The contractor shall make every reasonable effort to remove all piles completely from the bed of the river. With the prior written agreement of the PLA the contractor would ensure any piles which prove impossible to fully extract on application of the confirmed minimum crane pull of 40 tonnes, are driven down, cut off or removed to a depth of a least 1 metre below the adjacent riverbed level unless advised otherwise (*CoCP Part A* Section 4).

h. Appropriate measures would be taken with regard to ‘in river’ works to minimise the release of suspended sediment and solids into the water column (*CoCP Part A* Section 8).

i. For works where materials are being loaded and unloaded on the river, the Contractor is required to establish suitable management arrangements and mitigation measures so as to prevent spillage of transferred materials. This includes design of conveyor systems, enclosures, conveyor belt scrapper locations and selection of other loading equipment. Monitoring methods and contingencies arrangements are to be included in the River Transport Management Plan and Emergency Preparedness Plan (*CoCP Part A* Section 8).

j. Dewatering operations for cofferdams and in river structures need to consider fish rescue arrangements. To the extent that it is not dealt with in the application for development consent, prior written consent from the EA is required under the Salmon and Freshwater Fisheries Act, 1975, to net or trap fish, or introduce fish into a water course (*CoCP Part A* Section 8).

k. Avoidance of pollution of the river through measures that accord with industry guidelines, including the EA note PPG05: *Works in, near or liable to affect water courses* (Environment Agency, undated)[2] and Construction Industry Research and Information Association (CIRIA) report C532: *Control of water pollution from construction sites* (CIRIA, 2001)[3] (*CoCP Part A* Section 8).

l. The lighting, to be specified in a *Lighting management plan*, would be designed to comply with relevant standards. The lighting design needs to consider the aquatic environment and avoid direct lighting of watercourses, where reasonably practical, to avoid inhibiting movements of photophobic species such as eel (*CoCP Part A* Section 4). (See para 5.2.6 for *CoCP Part B* measures for site working hours relevant to lighting at Victoria Embankment Foreshore.)

m. In constructing temporary cofferdams the contractor would avoid any mixing of fill material with the underlying substrate. This would be achieved by installing a membrane between the existing river bed and the back fill material (*CoCP Part A* Section 11).

5.2.6 The *CoCP Part B* at Victoria Embankment Foreshore site commits to the following measures that are of relevance to aquatic ecology:

a. Membrane to be installed between existing river bed and back fill material to prevent contamination of habitat and benefits in preserving potential archaeology. Areas of foreshore used for temporary works would be restored to similar condition and material prior to the works (*CoCP Part B* Section 11).

b. A site specific lighting plan is required. The lighting would address the impact on terrestrial and aquatic ecology and include the use of low level directional lighting where possible whilst meeting safe work requirements (*CoCP Part B* Section 4).

c. The site would adhere to standard working hours, except for the connection of the Regent Street connection tunnel when continuous working hours would be employed (*CoCP Part B* Section 4).

d. The loading and unloading of barges would only be carried out during standard working hours (*CoCP Part B* Section 6).

Operation

5.2.7 The key elements of the operation of the proposed development of relevance to aquatic ecology are set out below. Further information, including dimensions of structures are provided in Section 3 of this volume.

5.2.8 Discharges from the Regents Street CSO would be intercepted at Victoria Embankment Foreshore site. Based on the base case (which includes permitted Thames Tideway sewage treatment works upgrades, and the Lee Tunnel scheme, as well as projected population increases) discharges (which have been modelled for 2012) during the Typical Year[i] from the Regents Street CSO are anticipated to increase to 26,000m^3 per annum over a total of ten events (or spills), by 2021. With the Thames Tideway Tunnel project in place discharges at Regents Street CSO are projected to reduce to zero. This represents a 100% decrease as a result of the Thames Tideway Tunnel project.

5.2.9 A permanent foreshore structure housing the CSO interception would be in place in the river and would give rise to effects from the construction phase of the project onwards. However, as it is a permanent structure, its effects would be ongoing for its full existence, and are therefore considered under the operational assessment.

5.2.10 Scour protection for the permanent foreshore structure and discharge apron would consist of buried rip-rap which would be overlaid with an appropriate substrate material.

5.2.11 The Tattershall Castle would be relocated approximately 50m upstream of the permanent foreshore structure.

5.2.12 Improvements in water quality are anticipated both in the local area around the discharge point for the Regents Street CSO and in the wider tidal Thames. The assessment of operational effects on the tidal Thames as a whole are contained within Volume 3.

Environmental design measures

5.2.13 Generic design principles of relevance to aquatic ecology at Victoria Embankment Foreshore site are as follows:

a. Where existing outfalls are made redundant by the project their aprons shall be broken out and removed where practicable, unless they are required for scour protection (e.g. around bridge abutments).

---

[i] The 'Typical Year' represents the most 'typical' 12 month period of rainfall observed between 1970 and 2011 and is represented by the period from October 1979 to September 1980

b. Scour protection would be provided beneath any new outfall extending to below the low water line and along the line of the new river wall (to protect its foundation). The detailed design and extent of this shall seek to avoid or minimise adverse effects.

c. Where practicable, at the base of the foreshore structure, measures such as low level habitat features shall be provided to encourage retention of sediment to promote aquatic ecology.

d. Light pollution shall be minimised within the sites by using capped, directional and cowled lighting units.

e. Lighting shall balance the need to provide a safe environment with one that also responds to the need to reduce light pollution and promote biodiversity (terrestrial and aquatic).

f. No lighting shall be proposed in the water, directed riverward or on the outside of the foreshore structure, unless required for navigational purposes.

5.2.14 Timber fenders are not appropriate to the character of this stretch of the river wall and would not be provided. New lighting to the foreshore structure shall be provided in accordance with the lighting design principles

5.3 Assessment methodology

Engagement

5.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of aquatic ecology are presented in Vol 17 Table 5.3.1.

Vol 17 Table 5.3.1 Aquatic ecology – stakeholder engagement for Victoria Embankment Foreshore

Organisation	Comment	Response
Environment Agency (Phase 2 consultation response - February 2012)	Land take onto the foreshore on this site is large and has increased in size since the phase 1 consultation. To minimise the constriction to the river channel and hence alteration of flows in the Thames created by the arrangement, an alternative exists to move the drop shaft closer to the river wall if necessary by locating it to a position either upstream or downstream of the overflow weir so that these two structures are more 'in line' in the direction of river flow.	The area of landtake on the foreshore has been minimised as far as possible.

Organisation	Comment	Response
	The *Environmental Statement* needs to specifically address the impacts of the relocation of the Tattershall Castle, both for the duration of the project and for the permanent impacts. Any dredging requirements will need to be assessed and appropriate mitigation suggested. The effects of the new encroachment resulting from the new mooring should be assessed in terms of the cumulative impact upon migratory fish.	The relocation of the Tattershall Castle is considered within the *Environmental Statement*.
Environment Agency (Section 48 consultation response - 2012)	Loss of intertidal foreshore would be significant here.	The permanent loss of intertidal foreshore is considered to be a moderate adverse effect (para 5.6.16). The footprint of the permanent structure has been minimised as far as possible to accommodate the necessary works therefore further mitigation is not possible. During operation, the permanent loss of habitat at Victoria Embankment Foreshore site contributes to an overall loss of habitat arising from all of the foreshore sites. Compensation for this project-wide, permanent loss of foreshore habitat is detailed in Vol 3.
	Tattershall Castle relocation should be considered with respect to flow changes and scour.	The relocated Tattershall Castle upstream, may lead to minimal alterations to flow dynamics in the

Organisation	Comment	Response
		river. The impact of altered flows is considered to be low adverse (para 5.6.10).
	Scour assessment for latest symmetrical design is needed.	The assessment is based on the final layout plans for Victoria Embankment Foreshore.

Baseline

5.3.2 The baseline methodology follows the methodology described in Vol 2. There are no site specific variations for identifying the baseline conditions for this site.

5.3.3 The assessment is based on survey and desk study data. For habitats, mammals, fish, invertebrates and algae desk study data has been obtained for the whole of the tidal Thames. The data sets for fish, invertebrates and algae are based on fixed sampling locations at intervals through the tidal Thames. Locations as close to Victoria Embankment Foreshore as possible have been selected. Details of the background data sets are provided in Vol 2.

5.3.4 Surveys for fish and invertebrates were undertaken during October 2010, within the proposed development site and within a 100m radius of the site boundary. During these surveys, the intertidal habitats present were recorded. Surveys for juvenile fish were also undertaken at five sampling locations along the Tidal Thames six times between May and September 2011. The closest location to Victoria Embankment Foreshore was the opposite bank to the Blackfriars Bridge Foreshore site, approximately 1km downstream of the Victoria Embankment Foreshore site. Surveys for algae were undertaken at eight sampling locations in May 2012, comprising each of the foreshore sites, including Victoria Embankment Foreshore. The survey comprised sampling of algae along a vertical transect of the river wall located within or as close to the proposed development site as possible.

Construction

5.3.5 The assessment methodology for the construction phase follows that described in Vol 2. The assessment area is the zone which lies within a 100m radius of the boundary of the proposed development site. The assessment year for construction effects is Site Year 1, ie, when construction would commence. There are no site specific variations for undertaking the construction assessment of this site.

5.3.6 Section 5.5 details the likely significant effects on aquatic ecology arising from the construction of the proposed development at the Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on aquatic ecology receptors within the construction assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

5.3.7 The site development schedule (Vol 17 Appendix N) identifies one in-river development scheme that is relevant to the aquatic ecology base case, the London Eye Pier Extension, which lies 160m upstream from the Victoria Embankment Foreshore site.. All other developments are in-land, do not comprise in-river development, development adjacent to the river or development discharging into the river and therefore would not affect the aquatic ecology baseline.

5.3.8 There are no schemes in the site development schedule that could lead to a cumulative impact at Victoria Embankment Foreshore. Therefore no cumulative impact assessment has been undertaken.

5.3.9 The assessment of construction effects also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Operation

5.3.10 The assessment methodology for the operation phase follows that described in Vol 2. The assessment area is as stated in para. 5.3.5. There are two assessment years for operational effects; Year 1 and Year 6. Year 1 is the year that the Thames Tideway Tunnel project would be brought into operation. Year 6 provides sufficient time after operation commences to allow the longer term effects on aquatic ecology to be assessed. There are no site specific variations for undertaking the operation assessment of this site.

5.3.11 Section 5.6 details the likely significant effects arising from the operation of the proposed development at the Victoria Embankment Foreshore site. The effects of the interception of all of the CSOs within the Thames Tideway Tunnel project on aquatic ecology receptors at a river wide level are considered in Vol 3 Project-wide assessment.

5.3.12 The London Eye Pier Extension is considered relevant to the operational base case for aquatic ecology, as outlined in the site development schedule (Vol 17 Appendix N). There are no schemes in the site development schedule that could lead to a cumulative impact at Victoria Embankment Foreshore. Therefore no cumulative impact assessment has been undertaken.

5.3.13 As with construction (see para. 5.3.9), the assessment of operational effects also considers the extent to which the assessment findings would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assumptions and limitations

5.3.14 The assumptions and limitations associated with this assessment are presented in Vol 2. Assumptions and limitations specific to this site are outlined below.

Assumptions

5.3.15 It has been assumed that:

a. The campshed would be a concrete structure.

b. Vibro-piling would be used.

c. It would be necessary to remove all alluvial and other deposits above the natural gravel within the temporary cofferdam and campsheds in order to establish a stable construction platform, as detailed in Section 5.2.

d. Campsheds would be constructed using the method similar to that described in 5.2.2c for the temporary cofferdams. Sheet piles would be used to create the outer edge of the campshed. Soft material would be removed from within the sheet piled area and replaced with a more coarse material similar to the existing river bed in order to provide stability. Concrete would be placed into the sheet piled area on top of a geotextile membrane.

e. The area between the outer edge of the temporary cofferdam and the maximum extent of the working area would be subject to disturbance and consolidation from jack up barges and similar equipment particularly during cofferdam installation.

f. No dredging would be required while the campshed is in use and dredging would not be required to enable the relocation of Tattershall Castle.

g. The trigger level for implementing scour protection measures (para. 5.2.3) would be set to ensure that scour would not penetrate below the depth of the existing substrate (i.e. there would be no change in broad habitat type as a result of scour).

Limitations

5.3.16 There are no site-specific limitations.

5.4 Baseline conditions

5.4.1 The following section sets out the baseline conditions for aquatic ecology within and around the site. Future baseline conditions (base case) are also described.

Current baseline

5.4.2 The following section sets out the existing baseline applicable to this site. The section begins with a discussion of any statutory (i.e. with a basis in law) or non-statutory (i.e. designated only through policy) sites designated for their nature conservation value. It then addresses habitats, followed by the species receptors associated with those habitats, namely mammals, fish, invertebrates and algae. This order is followed throughout the assessment sections.

Designations and habitats

5.4.3 This section sets out the effects on designations and habitats applicable at the site specific level. Designations and habitats applicable at the project wide scale are assessed in Vol 3.

5.4.4 The tidal Thames is part of the proposed Thames Estuary Marine Conservation Zone (MCZ no. 5), the details of which were submitted to Government in early 2012. If adopted, it will be designated as a national statutory site under the Marine and Coastal Access Act 2009. The purpose of MCZs is to protect the full range of nationally important biodiversity, as well as certain rare and threatened species and habitats. Species include smelt (*Osmerus eperlanus*), European eel (*Anguilla anguilla)* and tentacled lagoon worm (*Alkmaria romijnii*) (Balanced Seas, 2011)[4] The tidal Thames offers important spawning and migratory habitat for smelt, and migratory habitat for European eel.

5.4.5 There are no other international or national statutory sites (ie, Sites of Special Scientific Interest or Local Nature Reserves) designated for aquatic ecology within the assessment area.

5.4.6 Victoria Embankment Foreshore site falls within the non-statutory River Thames and Tidal Tributaries Site of Importance for Nature Conservation (SINC Grade III of Metropolitan importance)[ii]. The SINC is designated by the Greater London Authority (GLA) and adopted by all boroughs which border the tidal Thames. It recognises the range and quality of estuarine habitats including mudflat, shingle beach, reedbeds and the river channel. The SINC citation notes that over 120 species of fish have been recorded in the Tideway, though many of these are only occasional visitors. The more common species include dace (*Leuciscus leuciscus*), bream (*Abramis brama*) and roach (*Rutilus rutilus*) in the freshwater reaches (described in para. 5.4.8), and sand-smelt (*Atherina presbyter*), flounder (*Platichtyhys flesus*) and Dover sole (*Solea solea*) in the estuarine reaches. Important migratory species include Twaite shad (*Alosa fallax*), European eel, smelt, salmon (*Salmo salar*) and sea trout (*Salmo trutta*). A number of nationally rare snails occur, including the swollen spire snail *Mercuria confusa*, as well as an important assemblage of wetland and wading birds.

5.4.7 The tidal Thames is the subject of a Habitat Action Plan (HAP) within the London Biodiversity Action Plan (BAP) (Thames Estuary Partnership Biodiversity Action Group, undated)[5] and the targets prescribed for this HAP are reflected in the Westminster City Council BAP (2008)[6]. The tidal Thames HAP identifies a number of flagship habitats and species which characterise the estuary, such as gravel foreshore, mudflat and saltmarsh. A number of these habitats and species, including mudflat, are also the subject of action plans under the UKBAP.

5.4.8 The river is divided into three zones within the tidal Thames HAP; freshwater, brackish and marine (Vol 3 Figure 5.4.1, see separate volume of figures). The brackish zone is equivalent to the category known as

[ii] SINC (Grade M) = Site of Importance for Nature Conservation (Grade III of Metropolitan importance)

'transitional water' or estuaries under the Water Framework Directive (WFD). Further details of the WFD river zone classifications can be found in Vol 3.

5.4.9 Victoria Embankment Foreshore site lies within the brackish zone of the river, which means that the fish and invertebrate communities which occur within the river at this location consists of a mixture of more saline-tolerant freshwater species and more freshwater tolerant marine species. Invertebrate diversity is generally the lower than in the freshwater zone because species must be able to withstand wide variations in salinity and a stressful environment. Stress is caused by the fluctuating conditions, which means that flora and fauna have to be able to tolerate wide variations in salinity.

5.4.10 The intertidal habitat is narrowest in this section of the river due to development on either bank. During the survey of habitats within and immediately adjacent to the proposed CSO construction sites the intertidal habitat at Victoria Embankment was recorded as consisting of a narrow strip of silt and shingle.

5.4.11 There was a thin area of gravel foreshore exposed at the time of survey in 2010 at low tide, within the limits of the survey site. Substrate within this area was dominated by sand and silt, never exposed at low tide. However, small areas dominated by sand and gravel were exposed. Target habitats present included sublittoral sands and gravels and the river wall. The site is recognized as being located within an area of UK BAP priority habitat mudflats (Natural England, undated)[7].

5.4.12 The river in this location is confined by a constructed vertical river wall, and bridge abutments. There was no marginal vegetation and relatively little intertidal habitat. The vertical river wall does not support communities of macro and microalgae.

5.4.13 A summary of habitat types present, and other features of interest recorded during the October 2010 surveys are presented in Vol 17 Table 5.4.1. The survey area is presented in Vol 17 Figure 5.4.1 (see separate volume of figures).

Vol 17 Table 5.4.1 Aquatic ecology – principal habitat, substrate and other features of interest at Victoria Embankment Foreshore

UK BAP target habitats present and features of interest	Substrate present in intertidal zone (approximate % cover)	Substrate present in subtidal zone
Gravel foreshore Sublittoral sand and gravels Mudflats River wall CSO outfall	Sand (40%) Silt (40%) Shingle, pebbles (20%)	Sand Gravel Some pebbles

Evaluation of habitats for Victoria Embankment Foreshore

5.4.14 The value of the habitats for individual aquatic ecology receptors is described in the relevant baseline sections. For the purpose of this assessment the habitats are considered to be of medium-high (metropolitan) value as part of the River Thames and Tidal Tributaries SINC (Grade M).

Marine mammals

5.4.15 Records compiled by the Zoological Society of London (ZSL) for 2003-2011 indicate that small numbers of common seal (*Phoca vitulina*) and dolphin (unknown species) have been observed in this area of the tidal Thames.

Evaluation of marine mammals for Victoria Embankment Foreshore

5.4.16 The site is considered to be of low-medium (local) value for marine mammals given the small number of records, and the limited extent of intertidal habitat for species of seal to use as a haul out site.

Fish

5.4.17 In general, tidal Thames fish populations are mobile and wide ranging. Although the abundance and diversity of fish at any one site may provide some indication of the habitat quality offered at that site it is important to consider the data within the context of sites throughout the tidal Thames, since the factors influencing distribution are likely to be acting at this wider scale. To this end, the findings of the Thames Tideway Tunnel project site specific survey, relevant juvenile fish surveys and EA background data are presented in this section and are used to inform the evaluation of the site. Effects at the project wide scale are assessed in Vol 3.

Baseline surveys

5.4.18 A single day survey was undertaken at this site in October 2010. Full details of the methodology and rationale for timing of surveys are presented in Vol 2. The area covered by the survey is illustrated in Vol 17 Figure 5.4.1 (see separate volume of figures.)

5.4.19 Fish are routinely categorised into guilds according to their tolerance to salinity and habitat preference (Elliott, M and Taylor, CJL, 1989)[8] (Elliott, M and Hemingway, KL, 2002)[9], which can be defined as follows:

a. Freshwater – species which spend their complete lifecycle primarily in freshwater.

b. Estuarine resident – species which remain in the estuary for their complete lifecycle.

c. Diadromous – species which migrate through the estuary to spawn having spent most of their life at sea.

d. Marine juvenile – species which spawn at sea but spend part of their lifecycle in the estuary.

5.4.20 The survey recorded very low fish abundance in the area of Victoria Embankment, with only 28 individuals captured in total. The range of species recorded and the number of individuals is presented in Vol 17

Table 5.4.2. This was a relatively low number in terms of absolute abundance of fish, compared with catches during October 2010 surveys at other sampling sites. The low abundance of freshwater species at Victoria Embankment Foreshore site such as roach, bream and dace is explained by the site location, which is towards the upstream end of the brackish zone (Vol 3 Figure 5.4.1, see separate volume of figures), where salinity is relatively close to the tolerance threshold of freshwater species.

Vol 17 Table 5.4.2 Aquatic ecology – results of fish surveys at Victoria Embankment Foreshore

Common name	Scientific name	Number of individuals	Guild
		Oct 2010	
Flounder	*Platichthys flesus*	4	Estuarine resident
Common goby	*Pomatoschistus microps*	1	Estuarine resident
Smelt	*Osmerus eperlanus*	10	Diadromous
Common bream	*Abramis brama*	8	Freshwater
Roach	*Rutilus rutilus*	4	Freshwater
Roach/bream hybrid	Not applicable	1	Freshwater

Juvenile fish surveys

5.4.21 The shallow river margins, which shift across the intertidal foreshore with the ebb and flood of the tides, provide an important migration route for juvenile fish along the estuarine corridor. The young of species such as eel (known as glass eels or elvers), flounder, dace and smelt rely upon access to these areas of lower water velocity to avoid being washed out by tides and to avoid predation by the larger fish that occur in deeper water. Young fish also feed predominantly amongst the intertidal habitat. Adult migrants of larger fish tend to use faster mid-channel routes.

5.4.22 Surveys for juvenile fish were undertaken opposite the Blackfriars Bridge Foreshore site as part of a suite of five sites sampled six times between May and September 2011 as part of the project wide assessment. The site locations and details of the methodology are presented in Vol 2 Figure 5.4.4 (see separate volume of figures). The aim of the surveys was to record juvenile fish migrations through the Tideway to inform a study of the hydraulic effects of the temporary and permanent structures on fish migration. The extent of the surveys and details of the methodology are presented in Vol 2. The findings are relevant to the Victoria Embankment Foreshore site because it gives context to the assemblage of fish that may be expected to be found in this reach of the river. However, it should be noted that the survey area has a greater extent of intertidal foreshore habitat than the Victoria Embankment Foreshore site (see para. 5.4.24).

On that basis the Victoria Embankment Foreshore site may be expected to support a smaller number of juvenile fish, although the species assemblage is likely to be the same since the shallower margins of the river offers a continuous migratory pathway for juvenile fish.

5.4.23 The data from the juvenile fish surveys at Blackfriars Bridge are shown in Vol 17 Table 5.4.3.

Vol 17 Table 5.4.3 Aquatic ecology – results of 2011 juvenile fish surveys at Blackfriars Bridge

Common name	Scientific name	Number of individuals					
		Survey					
		1 May	2 late May	3 June	4 July	5 Aug	6 Sept
Flounder	*Platichthys flesus*	37	325	86	13	1	9
Smelt	*Osmerus eperlanus*	0	1	0	0	1	0
Eel	*Anguilla anguilla*	2	0	1	8	3	0
Common bream	*Abramis brama*	0	0	0	3	0	2
Dace	*Leuciscus leuciscus*	4	0	0	0	0	0
Roach	*Rutilus rutilus*	0	2	10	0	0	0
Perch	*Perca fluviatilis*	3	4	0	0	0	0
Goby	*Pomatoschistus* spp.	0	0	0	168	382	25
Sea bass	*Dicentrarchus labrax*	0	0	0	126	57	4
10-spined stickleback	*Pungitius pungitius*	0	0	0	0	1	0
Bullhead	*Cottus gobio*	0	0	0	0	1	0

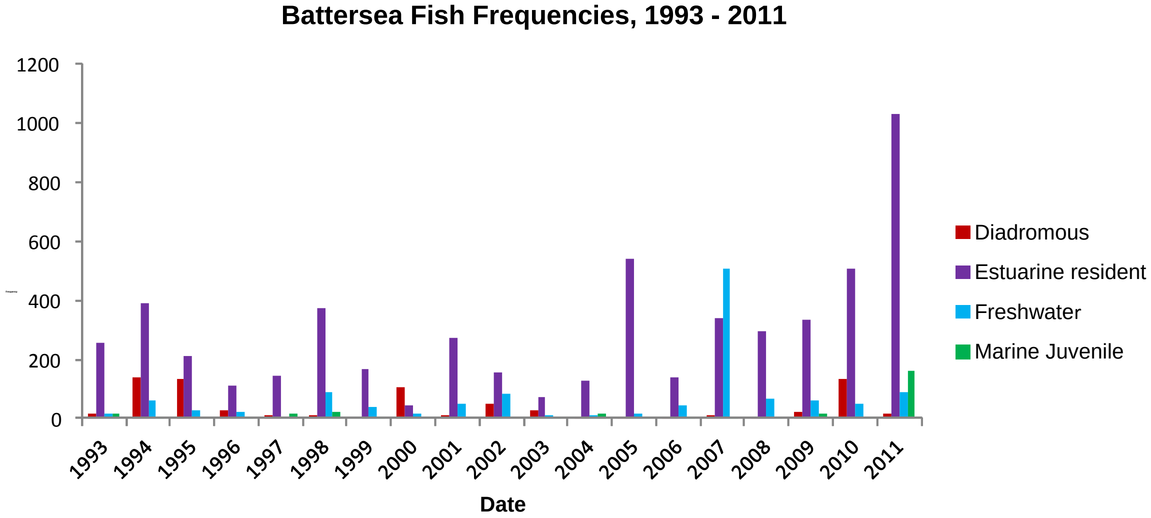
5.4.24 Post-larval flounders dominated the catch from surveys one, two, and three. Flounder were caught in the shallow littoral zone, indicating early springtime colonisation from marine spawning sites. From surveys three to six, sea bass (*Dicentrarchus labrax*) and gobies were numerous. Returns from the sixth survey were low. The survey area results indicate that the area just upstream of Blackfriars Bridge is of importance for juvenile fish as a nursery area, which is an area spatially segregated from adult habitats, providing refuges and a ready food supply for juveniles. However, since the survey site is 1km downstream, conclusions over the value of Victoria Embankment Foreshore site cannot be drawn from this particular survey, although it does provide a general context for this stretch of the river.

Environment Agency background data

5.4.25 The surveys described in paras. 5.4.18 to 5.4.24 provide up-to-date baseline information directly relevant to fish community composition at Victoria Embankment Foreshore site. EA records have also been used to provide a wider context for the fish community in the tidal Thames. The EA carry out annual surveys of fish within the tidal Thames, using a variety of methods including trawling and seine netting, with data available from 1992-2011. Methodologies for the survey are provided in Vol 2. The nearest sampling site with recent data is Battersea, 4.5km upstream.

5.4.26 A range of freshwater and estuarine resident fish species were recorded at this site where EA surveys have been carried out every year from 1993 to 2011. Fifteen fish species have been recorded at Battersea. Catches are dominated by estuarine resident fish such as common goby, flounder and sand smelt, freshwater species including dace, common bream, perch (*Perca fluviatilis*) and roach, and migratory species including eel and smelt (Vol 17 Plate 5.4.1). The numbers of fish caught is relatively consistent for each of the guilds over the 19 year period although there is some evidence of increases in estuarine resident species in the period since 2005. Other migratory species such as salmon and sea trout must pass through the area but are too infrequently present to be detected by only one or two surveys per year. The high frequency of freshwater species recorded in 2007 may be as a result of very high rainfall during that year. High flows may have led to a greater number of freshwater fish being washed in to the tidal Thames and lower salinity conditions which allowed them to survive.

Vol 17 Plate 5.4.1 Aquatic ecology – long term EA total fish catches from Battersea site



Water quality and current fish baseline

5.4.27 Prior to the 1960s, water quality in the tidal Thames was heavily degraded by raw sewage inputs caused by under-capacity of sewage treatment works (STWs). With the construction of new works (Wheeler, AC, 1979)[10] recorded the progressive improvement of fish populations from the 1960s onwards was recorded. The ecology of the tidal Thames has undergone further improvement in recent decades, with some 125 fish species now recorded by the EA.

5.4.28 However, hypoxia events (see para. 5.1.3) arising from regular CSO spills and occasional discharges of untreated waste from STWs still occur. Discharges have the effect of depleting DO (measured in mg/l) by the biological breakdown of organic matter in the discharge. This is referred to as biochemical oxygen demand (BOD). Substantial fish mortalities begin to occur when DO levels drop beneath 4mg/l. An example of the effects of a hypoxia events occurred in June 2011, in which approximately 26,000 fish were killed across the tidal Thames study area, following a release of around 450,000 tonnes of untreated sewage. This incident is discussed in further detail in the project wide assessment (Vol 3 Section 5)

5.4.29 The Tideway Fish Risk Model (TFRM) was developed to evaluate DO standards for the Tidal Thames (Turnpenny, AWH, *et al*., 2004)[11] as part of the Thames Tideway Strategic Study (TTSS). The DO standards for the tidal Thames comprise four threshold levels expressed as concentrations of DO in mg/l over specified tidal durations. Frequencies are set on the number of times per year each of these thresholds can be exceeded. Further details of the standards are presented in Vol 2 Section 14. Details of the TFRM are presented in Vol 2 and Vol 2 Appendix C.3. The TFRM considers fish distribution and the effects of low DO conditions within defined 3km zones within the tidal Thames. The zones are based on those used by the EA's automated water quality monitoring system (AQMS), for which DO data are collected continuously.

5.4.30 The model uses known hypoxia tolerance thresholds for seven species which are considered to represent the range of species which occur in the tidal Thames. The model is based on the assumption that most species of fish populations would be sustainable provided hypoxia related mortality does not exceed 10% of the total population. The model considers both adult and juvenile fish (known as 'life stage cases'), since juveniles generally have a lower tolerance to hypoxia.

5.4.31 It is not possible to isolate the contribution of individual CSO discharges to hypoxia related fish mortalities in the tidal Thames. This is because the TFRM provides outputs only at a population level. For example, DO conditions may be below a lethal threshold in one zone known to be used by a particular species of fish. However, provided conditions are above the threshold in other zones such that 90% of the population are unharmed then conditions are considered to be sustainable. The outputs are discussed in further detail in the project-wide assessment (Vol 3 Section 5.6). However, TFRM results for the existing baseline suggest that a total of five of the seven species/life stage cases are expected to suffer unsustainable hypoxia related mortality in the Tidal Thames each year. Given that the indicator species used in the model act as surrogates for a wider range of ecosystem components, other sensitive taxa are also likely to be unsustainable under this water quality regime.

Evaluation of fish community for Victoria Embankment Foreshore

5.4.32 The Victoria Embankment Foreshore site is considered to be of medium (borough) value for fish. Victoria Embankment Foreshore had one of the lowest fish catches of all the sites surveyed in October 2010. However, the site is a component of the migratory route of all resident Tidal Thames fish populations and in a borough context the fish populations are likely to notable.

Invertebrates

5.4.33 Benthic invertebrates are used in the freshwater, estuarine and marine environments as biological indicators of water and sediment quality since their diversity, abundance and distribution reflects natural or man-made fluctuations in environmental conditions. Species diversity is influenced by factors such as substrate and salinity. However high species diversity (or numbers of species) at any given site generally indicates good water and/or sediment quality, whilst low diversity may indicate poor quality.

5.4.34 Invertebrate populations and particularly those which occur in the water column (pelagic) are influenced by conditions throughout the estuary. The strongest influences on invertebrate distribution and density tend to be physical factors such as salinity, and substrate type followed by water quality and local habitat conditions.

Baseline surveys

5.4.35 A single day survey for invertebrates was undertaken at Victoria Embankment Foreshore site during October 2010. The area covered by the survey is the same as that described for the fish survey above (see paras. 5.4.18 to 5.4.20) and illustrated in Vol 17 Figure 5.4.1 (see separate volume of figures). Details of the sampling methods used can be found in Vol 2. Three intertidal and three subtidal samples were taken.

5.4.36 The invertebrates collected during the October 2010 field surveys are presented in Vol 17 Table 5.4.4. The Community Conservation Index (CCI) score (Chadd, R and Extence, C, 2004)[12] has been used to identify species of nature conservation importance. CCI classifies many groups of invertebrates of inland waters according to their scarcity and conservation value in Great Britain and relates closely to the Red Data Book (RDB) (Bratton, JH, 1991)[13], (Shirt, DB, 1987)[14] by attributing a score between 1 and 10. The higher the CCI score the more scarce the species and/or greater its conservation value.

Vol 17 Table 5.4.4 Aquatic ecology – invertebrate fauna sampled at Victoria Embankment Foreshore

Taxa	CCI Score	No individuals - subtidal samples			No individuals - intertidal samples		
Sample numbers		Air Lift1	Air Lift2	Air Lift3	Kick Sample	Sweep Net1	Sweep Net2
Theodoxus fluviatilis	3	10	2	2	0	0	0

Taxa	CCI Score	No individuals - subtidal samples			No individuals - intertidal samples		
Sample numbers		**Air Lift1**	**Air Lift2**	**Air Lift3**	**Kick Sample**	**Sweep Net1**	**Sweep Net2**
Potamopyrgus antipodarum	1	20	3	216	1	2	1
Radix balthica	1	0	3	2	0	0	0
Corbicula fluminea	-	0	1	0	0	0	0
Nereis diversicolor	-	0	2	2	0	2	0
Oligochaeta	-	500	1000	2000	3	13	3
Glossiphonia complanata	1	0	0	1	0	0	0
Erpobdella testacea	5	0	0	1	0	0	0
Palaemon longirostris	5	1	0	0	0	0	0
Crangon crangon	-	0	0	0	0	0	2
Eriocheir sinensis	-	0	0	2	0	0	0
Asellus aquaticus	1	0	1	0	0	0	0
Apocorophium lacustre	8	0	112	80	0	3	0
Gammarus zaddachi	1	25	15	12	0	0	0
Diptera pupae	-	0	0	0	0	13	0
Chironomidae	-	0	0	0	0	1	0
Diptera larvae	-	0	0	0	0	1	0
Number of taxa	**-**	**6**	**9**	**10**	**2**	**7**	**3**

5.4.37 Victoria Embankment samples were characterised by a higher diversity of invertebrates from subtidal areas and limited fauna from intertidal areas. In contrast to sites such as King Edwards Memorial Park Foreshore, six to ten taxa per sample were present in samples taken from subtidal areas and moderately sensitive groups, such as *Theodoxus fluviatilis*, *Gammarus* and *Apocorophium*, were abundant.

5.4.38 The low invertebrate diversity and abundance in the intertidal area is likely to reflect the physical conditions at the site, notably in sample number Sweep Net 2 taken in a shallow area of marginal silt and mud habitat. There is a very limited intertidal zone due to encroachment by the river defences and neighbouring development. Wave washing from the tide and passing river craft is therefore intense and affects the entire width of the intertidal habitat. The site also lies within the brackish zone of the river which means that invertebrates are subject to considerable variations in salinity.

5.4.39 The majority of taxa present are brackish species, with varying tolerance of different levels of salinity from estuarine to near freshwater. These included *Gammarus zaddachi* (a brackish species of shrimp) and *Crangon crangon* (shrimps, typical of estuarine and brackish conditions). However, the increasing saline influence compared to upstream sites is demonstrated by the presence of *Nereis diversicolor* (Polychaeta), which are exclusively associated with estuarine or marine conditions.

5.4.40 The presence of the taxa Oligochaeta (worms), which thrives in organically polluted conditions, in the intertidal zone may reflect the influence of the CSO outfall in reducing background water quality. However, this is unlikely to be as important as those factors such as salinity and substrate type.

5.4.41 The only species of high nature conservation importance was the mudshrimp *Apocorophium lacustre* (CCI 8), a RDB species. EA data has however shown *A. lacustre* to be common in the tidal Thames and therefore the relative value of the invertebrate community is not considered to be of higher value in this instance.

5.4.42 Chinese mitten crab (*Eriocheir sinensis*), an invasive and non-indigenous species, was sampled at Victoria Embankment Foreshore site. Individual mitten crabs were captured at a number of sampling locations along the Tidal Thames. Mitten crabs can cause bank destabilisation and erosion, and also compete for food resources with other species. The former issue is less of a concern at this location, as much of the river bank comprises hard defences, but competition with other species could occur.

5.4.43 The asiatic clam (*Corbicula fluminea*) was also identified. Asian clams can reach high densities, consuming significant amounts of phytoplankton. The increased water clarity caused by their filtration can lead to increases in light penetration, enhanced macrophyte growth, and alteration of fish stocks. Further, the clam may also alter the benthic substrate (Elliott, P, and zu Ermgassen, PSE, 2008)[15].

Environment Agency background data

5.4.44 Victoria Embankment is located within close vicinity of the EA monitoring site at South Bank Centre, which is the nearest sampling location with recent data (2005-2007). South Bank Centre was sampled ten times in 2005 using a 0.1m² core sampler, six times in 2006 using a 0.01m² grab sampler and 31 times in 2007 using a grab sampler.

5.4.45 The most abundant taxa that have been recorded at South Bank Centre between 2005 and 2007 included *G. zaddachi*, *Limnodrilus hoffmeisteri* and other Oligochaeta worms and *Potamopyrgus antipodarum*.

5.4.46 Species diversity recorded at Victoria Embankment Foreshore site in October 2010 is broadly consistent with data collected by the EA at South Bank Centre, and primarily reflects the mid-estuarine conditions at the site. Fewer species of animals are able to tolerate these intermediate levels of salinity than in true freshwater or marine environments.

5.4.47 However there were some notable differences, including the absence of *C. crangon* and Polychaeta worms (one of the most diverse groups at Southbank Centre) from samples taken in October 2010 at Victoria Embankment. Poorer water quality due to the presence of CSO outfalls in the area of Victoria Embankment may influence the invertebrate communities present. Higher species richness recorded in some sample years at South Bank Centre is likely to reflect the greater sampling frequency.

5.4.48 In addition to the native *G. zaddachi*, the amphipod *Gammarus tigrinus*, of North American origin, was recorded at Southbank Centre in 2007. The species was not sampled at Victoria Embankment in 2010. It is believed that this species of amphipod arrived in English waters via ballast water from ships. It lives in fresh and brackish waters and can expand rapidly, outcompeting local amphipods. However, based on available data, it appears to be much less abundant than the native *G. zaddachi* within the Tidal Thames.

Water quality and current invertebrate baseline

5.4.49 The influence of water quality, and specifically CSO discharges was investigated through statistical analysis of the EA invertebrate background data, Thames Tideway Tunnel project baseline data, and EA water quality data. The analysis is presented in Vol 3 Appendix C.5. Although it was not possible to isolate trends over time at a site specific level, a number of observations were made that helps to identify the factors influencing invertebrate abundance and diversity. For example, certain species of Oligochaete worm, present at Victoria Embankment Foreshore site, are indicative of polluted conditions because they are able to tolerate the low DO conditions and multiply rapidly in the enriched sediments.

5.4.50 The analysis is described in further detail in Vol 3 Section 5.4. The following summary is relevant to the brackish zone of the tidal Thames in which the Victoria Embankment Foreshore site is located.

5.4.51 The varying level of salinity and saline fluctuations appear to be a dominant factor determining the diversity and structure of benthic invertebrate assemblages. The analysis showed that, in general, samples in the brackish zone were less diverse compared with samples taken in the freshwater zone. This concurs with previous research into the invertebrate community of the Tidal Thames and other estuaries, which show diversity decreasing downstream as the saline influence increases (Bailey-Brock, JH, *et al*, 2002)[16]. This is generally attributed to the fact that relatively few invertebrates are adapted to significant fluctuations in salinity. Other factors such as poor water quality and lack of habitat diversity, particularly in central London, are also likely to contribute.

5.4.52 Redundancy analysis[iii] (RDA) was used to compare the invertebrate dataset with water quality data for the period between 1992 and 2011. The analysis demonstrated the importance of environmental variables in determining the invertebrate communities in the tidal Thames. It appears that dominance of either Gammaridae (sensitive to hypoxia) or Oligochaeta (more tolerant to hypoxia) is influenced by the DO concentrations and DO sags in the Thames, although other factors such as habitat are also highly important. Other invertebrate taxa also appeared to be affected by poor water quality (low DO) and/or saline intrusion, notably the insect group (mayflies), while other groups (essentially Polychaete and Oligochaete worms) were shown to be tolerant of these conditions.

Evaluation of invertebrate community for Victoria Embankment Foreshore

5.4.53 The Victoria Embankment Foreshore site is considered to be of medium (borough) importance due to the limited numbers and diversity of species present. Whilst of limited conservation value, the invertebrate community enriches the borough habitat resource. Only a single species of conservation importance (*A. lacustre*) was recorded, and it is ubiquitous within the Tidal Thames.

Algae

5.4.54 Algae occurs in the tidal Thames both in the water column and growing on the river wall and associated structures. The range of species which occur in the tidal Thames reflect both salinity, habitat and environmental conditions. As well as their intrinsic value algal communities provide valuable habitat for invertebrates and juvenile fish. Algae are often used as an indicator of water quality, since nutrients associated with sewage promote the growth of certain species of algae. This assessment focuses on the algal communities which grow on the river wall and associated structures.

Baseline surveys

5.4.55 A single day survey was undertaken in May 2012 at Victoria Embankment Foreshore site. All records are shown in Vol 17 Table 5.4.5.

Vol 17 Table 5.4.5 Aquatic ecology – marine algae sampled at Victoria Embankment Foreshore during 2012

Species	2012 Survey observations	Species presence within the Thames Estuary
Blidingia marginata	Dominant on the upper reaches of the river wall.	Widespread and abundant.

[iii] Redundancy analysis is a form of regression analysis which provides information on the influence of the environmental variables on the composition/ abundances of the invertebrates assemblage.

Species	2012 Survey observations	Species presence within the Thames Estuary
Blidingia minima	Common on the river wall.	Widespread and abundant.
Cladophora glomerata	Dominant on the lower reaches of the river wall.	Widespread and abundant.
Rhizoclonium riparium	Occasionally present on the river wall.	Common in the estuary
Ulva prolifera	Occasionally present on the river wall.	Common in the estuary
Vaucheria sp.	Occasionally present on the river wall.	The *Vaucheria sp* recorded is most probably *Vaucheria compacta*, which occurs on the upper littoral levels on sea walls. Widespread in the tidal Thames.
Bangia atropurpurea	Occasionally present on the river wall.	Occurs sporadically in brackish reaches

Natural History Museum background data

5.4.56 Data was obtained from the Natural History Museum, London (NHM) that identifies records of marine algae received for the period from the early 1970s to 1999. Algae were recorded from a sampling location at Cleopatra's Needle, approximately 250m downstream, and the records all shown in Vol 17 Table 5.4.6.

Vol 17 Table 5.4.6 Aquatic ecology – marine algae sampled at Cleopatra's Needle between early 1970s and 1999

Species	Observations
Blidingia marginata	Upper littoral and supra-littoral, and floating structure just above the water-line. Widespread and abundant.
Blidingia minima	Upper littoral and supra-littoral, wood breakwaters and halophyte stems. Abundant in Tidal Thames.
Rhizoclonium riparium	Upper mid-littoral levels on sea walls and occasionally on floating structures above the water-line. Common in the Tidal Thames.
Vaucheria compacta	Upper littoral levels on sea walls. Common in the Tidal Thames.

Water quality and algal communities

5.4.57 Algae depend on the nutrients nitrate and phosphate for growth. Although these nutrients occur naturally in water bodies, they are also present in sewage. Discharges of untreated sewage can result in elevated levels of nutrients which can lead to excessive growth of algae. As these algae die and decompose they use up oxygen in the water resulting in hypoxia (para. 5.1.3). This process is known as eutrophication. Excessive levels of algae can disrupt other elements of the ecosystem by smothering them.

5.4.58 Studies of the pelagic algae (para. 5.4.54) of the Tidal Thames to inform its classification for the WFD have concluded that the estuary is not eutrophic due to strong tidal flows (English Nature, 2001)[17]. However, historically poor water quality has had a considerable adverse influence on the algal communities of the Tidal Thames and the loss of pollution sensitive species. Improvements in sewage treatment since the 1960s have lead to a gradual process of recovery (Tittley, 2009)[18], although pollution tolerant species such as the green algal species still dominate the community.

Evaluation of algal community for Victoria Embankment Foreshore

5.4.59 None of the species recorded in Vol 17 Table 5.4.6 have protected or notable status (e.g. RDB species or UK or local BAP species). The algal populations are therefore given low-medium (local) value as only limited records of widespread species occur from this location.

Aquatic ecology receptor values and sensitivities

5.4.60 Using the baseline set out in paras. 5.4.1 to 5.4.59 the value accorded to each receptor considered in this assessment is set out in Vol 17 Table 5.4.7 below. The definitions of the receptor values and sensitivities used in this evaluation are set out in Vol 2.

Vol 17 Table 5.4.7 Aquatic ecology – summary of receptors and their values/sensitivities at Victoria Embankment Foreshore

Receptor	Value/sensitivity
Foreshore habitat (intertidal and subtidal)	Medium-high (metropolitan)
Marine mammals	Low-medium (local)
Fish	Medium (borough)
Invertebrates	Medium (borough)
Algae	Low-medium (local)

Construction base case

5.4.61 The base case in Site Year 1 of construction would include the improvements at the five main sewage treatment works that discharge into the Tidal Thames (Mogden, Beckton, Crossness, Long Reach and Riverside), and the Lee Tunnel project. TFRM modelling (Vol 3 Appendix C.3) has shown that at a river-wide level there would be a significant reduction in the occurrence of mass or population level fish mortalities (i.e. events which result in more than 10% mortality of fish populations). However, predictions for the base case show that, even with these schemes, unsustainable mortalities of salmon, the most sensitive species can be expected. Salmon is considered as acting as a surrogate for the more sensitive aspects of ecology, and thus taxa other than salmon may also be harmed under this condition.

5.4.62 Given that CSOs within the tidal Thames would continue to spill, including the Regent Street CSO, and no significant changes in habitat quality are anticipated the fish baseline for the Victoria Embankment Foreshore site may therefore be expected to support a similar assemblage of species to the current baseline, with potentially a greater number of pollution sensitive species and life stages. Recovery due to water quality improvements would, however, be at an early stage.

5.4.63 The invertebrate analysis demonstrates that more pollution sensitive groups such as shrimps (Gammaridae) are subject to significant fluctuations in abundances during low DO periods. With the improvements associated with the Lee Tunnel scheme and sewage treatment works upgrades at Mogden, these fluctuations are likely to be reduced. Whilst there may be minor changes, abundance and diversity would however be limited by the fact that even with the Lee Tunnel and STW improvements in place there are still predicted to be numerous failures of DO standards. Colonisation by DO sensitive taxa such as Corophiidae, Crangonidae and Gammaridae which would otherwise occur within the brackish zone, including Victoria Embankment Foreshore site would continue to be suppressed. As for fish, recovery of the invertebrate communities would be at an early stage. The recovery in algal communities that has taken place since the 1960s is expected to continue under the base case, however the baseline conditions are not anticipated to significantly change from that described in Section 5.4. No changes in marine mammals are anticipated as they are relatively insensitive to point source sewage discharges.

5.4.64 The London Eye Pier Extension scheme described in para. 5.3.7 would be operational at the time construction of the Thames Tideway Tunnel project commences at the Victoria Embankment Foreshore site and therefore it is considered part of the construction base case. The aspects of this scheme of relevance to aquatic ecology are that it would incorporate an altered arrangement of secured and floating structures extending into the river and therefore there is potential for slightly altered patterns of river flow past the site.

5.4.65 There is unlikely to be encroachment onto the Tidal Thames foreshore for any other non-river dependent uses as this is restricted through *London Plan* (Greater London Authority, 2012)[19] Policy 7.28 Restoration of the Blue Ribbon Network which states that development should ‘protect the value of the foreshore of the Thames and tidal rivers’. The EA’s *National Encroachment Policy for Tidal Rivers and Estuaries* (Environment Agency, 2005)[20] also presumes against developments riverward of the existing flood defences where these would, individually or cumulatively, change flows so that fisheries were affected or cause loss or damage to habitat. Therefore no further changes to the current baseline from other developments is considered likely.

Operational base case

5.4.66 The river-wide recovery in fish and invertebrate communities that would occur as a result of the Lee Tunnel and sewage treatment works upgrades would have advanced by Year 1 and Year 6 due to the reduced number of hypoxia events. However, as noted in para. 5.4.61, there would still be unsustainable mortalities of salmon, and possibly other sensitive taxa. Further catchment modelling shows that the frequency, duration and volume of spills from the Regents Street CSO would continue to rise due to population growth, which would limit improvements for aquatic ecology receptors (spill frequency and volume as stated in para. 5.2.8 : further details of projected spills are provided in Section 14 of this volume [Water resources – surface water]). Therefore recovery due to water quality improvements would be suppressed at the Victoria Embankment Foreshore site. As a result there are unlikely to be significant changes in habitat quality at the site level and pollution sensitive fish species, such as salmon would continue to be suppressed. Indeed, conditions in the immediate vicinity of the CSO may be less favourable for fish than the current baseline given the increase in frequency, volume and duration of CSO spills.

5.4.67 At a river wide scale invertebrate communities will be likely to include more pollution sensitive components as noted in para. 5.4.62, which would also be reflected to some degree at a site level. However, increased CSO spill frequency, durations and volumes would suppress recovery and may also be less favourable than current baseline conditions given the increase in frequency, volume and duration of CSO spills.

5.4.68 The recovery in algal communities that has taken place since the 1960s is expected to continue under the base case however the baseline conditions are not anticipated to significantly change from that described in Section 5.4. No changes in marine mammals are anticipated as they are relatively insensitive to point source sewage discharges.

5.4.69 The London Eye Pier Extension scheme considered in para. 5.4.64 would be operational at the time of operation of the Thames Tideway Tunnel project. The effects would be as identified in para. 5.4.64.

5.4.70 As stated in para. 5.4.65 there is unlikely to be encroachment onto the tidal Thames foreshore for non-river dependent uses. Therefore no further changes to current baseline from other developments is considered likely.

5.5 Construction effects assessment

5.5.1 This section presents the findings of the construction phase assessment. It outlines the construction impacts arising from the proposed development and the likely significant effects on aquatic ecology receptors.

Construction impacts

Temporary landtake

5.5.2 There would be a total of approximately 2695m^2 of temporary landtake from subtidal habitats associated with the presence of a temporary cofferdam and a campshed. This represents 0.01% of the River Thames and Tidal Tributaries SINC (Grade M). Material from within the cofferdam would be removed and a geotextile membrane used to separate the underlying substrate from the imported granular fill material. The cofferdam would be in place for a total of four years, which is therefore the duration of this temporary impact.

5.5.3 Where scour protection is not required around the permanent structure (see para. 5.2.10), reinstatement would involve the removal of imported granular fill and the geotextile membrane. Where soft material had been removed in order provide stable conditions within the cofferdam (see para. 5.2.2b) this would be replaced with an appropriate substrate material. The approach to reinstatement at each of the foreshore sites is presented in Vol 3 Appendix C.4. The objective would be to restore the area to a profile similar to the surrounding foreshore.

5.5.4 Given the uncertainty over the re-establishment of the habitat, the impact of temporary landtake is considered to be low negative. The probability of the impact occurring is considered to be certain.

Sediment disturbance and consolidation

5.5.5 It has been assumed that the area between the outer edge of the cofferdam and the maximum extent of working area would be subject to disturbance and consolidation due to the jack-up barge operation. At Victoria Embankment Foreshore this would represent a total area of approximately 8105m^2 outside the cofferdam (of which 55m^2 would be from intertidal habitat and 8050m^2 from subtidal habitat) which would be affected by construction activities during the site establishment phase. There is also likely to be consolidation and disturbance due to barge movements. At Victoria Embankment there would be a peak monthly average of approximately four barge movements per day.

5.5.6 Impacts on the intertidal and subtidal habitats and associated flora and fauna are considered to be low negative, probable and temporary, due to the small area likely to be subject to regular consolidation and disturbance within the maximum working area boundary.

Change to scour and accretion patterns

5.5.7 The approach to addressing scour associated with the temporary structures is summarised in para. 5.2.3. It consists of monitoring the structures and implementing mitigation only if trigger levels of scour are reached. Further details are provided in the *Scour and Accretion Monitoring and Mitigation Plan for Temporary Works in the Foreshore* (Vol 3 Appendix L.4).

5.5.8 There is currently some accumulation of sediment in the vicinity of the river wall beneath Hungerford Bridge and immediately upstream. With the temporary structures the areas of accretion would increase, particularly in the areas where the temporary cofferdam and river wall meet. There would be a more extensive zone upstream of the temporary structures where sediment would accumulate occasionally. On the downstream side of Hungerford Bridge there would be some occasional accumulations of sediment. These predicted areas of sediment and accumulation are illustrated in Vol 17 Section 14 (Water resources – surface water).

5.5.9 Based on the assumption that scour associated with the temporary structures would not be permitted to penetrate beyond the existing substrate layer (para. 5.3.15g) impacts associated with temporary scour and accretion are considered to be low negative, probable and temporary, due to the limited area over which scour would be experienced.

Change to flow velocity

5.5.10 The presence of the temporary cofferdam would result in alterations to the hydraulic regime. Hydraulic modelling shows that there would be an increase in maximum velocity of 2.5% on mean spring tides with normal fluvial flow. The presence of the temporary works changes the flow direction slightly through Hungerford Bridge on flood tides. The impact on flow velocity is considered to be negligible.

Waterborne noise and vibration

5.5.11 There would be approximately 400m of sheet piling installed for the permanent and temporary cofferdams. Piles would be driven using vibro-piling techniques, thus limiting the principal source of waterborne noise and vibration impacts. Further measures to limit noise and vibration impacts during the construction stage of the project have been incorporated into the *CoCP*. These are described in Section 5.2.

5.5.12 There would be additional sources of noise and vibration, including activities associated with construction of the shaft itself and vehicle and barge movements. Although background levels of noise and vibration within the Tidal Thames are likely to be moderately high due to existing boat movements, and ground-propagated noise from transport systems, the proximity of the works to the river and their scale means that noise and vibration levels are likely to be elevated locally during construction. Noise and vibration have the potential to cause physical damage to fish, and disrupt behaviour and movement. However, in this case, given the piling techniques proposed and the extent of the works relative to the width of the channel this is considered to be a low negative impact, probable and temporary.

Increase in suspended sediment loads

5.5.13 Construction of the campshed, piling operations, and barge movements are likely to lead to localised increases in suspended sediment with the possibility for effects on local and downstream habitats. It is predicted that the cofferdam would impact on scour patterns while in place, which could cause the mobilisation of increased levels of suspended solids and potentially contaminants into the river.

5.5.14 During chemical analysis of sediment, mercury (0.99-1.9 mg/kg compared with 0.7 mg/kg) and lead (140-220 mg/kg compared with 112 mg/kg) were both recorded above the Probable Effects Level (PEL) in each of four samples taken. The majority of poly aromatic hydrocarbons (PAH) were recorded above the PEL in each sample. Copper was above the PEL in one sample (130 mg/kg compared to 108 mg/kg) as well as zinc (310 mg/kg compared to 271 mg/kg). These levels are all very typical of levels in the tidal Thames. Excavation on the foreshore would be confined within a cofferdam which would effectively prevent release of contamination during sediment removal.

5.5.15 There would be small quantities of sediment liberated during cofferdam installation; however these would be negligible compared to the 40,000 tonnes (or 20,000m^3 assuming an in-situ density of 2t per m^3) of sediment (HR Wallingford, 2006)[21] that are carried on a spring tide. In this context, the volumes produced by the construction works from piling or scour would not be detectable against natural fluctuations in sediments and would not have an impact on surface water resources (HR Wallingford, 2012)[22]. Impacts are considered to be low negative, probable and temporary.

5.5.16 Measures and safeguards to minimise the risk of accidental releases of silty or contaminated discharges to the tidal Thames are included in the *CoCP* (Section 8). These are described in Section 5.2. No impacts from polluted discharges are anticipated with these control measures and safeguards in place.

Construction effects

5.5.17 The following section (paras. 5.5.18 to 5.5.45) describes the effects of these impacts on aquatic ecology receptors based on the significance criteria set out in Vol 2 Section 2.3. Only those impacts which are considered relevant to each receptor are assessed, in accordance with the methodology presented in Vol 2.

Designations and habitats

Loss of intertidal and subtidal habitat due to temporary landtake

5.5.18 There would be a temporary loss of approximately 2695m^2 of subtidal habitat, coupled with localised losses due to scour. The habitats affected by temporary landtake are presented in Vol 17 Table 5.4.1 and include gravel foreshore, sublittoral sand and gravels, mudflats and a river wall. These habitats which are considered to be of medium-high (metropolitan) importance are represented elsewhere across the Tidal Thames. The impact of temporary landtake is considered to be of low negative magnitude.

5.5.19 Subsequent excavation and removal of the granular fill material followed by reinstatement of substrate of comparable particulate material to the original substrate would facilitate recovery. This is expected to lead to establishment in the medium (1-5 years) or long term (+5 years). Habitats within the area occupied by the campshed would be expected to recover more rapidly since the level of disturbance would be lower. However, this does not affect the overall effect level. The overall effect is considered to be **minor adverse**, given the medium-high (metropolitan) value of the receptor.

Change in intertidal and subtidal habitat due to scour and accretion

5.5.20 The intertidal habitats at Victoria Embankment Foreshore are dominated by sand and silt, whilst subtidal habitats are dominated by sand, gravel and pebbles (Vol 17 Table 5.4.1). There may be some removal of the finer material in the areas subject to abutment and contraction scour, although based on the assumption that scour would not be permitted to develop beyond the depth of the existing broad habitat type, which is river gravel deposits. Changes are thus anticipated to be limited to minor and localised changes in the relative composition of the substrate types.

5.5.21 There would be an increase in the proportion of fine sediments in the vicinity of the site due to accretion. This may result in localised changes in the composition of the habitat as sediments accumulate on top of the coarser material. There is a risk that anoxic (i.e. low DO) conditions) can develop within accreted sediment with potentially adverse effects on sediment dwelling organisms.

5.5.22 Overall, the effect of scour and accretion is considered to be **minor adverse** given the medium-high (metropolitan) importance of the receptor and the low negative impact.

Disturbance and consolidation of intertidal and subtidal habitat

5.5.23 There would be disturbance and consolidation of approximately 9300m^2 outside the cofferdam during the site establishment phase due to the presence of a jack up barge to install the temporary cofferdam, and due to the relocation of Tattershall Castle. The jack-up barge may also be used to remove the piles once construction is complete. Habitats within this zone are expected to recover within the short term (less than 12 months) following site establishment. Coupled with the medium-high (metropolitan) intrinsic value of the habitats in this area the effect is considered to be **minor adverse** due to the low negative magnitude of the impact.

Marine mammals

Interference with the migrations of marine mammals within the Tideway

5.5.24 Noise, vibration and other construction activity could theoretically disturb mammals and deter them from passing the site. However, given the low-medium (local) value of the receptor at this site, the low negative magnitude of noise and vibration impacts, the vibro-piling methods proposed, the duration of the period when piling would be taking place, and the controls on underwater noise-generating activities described in the *CoCP* (Section 5.2) this is considered to be a **negligible** effect.

Fish

Loss of feeding, resting and nursery habitat for fish due to temporary landtake

5.5.25 The site is not considered to offer suitable spawning habitat for smelt or any other fish species and limited feeding and nursery habitat for juvenile fish given the limited intertidal habitat. Loss of foreshore habitat is considered to be a low negative impact, which on a medium (borough) receptor would result in a **negligible** effect.

Loss of feeding, resting and nursery habitat for fish due to sediment disturbance and consolidation

5.5.26 The area which would be subject to disturbance and compaction outside the cofferdam lies almost entirely within the subtidal zone. The subtidal zone is unlikely to provide significant feeding, resting or nursery habitat for fish. Given that recovery is likely to occur within the short term (less than 12 months) the effect is thus considered to be **negligible**, given the medium (borough) value of the receptor and the low negative magnitude of the impact.

Change in feeding, resting and nursery habitat for fish due to scour and accretion

5.5.27 The limited depths of scour predicted at this site are not predicted to result in a change in the extent or nature of feeding, resting and nursery habitats. Increase levels of accretion may cause minor localised changes in the invertebrate community. However, this is not anticipated to limit the feeding opportunities for fish. The site does not lie within the zone in which smelt and dace are known to spawn and therefore there is no risk of smothering of spawning habitats due to sediment accretion. Effects are thus considered to be **negligible** due to the medium (borough) importance of the receptor and the low negative magnitude of the impact.

Interference with the migratory movements of fish

5.5.28 Ideally the river channel should provide an uninterrupted route for juvenile fish migrations for species such as eel as glass eels or elvers, dace, goby (e.g. *Pomatoschistus* spp.) and flounder as they move through the estuary.

5.5.29 In general, encroachment of structures such as cofferdams into the river channel may affect the river hydraulics, particularly at high discharges associated with heavy fluvial inputs or spring tides. Changes in water velocity caused by constriction of the hydraulic channel may hinder movements of fish against the tide, including their ability to withstand, or hold station in the flow. Constriction of the hydraulic channel, reduction of the intertidal zone and increased water velocities at project sites might cause some fish to be lost, for example by forcing them into deeper water with increased predation risk. Formation of eddy currents in the wake of structures may temporarily entrap fish and delay progress of migrations. Persistently delaying the successful daily migrations of fish past individual sites may also interfere with key life stage events such as spawning through preventing fish from reaching spawning sites at appropriate times.

5.5.30 The Individual Based Modelling (IBM) used to simulate the effects of the temporary and permanent structures on juvenile fish migration demonstrates that the temporary works should benefit upstream migration by presenting more opportunities for fish to shelter from adverse currents. Although the structure would cause juvenile fish to move into deeper water where predation risk is higher, the period of time in which they are exposed to this risk is sufficiently short that the study found it would have no effect on overall mortality rates when compared to the base case.

Details of the study, including the modelling methods, are presented in Vol 3.

5.5.31 Given the temporary nature of the works, and the fact that the minor adverse effects of fish being forced into deeper water would be offset by the minor beneficial effect anticipated through increased opportunities for shelter, the effects of the temporary structures on juvenile fish migrations are considered to be **negligible**.

Effects of waterborne noise and vibration on fish

5.5.32 The effects of waterborne noise and vibration on fish vary according to the proximity of the receptor to the source. Effects depend on distance from source, ranging from potential death at very close proximities, through injury, and behavioural disturbance with increasing distance from the source. The driving of sheet piles for the cofferdams would be undertaken using techniques that minimise the level of noise and vibration. The period of piling would be sufficiently brief (assumed for the purposes of this assessment to be approximately 5 weeks for the temporary cofferdam). Removal of the piles would take a similar length of time at the end of the construction period. Furthermore, a series of control measures relating to the timing and duration of piling operations have been included in the *CoCP* (see Section 5.2).

5.5.33 The site is not considered to support sensitive spawning habitat, and limited value as nursery, feeding and migratory habitat. It was considered to have value for juvenile fish as part of a migratory pathway through the Tidal Thames. Waterborne noise and vibration is considered to be a low negative impact, and given that the value of the receptor is medium (borough), the overall effect is assessed as being **negligible**.

Reduction in water quality due to suspended sediment

5.5.34 Although the Tidal Thames is a sedimentary environment with high levels of suspended solids, construction activities such as piling and barge movements may generate levels of suspended sediment which may cause disorientation of fish.

5.5.35 Given the length and extent of cofferdams in contact with the tidal flow (160m of temporary cofferdam), there is the potential for re-suspended sediments from piling and barge movements to affect juvenile fish migrations, particularly when considered along with the hydraulic effects described in paras. 5.5.28 to 5.5.31. Adult fish are considered to be less likely to be affected as they are able to move away from the turbid water. However, the value of the receptor is medium (borough), and the impact is considered low negative and therefore the effect is considered to be **negligible**.

Invertebrates

Direct mortality of invertebrates due to temporary landtake, sediment disturbance and consolidation

5.5.36 There would be direct mortality of invertebrates within sediments removed or covered by the cofferdams, and due to consolidation and disturbance of sediment due the site establishment phase. The effect is considered to be

negligible due to the medium (borough) value of the receptor and considering the low negative magnitude of impact.

Loss of burrowing and feeding habitat for invertebrates due to temporary landtake

5.5.37 The area beneath the temporary cofferdam would also be lost as burrowing and feeding habitat for invertebrates during the entire construction period. Subsequent excavation and removal of the granular fill material followed by reinstatement of substrate of comparable particulate material to the original substrate would facilitate recovery.

5.5.38 Given the medium (borough) value of the receptor and the low negative impact of habitat loss, the overall effect is considered to be **negligible**, particularly given the relatively limited loss of a burrowing and feeding resource.

Loss of feeding and burrowing habitat for invertebrates due to sediment disturbance and consolidation

5.5.39 The area beneath the temporary cofferdam would be subject to heavy consolidation, and hence would be unavailable to burrowing invertebrates in the medium term (one to five years) following removal of the cofferdam. The temporary consolidation and disturbance to the habitat for burrowing invertebrates is considered to be a **negligible** effect. This is because the receptor is of medium (borough) value, the impact of sediment disturbance and consolidation is considered to be low negative, and the effects are considered likely to be reversed upon recovery of the habitat, which would occur in the short term (less than 12 months).

Change to burrowing and feeding habitat due to scour and accretion

5.5.40 Whilst there may be some losses of fine material in the localised areas where scour is predicted, this is not anticipated to result in a change in the invertebrate community. The increase in the proportion of fine material associated with accretion may favour certain benthic invertebrates including the sediment dwelling Oligochaeta and Polychaeta. Oligochaeta are already the dominant benthic invertebrate group at the site and the change in the proportion of fine sediments is unlikely to change the overall community composition.

5.5.41 Overall, the effects are considered to be **negligible** due to the low negative magnitude of the impact and the medium (borough) importance of the receptor.

Reduction in water quality due to suspended sediment

5.5.42 The predicted increases in suspended sediment due to general construction activity such as barging are not expected to affect invertebrate communities given the existing background levels within the Tidal Thames. However, high levels of suspended sediment which may occur as a result of a sudden scour events could give rise to localised reductions in DO and potentially, increases in the concentrations of contaminants.

5.5.43 The majority of the invertebrates present are not considered to be particularly sensitive to accretion or low DO conditions. These organisms are adapted to withstand tidal flows that bring about movements of degradable and non degradable solids. The feeding mechanisms of animals that filter water might be affected (e.g. larger bivalves), but these are sparsely recorded in the Tidal Thames. Tube living animals such as Corophidae might be more susceptible, but they are quite mobile and able to move away from sources of impact.

5.5.44 Effects are thus considered to be **negligible**, given the medium (borough) value of the receptor and the low impact magnitude.

Algae

Loss of habitat due to temporary landtake

5.5.45 The construction of a temporary cofferdam would mean that any algae would be lost from the area of river wall within the permanent and temporary cofferdams, as the algae require regular inundation with water in order to survive. However, given the low-medium (local) value of the receptor, the low negative impact, and the fact that algae are likely to re-colonise rapidly following removal of the cofferdam, the effect is considered **negligible**.

Blanketing of areas and increase in water column turbidity due to suspended sediment

5.5.46 As stated in para. 5.5.34, the Tidal Thames is already a sedimentary environment with high levels of suspended solids. The generation of increased levels of suspended sediment from construction activities may cause smothering of marine algae.

5.5.47 Given the length and extent of cofferdam in contact with the tidal flow as described in para. 5.5.35, there is the possibility that re-suspended sediments may affect marine algae located on river walls immediately downstream. The value of the receptor is low-medium (local) and the impact considered low negative and therefore the effect is considered to be **negligible**.

Sensitivity test for programme delay

5.5.48 For the assessment of effects on aquatic ecology during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 5.5.1 to 5.5.47). This is because there are no developments in the site development schedule that would fall into the base case as a result of this delay and therefore the base case would remain as described in paras. 5.4.61 to 5.4.65.

5.6 Operational effects assessment

5.6.1 This section presents the findings of the operational phase assessment. It outlines the operational impacts arising from the proposed development and the likely significant effects on aquatic ecology receptors.

Operational impacts

Permanent landtake

5.6.2 There would be a total of 1530m^2 of landtake (of which 445m^2 would be associated with a permanent apron that would consist of buried rip-rap which would be overlaid with an appropriate substrate material). The remaining 1085m^2 would be from subtidal habitats associated with a permanent foreshore structure housing the CSO interception and other operational infrastructure. The permanent foreshore structure would extend approximately 27m into the channel. This would result in loss of feeding and resting habitat for fish and invertebrates. Permanent landtake is certain and is considered to have a medium negative impact since, although the scale is smaller than the temporary landtake, it would be permanently lost.

Modification of habitat as a result of scour protection measures

5.6.3 The outfall at Victoria Embankment Foreshore site would include scour protection around the perimeter of the permanent structure. Scour protection (including aprons) would comprise buried rip rap. A total area of up to 445m^2 of subtidal habitat is likely to be affected by scour protection at the Victoria Embankment Foreshore site.

5.6.4 This is regarded as a low negative impact as habitat modification, rather than habitat loss, would result.

Permanent consolidation due to relocation of the Tattershall Castle

5.6.5 There is also potential for disturbance and consolidation of sediment associated with relocation of Tattershall Castle to a new mooring 130m upstream of its current position. The vessel would be moored in the subtidal zone although it is likely to rest on the bed of the river at low tide. The affected area would be approximately 700m^2 . Impacts are considered to be negligible, probable and permanent.

Change to scour and accretion patterns

5.6.6 The permanent foreshore structure would extend into the channel by approximately 20m at the upstream end and 33m at the downstream end. Hydraulic modelling has shown that the structure would impact on scour patterns.

5.6.7 Scour protection would be provided beneath the new outfall where it extends below the mean low water line, in the form of an outfall apron, and along the line of the new river wall (to protect its foundation). The detailed design and extent of this would seek to avoid or minimise adverse effects on aquatic ecology

5.6.8 With the permanent structure in place, some sediment accumulation is predicted to occur immediately upstream of the permanent foreshore structure and to a greater extent downstream, within the subtidal zone. Some occasional deposition has been predicted both upstream and downstream of the permanent foreshore structure within the intertidal and subtidal zones. These predicted areas of sediment and accumulation are illustrated in Vol 13 Section 14 (Water resources – surface water).

5.6.9 Impacts due to scour on the intertidal and subtidal habitats and associated flora and fauna are considered to be negligible, probable and permanent. Impacts due to accretion on the intertidal and subtidal habitats and associated flora and fauna are considered to be low negative, probable and permanent

Change to flow velocity

5.6.10 The presence of the permanent foreshore structure would result in alterations to the hydraulic regime. On both mean and maximum spring tides, maximum velocities are predicted to increase by less than 2% on normal fluvial flows. The relocated Tattershall Castle upstream, may lead to minimal alterations to flow dynamics in the river. The impact is considered to be low negative.

Increases in dissolved oxygen concentrations in the vicinity of the CSO

5.6.11 The projected Typical Year 100% decrease in discharges compared against the base case (see para. 5.2.8) would result in improvements in DO concentrations at a local level and throughout the Tidal Thames. The Thames Tideway Tunnel improvements would ensure compliance with the DO standards described in para. 5.4.29. These improvements are assessed at a river wide level in Vol 3. The impact is considered to be medium positive due to the existing relatively large number and volume of spills from the Regent Street CSO, and impacts would be near certain and permanent.

Reduction in sediment nutrient levels

5.6.12 Elevated concentrations of nutrients (phosphate and nitrate) are likely to have accumulated in the sediments in close proximity to the existing CSO discharge point as a result of the faecal material and sewage derived litter discharged from the CSO. In addition to the directly toxic effects of elevated ammonia (particularly in low oxygen situations) increased nutrients in the sediment can reduce the natural limits on algal growth and enable more nitrogen/phosphate responsive species to outcompete other species reducing diversity Interception of the CSO would lead to a gradual reduction in sediment nutrient levels. The impact is considered to be low positive, probable and permanent.

Reduced levels of sewage derived litter

5.6.13 Sewage derived litter from the CSO can be expected to reduce by 100%, from approximately 7t to zero, in the Typical Year with beneficial effects on aquatic ecology receptors. This is considered to be a low positive impact and would be near certain and permanent.

Operational effects

5.6.14 The following section describes the effects of these impacts on aquatic ecology receptors based on the significance criteria set out in Vol 2 Section 2.3. Only those impacts which are considered relevant to each receptor are assessed, in accordance with the methodology presented in Vol 2.

5.6.15 Unless stated the effects described below apply to both Year 1 of operation and Year 6 of operation.

Designations and habitats

Permanent loss of intertidal habitats

5.6.16 There would be a permanent loss of approximately 1085m^2 of subtidal habitat due to the permanent structure. A further 445m^2 of subtidal habitat would be modified as a result of the scour protection measures and permanent apron. This would consist of buried rip-rap which would be overlaid with an appropriate substrate material. The effect is considered to be **moderate adverse** due to the magnitude of the impact (medium negative) and the value of the receptor (medium-high (metropolitan)).

Consolidation of subtidal habitat due to relocation of the Tattershall Castle

5.6.17 There would be consolidation and disturbance of a 700m^2 area of subtidal habitat due to the re-location of the Tattershall Castle. Although moored in the subtidal the vessel is likely to ground out at the lowest states of the tide. Consolidation combined with shading and abrasion of the bed from the moored vessel would reduce the value of the surface layers of sediment for other receptors such as benthic invertebrates and algae. Given the medium (metropolitan) value of the habitats and the negligible magnitude of the impact the effect is considered to be negligible.

Change in intertidal and subtidal habitat due to accretion

5.6.18 The modelling results have predicted some changes in sediment accumulation and occasional deposition as a result of the permanent foreshore structure. Therefore overall the effect of accretion is considered to be **minor adverse**, given the medium-high (metropolitan) value of the receptor and low negative impact impact.

Improvements in habitat quality through changes in water quality

5.6.19 The predicted increases in DO concentrations and reductions in BOD would result in localised improvements in habitat quality. This may be characterised by increased levels of photosynthesis by microscopic algae at the interface with the sediment and within the water column, termed primary production. These algae form the basis of the estuarine food chain, providing a food source for fish and invertebrates. The gradual breakdown and removal of sewage derived litter associated with the sewage discharge would contribute to the recovery. However, habitats per se are relatively insensitive to alterations in DO concentrations, with reductions in sediment nutrient levels and sewage derived litter more important factors with regards to habitat quality improvements. Therefore the impact in this instance is considered to be of low positive magnitude, rather than medium positive. The effects are considered to **negligible** at Year 1 increasing to **minor beneficial** by Year 6, given the medium-high (metropolitan) value of the receptor and the low positive magnitude of impact.

Marine mammals

Increase in the number and/or change in the distribution of marine mammals

5.6.20 No changes are anticipated on marine mammals as a result of the water quality improvements associated with interception of a single CSO discharge. This is because they are relatively insensitive to point source sewage discharges. Improvements in habitat quality due to the reduction in sewage derived litter may make the habitat more favourable, although the factor determining its use by seals relates predominantly to the lack of disturbance rather than water quality. Effects are considered **negligible**, given the low-medium (local) value of the receptor and the low positive magnitude of impact.

Fish

Permanent loss of intertidal and subtidal feeding and resting habitat for fish due to landtake

5.6.21 The site is not considered to offer suitable spawning habitat for smelt, or any other fish species and given the limited intertidal habitat, it is unlikely provide significant feeding, resting or nursery habitat. However, loss of 1085m^2 of subtidal foreshore habitat is considered to be a medium negative impact. Combined with the medium (borough) value of the receptor, the effect on fish is considered to be **minor adverse**.

Modification of intertidal feeding and subtidal habitat for fish

5.6.22 At Victoria Embankment Foreshore site, scour protection would occupy an area of approximately 445m^2 of subtidal habitat. The scour protection areas, which would consist of rip-rap overlain with an appropriate substrate material, may offer some benefits to juvenile fish by providing refuges from the current and from predators. In this respect it is analogous to artificial reef structures created in the marine environment to provide shelter for fish and increase the heterogeneity of otherwise uniform habitats (Grove, RS, *et al*. 1991)[23.]

5.6.23 Similarly, the rip rap scour protection may offer shelter for pelagic invertebrates such as *Gammarus* species which represent a food source for some fish species. It is unlikely to have potential as feeding habitat for benthic feeding fish except where accretion allows colonisation by invertebrates.

5.6.24 The effects on fish are considered to be **negligible**. This is because although the overall impact is low negative, the balance of positive and negative effects for fish gives rise to a negligible effect.

Consolidation of subtidal feeding habitat due to relocation of the Tattershall Castle

5.6.25 The area of subtidal habitat affected by the relocation of the Tattershall Castle (para 5.6.17) would have reduced value as invertebrate habitat and therefore as a foraging area for fish. The overall effect is considered to be negligible given the low medium (Borough) value of the receptor and the negligible magnitude of the impact.

Change in feeding, resting and nursery habitat for fish due to accretion

5.6.26 The modelling results have predicted some changes in sediment accumulation and occasional deposition as a result of the permanent foreshore structure. Increase levels of accretion may cause minor localised changes in the invertebrate community. However, this is not anticipated to limit the feeding opportunities for fish. The site does not lie within the zone in which smelt and dace are known to spawn and therefore there is no risk of smothering of spawning habitats due to sediment accretion. Therefore overall the effect of accretion is considered to be **negligible**, given the medium (borough) value of the receptor and low negative impact.

Interference with migratory movements of fish

5.6.27 The Individual Based Modelling study shows that none of the three species (bass, eel and flounder) used to represent the range of species found in the Tideway flounder were significantly affected when comparing the base case and the proposed development at Victoria Embankment Foreshore site. This is likely to be influenced by the angular nature of the permanent foreshore structure at Victoria Embankment Foreshore offering refuges for juvenile fish against adverse currents, and thus offsetting the slightly increased velocities around the corners of the permanent foreshore structure. The effect is therefore considered to be **negligible**, based on low negative impact on a receptor of medium (borough) value.

Reduction in the occurrence of dissolved oxygen related fish mortalities

5.6.28 Interception of the CSOs throughout the Tidal Thames would result in far fewer hypoxia events. The TFRM has been used to predict the change in the number of hypoxia events, and the results are reported in Vol 3. In summary, all Tideway fish populations would become sustainable (ie, less than 10% mortality as a result of hypoxia (Turnpenny *et al*., 2004)[24]), compared with the current baseline in which there is a greater than 10% mortality due to hypoxia for four key species (smelt, dace, flounder and common goby).

5.6.29 Interception of the Regent Street CSO would contribute to Tidal Thames-wide improvement, but would also result in improvements in the local area. Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is thus considered to be **minor beneficial**.

Increase in the distribution of pollution sensitive fish species

5.6.30 The Tidal Thames currently supports a small number of rare fish species such as salmon, sea trout, twaite shad and river lamprey (*Lampetra fluviatilis*). A number of factors limit the colonisation of habitats by these species, including salinity, substrate type and current, but pollution is known to be a significant factor in determining colonisation (Maitland, PS and Hatton-Ellis, TW, 2003)[25]. Improving water and sediment quality would facilitate the spread of those pollution sensitive species which are currently being impeded by poor water and sediment quality.

5.6.31 EA data and project surveys have indicated no records of rare fish species in the vicinity of Victoria Embankment Foreshore site and habitat quality at this site is limited by confinement of the river channel between vertical river walls, which limits the extent of intertidal habitat and lead to increased current velocities. Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is thus considered to be **negligible** in the short term (Year 1), increasing to **minor beneficial** in Year 6 of operation since it would take time for species to colonise.

Improvement in the quality of foraging habitat

5.6.32 Intertidal habitat in the upper and middle Tideway is used by juvenile fish for foraging. For example, juvenile flounder, bass and smelt migrate to the tidal limit in spring and early summer and then migrate downstream in search of suitable foraging habitat. As habitat quality improves as described in para. 5.6.19, and the invertebrate community becomes more diverse (paras. 5.6.40 to 5.6.44) foraging opportunities for fish may increase. Taking into account the medium (borough) value of the resource and the medium positive impact magnitude, the effect is considered to be **negligible** in the short term (Year 1 of operation), increasing to **minor beneficial** in Year 6 of operation as it would take time for communities to develop.

Invertebrates

Permanent loss of feeding and burrowing habitat for invertebrates due to landtake

5.6.33 The area beneath the permanent works would be lost as burrowing and feeding habitat for invertebrates. Given that the impact is considered to be medium negative, and the value of the receptors is medium (borough), the overall effect is considered to be **minor adverse**.

Modification of intertidal and subtidal habitats for invertebrates by scour protection

5.6.34 As for fish the degree to which the scour protection would change conditions for invertebrates depends on the nature of the existing substrate. Fine substrates are unlikely to accumulate extensively within the rip rap scour protection given that high flow velocities which are likely to occur in the vicinity of them. Benthic invertebrates may thus be excluded from these areas, except in sheltered pockets where accretion can occur.

5.6.35 Pelagic invertebrates such as *G. zaddachi* may be attracted to these areas in order to shelter from the current.

5.6.36 The overall effect on invertebrates is considered to be **negligible**, given the medium (borough) value of the receptor and the low negative impact magnitude.

Consolidation of subtidal feeding and burrowing habitat due to relocation of the Tattershall Castle

5.6.37 The area of subtidal habitat affected by the relocation of the Tattershall Castle (para 5.6.17) would have reduced value as invertebrate habitat due to consolidation, shading and abrasion by the vessel at low tide. The overall effect is considered to be negligible given the low medium (Borough) value of the receptor and the negligible magnitude of the impact.

Change to burrowing and feeding habitat due to accretion

5.6.38 The modelling results have predicted no changes in sediment accumulation as a result of the permanent foreshore structure. The increase in the proportion of fine material associated with accretion may favour certain benthic invertebrates including the sediment dwelling Oligochaeta and Polychaeta. Oligochaeta are already the dominant benthic invertebrate group at the site and the change in the proportion of fine sediments is unlikely to change the overall community composition. Therefore overall the effect of accretion is considered to be **negligible**, given the medium (borough) value of the receptor and low negative impact.

Localised improvements in invertebrate diversity and abundance

5.6.39 Improvements in DO concentrations are likely to lead to an increase in the distribution of a range of species that are currently being suppressed by poor water quality conditions. Some of these improvements would occur under the base case due to the Lee Tunnel and sewage treatment works upgrades. However, even with these improvements in place there are still predicted to be a number of occasions during an average year when DO standards would be breached. Colonisation by DO sensitive taxa such as Corophiidae, Crangonidae and Gammaridae which would otherwise occur within the brackish zone would continue to be suppressed.

5.6.40 Full compliance with the standards as a result of the Thames Tideway Tunnel is expected to enable colonisation by these DO sensitive taxa. In the localised areas around CSO discharges gradual reductions in organic material associated with sewage would also allow for a transition from invertebrate communities dominated by small numbers of species to a more diverse and balanced community. For example, pollution sensitive estuarine taxa such as Corophiidae, Crangonidae, Gammaridae, Sphaeromatidae, Nuculidae, Anthuridae, and Palaemonidae may be expected to increase in abundance.

5.6.41 Improvements in water quality could theoretically selectively enhance colonisation by invasive, non-native species. However, studies on mitten crabs, for example, have determined that the species is able to tolerate poor water quality, but that improvement of water quality does not necessarily lead to an increased distribution (Veilleux, E and de Lafontaine, Y, 2007)[26].

5.6.42 Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is considered to be at

negligible at Year 1 and **minor beneficial** Year 6 of operation since it would take time for new species to colonise.

Increase in the distribution of pollution sensitive invertebrate species

5.6.43 The Tidal Thames currently supports a small number of rare invertebrate species, such as swollen spire snail and tentacled lagoon worm. A number of factors limit the colonisation of habitats by these species, including salinity, substrate type and current, but pollution is known to be a significant factor in determining colonisation. Improving water and sediment quality would facilitate the spread of those pollution sensitive species which are currently being impeded by poor water and sediment quality.

5.6.44 EA data and bespoke project surveys have indicated no records of rare invertebrate species in the vicinity of Victoria Embankment Foreshore (other than *A. lacustre* which as discussed although uncommon nationally is common in the tidal Thames). Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is thus considered to be **negligible** in Year 1, and **minor beneficial** in Year 6 as it would take time for species to colonise.

Algae

Permanent loss of original river wall

5.6.45 The algae that have previously been found on the river wall at the Victoria Embankment Foreshore site can be expected to recolonise the new river wall (i.e. the outer wall of the permanent structure) relatively quickly following the completion of construction (within 5 years). As none of these species are uncommon the effect is considered to be **negligible**, given the low-medium (local) value of the receptor and the impact magnitude.

Changes in algal communities

5.6.46 The reduction in nutrient levels, both in the water column and the sediments in the vicinity of the discharge may cause local changes to the algal communities of the river wall. Whilst it is not possible to predict these changes precisely it is likely that the reduction in nutrients would contribute to the recovery of algal flora, with pollution sensitive species becoming a more common component of the community at the expense of more pollution tolerant species.

5.6.47 However, habitat availability would remain a key factor determining the diversity and abundance of algal communities and so the effects associated with the Thames Tideway Tunnel project are considered to be **negligible**, given the low-medium (local) value of the receptor and the low positive impact magnitude.

Sensitivity test for programme delay

5.6.48 For the assessment of effects on aquatic ecology during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 5.6.1 to 5.6.47). This is because there are no developments in the site development schedule that would fall into the base case as a result of this delay and therefore the base case would remain as described in paras.5.4.66 to 5.4.70.

5.7 Cumulative effects assessment

5.7.1 As described in Section 5.3, no schemes within the site development schedule (Vol 17 Appendix N) have been identified as being under construction during the construction or operational phase that could impact on aquatic ecology receptors. Therefore a cumulative assessment has not been undertaken.

5.7.2 Therefore the effects on aquatic ecology would remain as described in Sections 5.5 and 5.6 above.

Sensitivity test for programme delay

5.7.3 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, the cumulative effects assessment would remain unchanged. As described above in paras. 5.7.1 to 5.7.2, there are no schemes anticipated to generate cumulative effects on aquatic ecology and this would remain the case with a programme delay of approximately one year.

5.8 Mitigation and compensation

Mitigation

5.8.1 The approach to mitigation has been informed by the Mitigation and Compensation Hierarchy consulted on with the Thames Tideway Tunnel project Biodiversity Working Group and EA Technical Working Group as a systematic and transparent decision-making process. The hierarchy is appended to Vol 2.

5.8.2 The hierarchy is sequential and seeks to avoid adverse environmental effects. The hierarchy of ‘avoid effect’, ‘minimise’, ‘control’, ‘compensate’ and ‘enhance’ has been strictly applied in this sequence.

5.8.3 All *CoCP* and embedded design measures of relevance to aquatic ecology are summarised in Section 5.2. No significant adverse effects have been identified during construction which require mitigation.

5.8.4 The permanent loss of intertidal foreshore habitat is considered to be a moderate adverse effect. The footprint of the permanent structure has been minimised as far as possible to accommodate the necessary works therefore further mitigation is not possible. This permanent loss of habitat contributes to an overall loss of habitat arising from all of the foreshore sites. Compensation for this project-wide, permanent loss of foreshore habitat is detailed in Vol 3.

5.8.5 A monitoring programme to measure the recovery of aquatic ecology receptors throughout the Tidal Thames following interception of the CSO network would be implemented.

Compensation

5.8.6 Significant adverse effects would occur due to the permanent loss of intertidal and subtidal habitats, and intertidal feeding and resting habitat for fish. On site habitat compensation is not considered possible due to the limited availability of land to create new habitat within the boundary of the site. A package of off site measures which would compensate for significant adverse effects on habitats and fish has been developed and is reported in full in Vol 3 Section 5.8. It includes measures such as the creation of an intertidal terrace on the Bell Lane Creek, and the installation of fish passes on several structures which are currently inhibiting the migration of fish from the Tidal Thames into freshwater tributaries.

5.9 Residual effects assessment

Construction effects

5.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 5.5. All residual effects are presented in Section 5.10.

Operational effects

5.9.2 Compensation for the overall permanent habitat loss across the Thames Tideway Tunnel project is outlined in the project-wide assessment (Vol 3). At a project-wide level the total habitat losses have been addressed through creation/ enhancement of sites along the route of the Thames Tideway Tunnel project to compensate for adverse effects on aquatic ecology. The loss of habitat at Victoria Embankment Foreshore site has been reported here without taking account of these compensation sites. This is to ensure that the local effects are presented. However, it is recognised that aquatic ecological resources are highly mobile and river wide. Reference should therefore be made to the project-wide assessment which includes the compensation sites to understand the total effects anticipated to result from the Thames Tideway Tunnel project.

5.9.3 As no other mitigation is required all other effects remain as reported in section 5.6. Residual effects are reported in section 5.10.

5.10 Assessment summary

Vol 17 Table 5.10.1 Aquatic ecology – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Designations and habitats	Loss of habitat due to temporary landtake	Minor adverse	None	Minor adverse
	Change in intertidal and subtidal habitat due to scour and accretion	Minor adverse	None	Minor adverse
	Disturbance and consolidation of intertidal and subtidal habitat	Minor adverse	None	Minor adverse
Marine mammals	Interference with the migrations of marine mammals within the Tideway	Negligible	None	Negligible
Fish	Loss of feeding, resting and nursery habitat for fish due to landtake	Negligible	None	Negligible
	Loss of feeding, resting and nursery habitat for fish due to sediment consolidation and disturbance	Negligible	None	Negligible
	Change in feeding, resting and nursery habitat for fish due to scour and accretion	Negligible	None	Negligible
	Interference with migratory movements of fish	Negligible	None	Negligible
	Effects of waterborne noise and vibration on fish	Negligible	None	Negligible
	Reduction in water quality due to suspended sediment	Negligible	None	Negligible
Invertebrates	Direct mortality of invertebrates due to temporary landtake, sediment disturbance and consolidation	Negligible	None	Negligible
	Loss of feeding and burrowing habitat for invertebrates due to landtake	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	Loss of feeding and burrowing habitat for invertebrates due to sediment disturbance and consolidation	Negligible	None	Negligible
	Change to burrowing and feeding habitat due to scour and accretion	Negligible	None	Negligible
	Reduction in water quality due to suspended sediment	Negligible	None	Negligible
Algae	Temporary landtake	Negligible	None	Negligible
	Blanketing of areas and increase in water column turbidity due to suspended sediment	Negligible	None	Negligible

Vol 17 Table 5.10.2 Aquatic ecology – summary of operational assessment

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
Designations and habitats	Permanent loss of designated intertidal habitat	Moderate adverse	Moderate adverse	None	Moderate adverse	Compensation would be provided through a suite of off site habitat creation schemes which are described in the project wide volume (Vol 3)

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
	Consolidation of subtidal habitat due to relocation of the Tattershall Castle	Negligible	Negligible	None	Negligible	None
	Change in intertidal and subtidal habitat due to accretion	Negligible	Negligible	None	Negligible	None
	Improvement in habitat quality through changes in water quality	Negligible	Minor beneficial	None	Minor beneficial	None
Marine mammals	Increase in the number and/or change in the distribution of marine mammals	Negligible	Negligible	None	Negligible	None
Fish	Permanent loss of feeding and resting habitat for fish due to landtake	Minor adverse	Minor adverse	None	Minor adverse	None
	Consolidation of subtidal feeding habitat due to relocation of the Tattershall Castle	Negligible	Negligible	None	Negligible	None
	Modification of intertidal feeding and subtidal habitat for fish	Negligible	Negligible	None	Negligible	None
	Change in feeding, resting and nursery habitat for fish due to accretion	Negligible	Negligible	None	Negligible	None
	Interference with migratory movements of fish	Negligible	Negligible	None	Negligible	None
	Reduction in the occurrence of dissolved oxygen related fish	Minor beneficial	Minor beneficial	None	Minor beneficial	None

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
	mortalities.					
	Increase in the distribution of pollution sensitive fish species.	Negligible	Minor beneficial	None	Minor beneficial	None
	Improvement in the quality of foraging habitat	Negligible	Minor beneficial	None	Minor beneficial	None
Invertebrates	Permanent loss of feeding and burrowing habitat for invertebrates due to landtake.	Minor adverse	Minor adverse	None	Minor adverse	None
	Consolidation of subtidal feeding and burrowing habitat due to relocation of the Tattershall Castle	Negligible	Negligible	None	Negligible	None
	Modification of intertidal feeding and subtidal habitat for invertebrates	Negligible	Negligible	None	Negligible	None
	Change to burrowing and feeding habitat due to accretion	Negligible	Negligible	None	Negligible	None
	Localised improvements in invertebrate diversity and abundance.	Negligible	Minor beneficial	None	Minor beneficial	None
	Increase in the distribution of pollution sensitive invertebrate species.	Negligible	Minor beneficial	None	Minor beneficial	None
Algae	Permanent loss of original river wall	Negligible	Negligible	None	Negligible	None

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
	Changes in algal communities	Negligible	Negligible	None	Negligible	None

This page is intentionally blank

References

[1]Defra. *National Policy Statement for Waste Water.* (2012). http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf last accessed November 2012

[2] Environment Agency. *Pollution Prevention Guide 05: Works in, near or liable to affect water courses*. (undated)

[3] CIRIA.. *C532: Control of water pollution from construction sites: Guidance for consultants and contractors* (2001)

[4] Balanced Seas. *Marine Conservation Zone project – final recommendations* (September 2011).

[5] Thames Estuary Partnership Biodiversity Action Group. *Tidal Thames Habitat Action Plan*. Thames Estuary Partnership (undated).

[6] Westminster City Council. *Westminster's Biodiversity Action Plan*. (2008). Available at: http://www.westminster.gov.uk/services/environment/greencity/biodiversity/biodiversity-action-plan/. Last accessed November 2012

[8] Elliott, M. and Taylor, CJL. *The structure and functioning of an estuarine/marine fish community in the Forth estuary, Scotland*. Proc. 21st European Marine Biological Symposium (Gdansk). Polish Academy of Sciences, Institute of Oceanology, Warsaw, Poland, 227-240. (1989).

[9] Elliott, M. and Hemingway, KL. *Fishes in Estuaries*. London: Blackwell Science (2002).

[10] Wheeler, AC. *The Tidal Thames. The History of a River and its Fishes*. Routledge and Kegan Paul, London (1979).

[11] Turnpenny, AWH, Clough, SC, Holden, SDJ, Bridges, M, Bird, H, O'Keeffe, NJ, Johnson, D, Edmonds, M, and Hinks, C. *Thames Tideway Strategy: Experimental Studies on the Dissolved Oxygen Requirements of Fish*. Consultancy Report no.FCR374/04 to Thames Water Utilities, Ltd. Fawley Aquatic Research, Fawley Southampton (April, 2004).

[12] Chadd, R and Extence, C. *The conservation of freshwater macroinvertebrate populations: a community based classification scheme*. Aquatic Conservation: Marine and Freshwater Ecosystems. 14: 597-624. (2004).

[13] Bratton, JH, (editor). *British Red Data Books: 3. Invertebrates other than insects*. JNCC, Peterborough (1991).

[14] Shirt, DB, (editor). *British Red Data Books: 2 Insects*. Peterborough: Nature Conservancy Council (1987).

[15] Elliott, P. and zu Ermgassen, PSE. *The Asian clam (Corbicula fluminea) in the River Thames*. London, England. Aquatic Invasions Vol 3, Issue 1, pp 54-60. (2008).

[16] Bailey-Brock JH, Paavo B, Barrett, BM and Dreyer, J. *Polychaetes associated with a tropical ocean outfall: synthesis of a biomonitoring program off O'ahu Hawai*'i Pac. Sci. 56: 459-479. (2002).

[17] English Nature. *Thames Estuary European Marine Site: English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats & c.).* Regulations 1994 (2001).

[18] Tittley. *The Marine Algae (Seaweeds) of the Tidal Thames: a Floristic Account*. The London Naturalist. No.88 (2009).

[19] Greater London Authority. *London Plan.* Available at: www.london.gov.uk/priorities/planning/londonplan. Last accessed May 2012.

[20] Environment Agency. *National Encroachment Policy for Tidal Rivers and Estuaries* (2005)

[21] 'HR Wallingford. *Thames Estuary 2100, Morphological changes in the Thames Estuary, Technical Note EP6.8, The development of an historical sediment budget. Report for the Environment* (2006)

[22] HR Wallingford*. Effect of Thames Tideway Tunnel Construction Activities on Morphology of the Thames Estuary Designated Habitats. Thames Tideway Tunnel Technical Note DDM6485-02, 100-RG-MDL-WALLI-000035'* (November 2012)

[23] Grove, RS, Nakamura, M, & Sonu, CJ. *Design and engineering of manufactured habitats for fisheries enhancement*. In Artificial habitats for marine and freshwater fisheries (eds W. Seaman & L.M. Sprague), pp. 109-152. Academic Press, San Diego, California (1991).

[24] Turnpenny et al. (2004). See citation above

[25] Maitland, PS, and Hatton-Ellis, TW. *Ecology of the Allis and Twaite Shad*. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough (2003).

[26] Veilleux, E. and de Lafontaine, Y. *Biological synopsis of the Chinese mitten crab (Eriocheir sinensis)*. Fisheries and Oceans, Canada (2007).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 6: Ecology - terrestrial

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 6: Ecology – terrestrial

List of contents

Page number

6 Ecology – terrestrial ... 1

6.1 Introduction ... 1

6.2 Engagement ... 1

6.3 Baseline ... 2

6.4 Overview ... 3

List of tables

Page number

Vol 17 Table 6.2.1 Terrestrial ecology – stakeholder engagement ... 1

This page is intentionally blank

6 Ecology – terrestrial

6.1 Introduction

6.1.1 Construction and operational effects for terrestrial ecology at Victoria Embankment Foreshore have been scoped out. This is on the basis that no significant adverse effects on terrestrial ecology are anticipated during either construction or operation, as there are no notable species or habitats known to be present, or the potential for them to be present, on or adjacent to the site.

6.1.2 This section nevertheless presents details of engagement, baseline information and an overview of the reasons why this topic has been scoped out.

6.1.3 Likely significant effects on aquatic ecology are reported in Section 5 of this volume.

6.1.4 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Vol 17 Victoria Embankment Foreshore Figures).

6.2 Engagement

6.2.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for terrestrial ecology are presented in Vol 17 Table 6.2.1. The construction and operational assessment for this site was scoped out as part of scoping.

Vol 17 Table 6.2.1 Terrestrial ecology – stakeholder engagement

Organisation	Comment	Response
City of Westminster (May 2011)	There are trees along Victoria Embankment that may be affected by access and egress from the site. It should be clarified that Victoria Embankment Gardens are not affected by the proposed works.	A Phase 1 Habitat Survey to confirm the value of habitat has been undertaken. Replacement planting would be provided for trees to be removed. The works would not affect Victoria Embankment Gardens.
Greater London Authority (including TFL) (Section 48 consultation, October	It now appears that there is extensive loss of mature trees at this site. Such extensive loss is questioned as it is likely to lead to a much more barren townscape as well as the loss of the	Replacement planting would be provided for trees to be removed. The works would not affect Victoria Embankment Gardens.

Organisation	Comment	Response
2012)	environmental and amenity benefits that such mature trees present.	
Environment Agency (Section 48 consultation, October 2012)	Para 16.3.8 The extent of inter-tidal foreshore on this location is limited, loss of foreshore habitat is in this location is likely to be significant.	There is no notable foreshore habitat for wintering birds on or immediately adjacent to the site. This habitat is not considered to be important for wintering birds. Effects on aquatic ecology receptors are assessed in Section 5 Aquatic Ecology.

6.3 Baseline

6.3.1 The River Thames and Tidal Tributaries Site of Importance for Nature Conservation (SINC Grade III of Metropolitan importance[i]) is included in the aquatic ecology assessment in Section 5 of this volume. There are two designated sites relevant to terrestrial ecology within 250m of the site (Vol 17 Figure 6.4.1, see separate volume of figures):

a. Victoria Embankment Gardens: Whitehall Gardens SINC (Grade L[ii]), approximately 20m to the west of the proposed development site

b. Victoria Embankment Gardens: Main Gardens SINC (Grade L) approximately 100m to the north of the proposed development site.

6.3.2 The Whitehall Gardens are separated by the busy road along Victoria Embankment, while the Main Gardens are separated by roads and other urban development. It is considered unlikely that works associated with construction or operation at the Victoria Embankment Foreshore site would affect these designated sites.

6.3.3 A Phase 1 Habitat Survey (Vol 17 Figure 6.4.2, see separate volume of figures) identified that habitat is limited to hardstanding and semi-mature London plane (*Acer platanus x acerifolia*) trees. Nine of these trees would be removed. The hardstanding has negligible biodiversity value. The semi-mature trees have low intrinsic biodiversity value and would support only small numbers of nesting common bird species.

6.3.4 For the purposes of the *Environmental Statement* wintering birds are considered as a terrestrial species. There is no notable foreshore habitat for wintering birds on or immediately adjacent to the site. A narrow strip of

[i] SINC (Grade M) = Site of Importance for Nature Conservation (Grade III of Metropolitan importance).

[ii] SINC (Grade L) = Site of Importance for Nature Conservation (Grade I of Local Importance)

foreshore is exposed at the lowest seasonal tides and therefore this habitat is not considered to be important for wintering birds.

6.4 Overview

6.4.1 It is confirmed that there is no potential for likely significant effects on terrestrial ecology arising from the construction or operation of the proposed development at Victoria Embankment Foreshore as the site comprises habitats of limited ecological value and therefore the proposed development is unlikely to result in significant adverse effects on notable species.

6.4.2 Replacement tree planting would be provided for those trees removed during works at Victoria Embankment Foreshore site. In the unlikely event that sensitive receptors are found on site during construction, such as nesting birds, management measures in line with the *Code of Construction Practice* (*CoCP*)[iii] would be implemented in conjunction with the contractors' site specific *Ecological and Landscape Management Plan*.

6.4.3 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately one year, it is not anticipated that the ecological value of the site described in Section 6.3 would change and therefore this site would remain scoped out.

[iii] The Code of Construction Practice (CoCP) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 7: Historic environment

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

Hard copy available in

Box **31** Folder **A**
January 2013

Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 7: Historic environment

List of contents

Page number

7 Historic environment ... 1

7.1 Introduction ... 1

7.2 Proposed development relevant to the historic environment ... 2

7.3 Assessment methodology ... 7

7.4 Baseline conditions ... 18

7.5 Construction effects assessment ... 35

7.6 Operational effects assessment ... 41

7.7 Cumulative effects assessment ... 43

7.8 Mitigation ... 43

7.9 Residual effects assessment ... 45

7.10 Assessment summary ... 47

References ... 57

List of plates

Page number

Vol 17 Plate 7.4.1 Historic environment - view north from Hungerford Bridge south west towards Whitehall Conservation Area ... 27

Vol 17 Plate 7.4.2 Historic environment - view north-east from gangway of Tattershall Castle towards Embankment Wall ... 29

Vol 17 Plate 7.4.3 Historic environment - view north-east from within Victoria Embankment Gardens towards the site ... 31

Vol 17 Plate 7.4.4 Historic environment - view north along Victoria Embankment towards Savoy Conservation Area. The Shell Mex Building is at the centre of the photograph ... 33

Vol 17 Plate 7.4.5 Historic environment - view south from Hungerford Bridge along Victoria Embankment towards the Palace of Westminster WHS ... 34

Vol 17 Plate 7.4.6 Historic environment - view north from Westminster Bridge adjacent to the Palace of Westminster WHS towards Hungerford Bridge 34

List of tables

Page number

Vol 17 Table 7.3.1 Historic environment – consultation response 8
Vol 17 Table 7.10.1 Historic environment – summary of construction assessment. 47
Vol 17 Table 7.10.2 Historic environment – summary of operational assessment... 54

7 Historic environment

7.1 Introduction

7.1.1 This section presents the findings of the assessment of the likely significant effects on the historic environment of the proposed development at the Victoria Embankment Foreshore site. The historic environment is defined in para. 4.10.2 of the NPS as including all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora. For the purposes of this assessment, heritage assets comprise below and above-ground archaeological remains, buildings, structures, monuments and heritage landscapes within and around the site. Effects during construction and operation are assessed with effects on below-ground assets presented first, followed by above-ground assets.

7.1.2 Based on a review of the noise and vibration assessment (Section 9), it is concluded that there would be no significant noise or vibration effects requiring offsite mitigation to any listed building. Such effects are therefore not considered further in this assessment.

7.1.3 The construction assessment includes an assessment of the effects of ground movement generated by tunnelling and deep excavations (in this case ground settlement). As the ground movement would be generated by construction activity and any damage would be greatest for the period of construction, an assessment has not been undertaken of operational effects on above ground heritage assets from ground movement. An assessment of effects from ground movement resulting from the whole Thames Tideway Tunnel project is covered in Vol 3 Project wide effects.

7.1.4 Once the proposed development is operational, scour protection around foreshore structures would prevent scour affecting heritage assets. In the deeper mid channel of the river, where contraction scour may occur, it is unlikely that archaeological remains would be present. The operational phase would not involve any activities below-ground aside from maintenance confined within the tunnel infrastructure. For these reasons, an assessment has not been undertaken of operational effects on buried assets.

7.1.5 A separate but related assessment of effects on townscape character and visual amenity is included in Section 11 Townscape and visual.

7.1.6 The assessment of the historic environment effects of the project has considered the requirements of the National Policy Statement for Waste Water (NPS). As such the assessment covers designated and non-designated assets, and a description of the significance of each heritage asset affected by the proposed development and the contribution of their setting to that significance. The assessment covers both above and below ground assets. The effect of the proposed development on the significance of heritage assets is clearly detailed in line with the requirements of the NPS. The role of the design process in helping to minimise effects on the historic environment is explained, and where appropriate, mitigation is proposed. Vol 2 Section 7 provides further details on the methodology.

7.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

7.2 Proposed development relevant to the historic environment

7.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to the historic environment are set out below.

Construction

7.2.2 The method of construction for the proposed development is described in Section 3. All below-ground works during construction are relevant to the assessment of effects on built and buried heritage because they would potentially truncate or entirely remove any archaeological assets within the footprint of the works, or cause ground movement that could potentially induce damage to the listed heritage asset. These are described below.

7.2.3 Site fencing would be erected, supported by timber posts in concrete foundations. A site office and welfare facilities would be constructed over part of the Embankment pavement (see Construction phase 1 plan, separate volume of figures - Section 1), assumed for the purposes of this assessment to be set on foundations with a depth of approximately 1.0 metres below ground level (mbgl). The diversion of existing services and the construction of new service trenches would extend to a depth of approximately 1.5mbgl.

7.2.4 Demolition works would require the removal of part of the parapet and lower structure of the Grade II listed riverside wall, including the removal of three ‘sturgeon’ lamp standards, which form part of the listed structure. Three Grade II listed catenary lamp standards and four Grade II listed decorative benches would be temporarily removed from the Embankment pavement for the duration of the construction works. Seven London plane trees along the pavement of the Embankment would be removed (see Demolition and site clearance plan 1 and 2, separate volume of figures - Section 1).

7.2.5 All works to listed structures are shown on the following plans:

a. As existing landscape plan 1 and 2 (see separate volume of figures - Section 1)

b. As existing listed structure interface - foreshore structure (see separate volume of figures - Section 1)

c. Proposed listed structure interface - foreshore structure (see separate volume of figures - Section 1)

d. As existing and proposed listed structure interface weir structure (see separate volume of figures - Section 1)

7.2.6 The Tattershall Castle vessel would be relocated to the south of its current mooring during construction, and permanently relocated to a position south of its current location during operation. Access to the ship would be removed, and rebuilt. Piles for access gangways would be removed and rebuilt. An access ramp would be constructed along the adjacent river embankment. Two service moorings would be removed. These superficial works are assumed for the purposes of the assessment to entail no significant ground disturbance. The Hispaniola vessel, adjacent to the site on its northern side would remain in this location (see Demolition and site clearance plan 1, separate volume of figures - Section 1).

7.2.7 A temporary cofferdam would be built on the Thames foreshore to provide a working area for construction works on the eastern side of the riverside wall (see Construction phase 2 plan, separate volume of figures - Section 1). A permanent cofferdam to contain the new permanent installations would be built within it. A campshed for the delivery and removal of materials by barge would be built on the Thames foreshore and riverbed.

7.2.8 For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdam and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. It is assumed for the assessment that the majority of foreshore material within the temporary cofferdam would remain *in situ*. Removal of the soft material would ensure that any settlement of the cofferdam fill material would not adversely affect the ties between the walls of the twin walled temporary cofferdam leading to structural difficulties, and to ensure sound foundations for permanent construction. The exact extent and depth of the foreshore deposits to be removed at each site would be informed by geotechnical investigations. Areas of removed material would be filled with gravel similar to the existing bed material. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer, to a total average depth of 8.5m as assumed for the purposes of this assessment. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore.

7.2.9 The cofferdams would be inserted into slots cut into the river wall, and would be constructed from a jack-up barge located in the River Thames. The supports of the jack-up barge would sit on the river bed.

7.2.10 All alluvium and other soft deposits would be removed from the footprint of the campshed to a depth of 0.3m, as assumed for the purposes of this assessment. The area of the foreshore where permanent scour protection is required would be excavated to a depth of approximately 1.5m by an excavator.

7.2.11 The permanent structures would include deep excavations for the construction of a combined sewer overflow (CSO) shaft. Other below ground structures would be contained within the cofferdam fill material within the permanent foreshore structure. A permanent outfall apron 1.0m deep would be constructed within the footprint of the temporary cofferdam up to 0.5m below the foreshore level, as assumed for the purposes of this assessment (see Site works parameter plan, separate volume of figures - Section 1).

7.2.12 The installations connecting the existing Northern Low Level Sewer to the new CSO shaft would be located and built within the zones shown on the site works parameter plan (see separate volume of figures - Section 1).

7.2.13 Ground intrusion from tree planting and root action, and paving as part of landscaping works is assumed for the purposes of this assessment to reach a depth of approximately 1.5mbgl (see Site works parameter plan, separate volume of figures - Section 1).

7.2.14 The specific construction activities which may give rise to effects on the historic character, appearance and setting of heritage assets are:

a. removal of several ‘sturgeon’ lamp standards, catenary lamps, decorative benches and part of the granite parapet along the Embankment Wall

b. the relocation of the Tattershall Castle to a mooring south of its present location

c. establishment of hoardings around the boundary of the construction site

d. use of cranes and other plant during shaft construction sinking and secondary lining of the tunnel

e. provision of welfare facilities

f. lighting of the site when required.

Code of Construction Practice

7.2.15 Measures incorporated into the *Code of Construction Practice* (*CoCP*) Part A (Section 12) to protect heritage assets include:

a. The requirement for the contractor to prepare a site-specific *Heritage Management Plan* (HMP), indicating how the historic environment is to be protected. This may take form of both physical protection and working practices. It would also address any effects from third-party impacts, vibration, ground movement and dewatering.

b. Protective measures, such as temporary support, hoardings, barriers, screening and buffer zones around heritage assets, and archaeological mitigation areas within and adjacent to worksites.

c. Advance assessment to inform the types of plant and working methods for use where heritage assets are close to worksites, or attached to structures that form parts of worksites.

d. Where elements to be demolished are attached to listed structures being retained, they would be separated where practicable, prior to demolition, using non-vibratory techniques such as diamond sawing.

e. Care shall be taken when jack-up barges; piling or borehole rigs; mechanical excavators or other plant is operating over areas of the river channel or foreshore known to be particularly archaeologically sensitive. In exceptional cases exclusion zones may apply. Safeguards may include appropriate methods for installing and operating plant, and the use of suitable foreshore protection.

f. Condition surveys to define ground movement and vibration limits for heritage assets potentially affected by the works - to include monitoring regimes and provision for cessation of works where feasible, should levels exceed the specified limits.

g. Procedures under EPP for the emergency repair of damage to listed buildings. Where there is damage that does not require emergency repair, repair would be affected as making good as part of the construction process. Final repairs to significant finishes would be 'like for like'.

h. Security procedures to prevent unauthorised access to heritage assets and archaeological investigations, and damage to or theft from them, including by the use of metal detectors.

i. Procedures in the event of the discovery of human remains.

j. Procedures under the Treasure Act Code of Conduct 1997, to address the discovery of any artefacts defined in the Treasure Act 1996.

7.2.16 The *Code of Construction Practice (CoCP)* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

7.2.17 Section 13 of the *CoCP* details the approach to third party impact and the asset protection process in relation to ground movement. This includes measures for the contractor to undertake a condition survey of the relevant infrastructure and buildings prior to commencing works that could impact them. The contractor would put in place protection measures during construction to minimise the impact to third-party infrastructure and buildings as a result of ground movement. Monitoring would be carried out prior to commencement of construction work to enable baseline values to be established and would continue until any significant ground movement due to the works, as shown by the monitoring, has effectively ceased. Post condition surveys would be carried out, as well as installation of instrumentation and monitoring to confirm that ground movements is as predicted and acceptable. An Emergency Planning and Response Plan would be developed in conjunction with the asset owner to include relevant contingency plans and trigger levels for action.

7.2.18 Site specific measures incorporated in the *CoCP* Part B (Section 12) comprise:

a. intrusive structural investigations to the listed river wall, beyond the area of proposed fabric removal.

b. Existing granite blocks are to be used to make up the joint between new and old river wall sections.

c. The sturgeon lamp stands would be removed and their reuse sought in accordance with the procedures set out in the *Heritage Statement*.

7.2.19 All the measures detailed above form part of the proposed development subject to the assessment, and therefore impacts such as strike damage on heritage assets are considered unlikely to occur and are not assessed. However, site specific measures to mitigate effects on buried heritage, which would be detailed in *Site Specific Archaeological Written Scheme of Investigation (SSAWSI)*, in line with the *Overarching Archaeological Written Scheme of Investigation (OAWSI)* (Vol 2 Appendix E.2), would be subject to the findings of field evaluation, and are therefore reported as mitigation as detailed further in para 7.8.4.

Operation

7.2.20 The operation of the proposed development at Victoria Embankment Foreshore site is described in Section 3. The particular components of importance to this topic include the scale of the foreshore structure, design of the public realm and the design and siting of the proposed ventilation structure and electrical kiosk (see Site works parameter plan, separate volume of figures - Section 1).

7.2.21 The operational design has been developed through close liaison with stakeholders, including the local authority and English Heritage, and in response to early iterations of the environmental impact assessment, through a series of design workshops, as well as in response to other design factors, such as operational requirements. The design process has therefore helped to minimise effects on the character, appearance and setting of heritage assets. Such design decisions are 'embedded' within the development which has been assessed. Alternatives to the proposed development, including design iterations, are fully detailed in Section 3 of this volume.

Historic environment design measures

7.2.22 A high quality design in keeping with the character of the surrounding townscape has been proposed for the development of this site to minimise adverse effects on the historic character, appearance and setting of heritage assets in accordance with the design principles set out in Vol 1 Appendix B. Generic design principles of relevance to the historic environment at this site include the following, as they would inform the design and appearance of the operational infrastructure:

a. All the principles that apply to the site with respect to the integration of functional component principles because they would inform the appearance of the completed operational infrastructure at the site.

b. All the heritage design principles that apply to the site.

c. All the principles dealing with riparian and in-river structures regarding appearance and functionality which apply to the site.

d. All of the landscape principles which apply to the site. These relate to matters including hard and soft landscaping, materials and public accessibility.

e. All the lighting principles apply at the site. These are related to matters that include safety, aesthetic effects and the quality of fittings.

7.2.23 The following site specific design principles are also relevant:

a. The new river wall would be finished in granite blocks to tie in with existing.

b. Replacement trees planted on the existing embankment would be semi-mature London Planes.

c. The sturgeon lamp standards would be reinstated in their current position as far as possible.

d. The decorative benches to the embankment would be reinstated in their current positions as far as possible.

e. Proposed seating would be positioned to maximise views over the river and of the Palace of Westminster World Heritage site.

f. The kiosks would be clad in natural stone appropriate to their setting and include a planted roof.

g. Access ramps to relocated moorings would be like for like. They would bridge over the river wall with minimum physical and visual impact on the listed structure.

h. The festoon lighting to Victoria Embankment would be reinstated as far as possible. This would terminate either side of the structure.

i. The electrical and control kiosk(s) would be located on the line of the existing river wall.

j. Paving materials would be of natural stone appropriate to the setting.

k. The central part of the public realm would be raised to flood defence level to create viewing platforms facing towards the Palace of Westminster World Heritage Site.

l. The railing design to the front projecting area would be visually unobtrusive and unglazed.

m. Timber fenders would not be appropriate to the character of this stretch of the river wall and would not be provided.

n. The design (including planting and maintenance of trees, public furniture and railings) would respect the character of the historic environment along this stretch of river.

7.3 Assessment methodology

Engagement

7.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of the historic environment are presented here. Throughout the environmental impact assessment (EIA) there has been regular liaison with English Heritage and other stakeholders. Vol 17 Table 7.3.1 summarises the comments raised by consultees and how each comment has been addressed.

7.3.2 In addition to the consultation detailed in the table below, the design at this site has been developed in light of ongoing consultation, which has been undertaken throughout the pre-submission phase, with consultees including English Heritage and the Westminster City Council. Consultation has highlighted the prime historic environment design considerations and helped to guide the direction of design development.

7.3.3 It was recognised that an orthogonal plan design for the combined interception and CSO drop shaft foreshore structure was appropriate for its location on Bazalgette's Victoria Embankment as other projections from the river wall in this location, are also orthogonal. The sensitivity of the embankment's significance also dictated that granite was the appropriate facing material for the foreshore structure and that design references should acknowledge the primacy of the embankment wall line. English Heritage and Westminster City Council, felt that the asymmetry of an earlier design iteration was not appropriate and that the extent that the structure projected into the river was a concern. An alternative design was produced with a shallower symmetrical orthogonal projection into the river, from which a bridge extended to a circular island accommodating the CSO drop shaft. The consultees felt that the circular island and bridge were inappropriate and the proposed design of an orthogonal, symmetrical foreshore structure, which projects less far into the river than the originally designed orthogonal structure, was developed. The ventilation columns were seen as an appropriate signature feature by the consultees. Westminster City Council asked whether an inshore option was possible. English Heritage confirmed that using Victoria Embankment Gardens would be inappropriate.

Vol 17 Table 7.3.1 Historic environment – consultation response

Organisation and date	Comment	Response
English Heritage Comments on draft environmental information for Victoria Embankment (letter dated 8 August 2011)	English Heritage is satisfied with the baseline assessment of buried heritage assets, the impacts identified and the mitigation proposed.	Noted.
	Notable above ground receptors need to be assessed: the Westminster World Heritage Site and other key heritage assets such as the Grade II* listed National Liberal Club and Grade II* registered Victoria Embankment Gardens.	Effects on the character, appearance and setting of these assets are assessed in Section 7 of Vol 17 of the *Environmental Statement*.

Organisation and date	Comment	Response
English Heritage - methodology workshop (November 2011)	The assessment of effects on receptor setting should consider the contribution of setting to asset significance.	This assessment details the contribution made by setting to asset significance.
English Heritage Phase Two response (February 2012)	EH strongly opposes the proposed relocation site of Tattershall Castle ship because of its potential visual impact on the World Heritage Site.	An assessment of likely significant effects on the setting of the World Heritage Site has been undertaken and concludes that there would be no significant adverse effects.
	Whitehall Court and National Liberal Club require mention as two distinct Grade II* listed assets (not Grade II listed).	Baseline conditions are described in Section 7.4 of the *Environmental Statement.* This acknowledges that these assets are separately listed as Grade II*.
	Significance of Whitehall Court and National Liberal Club to be discussed, including noise and vibration impacts.	The significance of these assets is discussed in para. 7.4.55, and the effects upon their settings are assessed in the sections on Whitehall Conservation Area (paras. 7.5.20 and 7.6.1). Based on a review of the noise and vibration assessment (Section 9 of this volume), there would be no significant noise or vibration effects requiring offsite mitigation to any listed building. This is therefore not considered further in this assessment.
	Discussion of World Heritage Site required.	Effects on the Palace of Westminster WHS from construction and operation are assessed and presented in this section of the *Environmental*

Organisation and date	Comment	Response
		Statement.
	Preservation by record is not in itself sufficient mitigation, where moderate effects remain, indicating a need for additional mitigation or enhancement, eg, offsetting enhancement for York Water Gate.	This assessment recognises that recording would reduce the severity of adverse effects, as agreed by English Heritage at the November 2011 methodology meeting, although it would not remove adverse effects entirely. The design principles include a commitment to including interpretation of the historic environment to enhance understanding of the historic environment which would further contribute to mitigation of effects. EH have indicated (at a meeting on 2 May 2012) that enhancement for York Water Gate is not required.
Westminster City Council (phase two consultation response, February 2012)	Importance of listed building heritage assets, settings and views to be assessed.	This assessment describes the asset significance of listed buildings and their settings, and assesses the effect of the proposed development at Victoria Embankment on these assets. Effects on townscape character and views are separately assessed in Section 11 Townscape and visual.
	Potential impact from truncation of Embankment Wall to be assessed	The effect of the proposed development on the listed Embankment Wall has been assessed and is presented in this assessment.
	Care needed during construction works for Embankment assets, such as sturgeon lamps, including both those in	The *CoCP* Part A (Section 12) includes measures to protect these designated assets.

Organisation and date	Comment	Response
	situ and storage and those temporarily removed.	
	Potential scour effects on river wall and bridges from temporary and permanent works.	This assessment assesses effects arising from scour around temporary structures, and sets out appropriate mitigation. Once operational, scour protection around foreshore structures would prevent scour affecting heritage assets.
Meeting with Westminster City Council and English Heritage 16th May 2012	Following alternative design for the CSO drop shaft on a small island, Westminster City Council expressed concern over the design and asked if there were any shore based options, as justification was needed for intrusion into the river	A shore based option was not considered viable due to the environmental constraints of inshore heritage assets which are very sensitive to development.
	English Heritage stated their support for a more symmetrical option, and concern over the island option.	The proposed design has been amended to a symmetrical orthogonal structure.
	English Heritage confirmed their view that the use of the Embankment Gardens was unacceptable	This was noted and improvement of the foreshore design was therefore progressed.
English Heritage response to Targeted Consultation (July 2012)	Setting of heritage assets should be considered, together with stronger treatment of visual impacts.	This assessment includes an assessment of likely significant effects on the setting of heritage assets. The assessment of townscape and visual effects is included in Section 11 of this volume.
English Heritage response to Section 48	The ES would benefit from explaining that the design at this site is the result of rigorous design	The design iteration process, including consultation with stakeholders in relation to

Organisation and date	Comment	Response
publicity (October 2012)	iterations to arrive at a form which is complementary to the historic environment in this location.	the historic environment, is set out in paras 7.3.2 and 7.3.3 of this assessment, and consideration of alternatives is also detailed in Section 3.
	English Heritage believes the relocation of the Tattershall Castle would have an adverse impact if it is placed within the view along Horse Guards' Parade.	The effect of relocating the Tattershall Castle is assessed in the ES. This was further discussed with EH at a meeting on 11th October 2012. It was explained that the vessel would now be slightly off the line of Horse Guards Parade, which would have less effect. EH confirmed that this was a better arrangement and acceptable in visual terms.
	English Heritage would welcome an explanation of why, in the assessment for this site, the historic environment impacts on some heritage assets differ from the townscape impacts.	Such differences arise due to differences in the methodologies applied, which reflect the different foci and purposes of the assessments. Where these differences exist, the historic environment assessment includes an explanation.
	English Heritage requests that the assessment includes the broader visual envelope and acknowledges the many prominent landmarks, the World Heritage Site and its setting, protected views, and the international renown of this stretch of the Thames.	Section 7 of Vol 17 of the ES takes account of the wider context, the setting the World Heritage Site and protected views. It acknowledges the internationally-renowned character of the Thames at this point.
Westminster City Council response to Section 48	The site is in a very sensitive townscape location, with a large number of listed	This assessment assesses effects on all heritage assets in the vicinity, where they lie within the zone of

Organisation and date	Comment	Response
publicity (October 2012)	buildings, a registered garden, and other heritage assets nearby, including the Westminster World Heritage Site. The Council feels there is merit in a design which reflects the line of the embankment wall in the form of an orthogonal and symmetrical plan. Any ventilation columns should be appropriately designed to minimise harmful impact on the settings of heritage assets and wider views.	theoretical visibility and could be subject to likely significant effects. The proposed development reflects the line of the embankment wall, and the assessment considers its likely significant effects upon all relevant heritage assets and their settings, as well as views along and around the riverfront. Effects on townscape character and views are assessed in Section 11 Townscape and visual.
	The Council considers the proposals to relocate the Tattershall Castle would cumulatively have a significant and detrimental impact on the listed river wall and upon views of the river, as well as the setting of the World Heritage Site.	This assessment assesses the effect of the relocation of the Tattershall Castle and its impact upon the historic character and settings of heritage assets in the vicinity.

Baseline

7.3.4 The baseline methodology follows the methodology described in Vol 2. It should be noted that whilst most topics within the ES use the term 'value' to define the sensitivity of environmental receptors within the baseline, the historic environment assessment uses 'asset significance' as per the terminology used within the NPS. Distinction is made between the significance of the resource, i.e. asset significance, and the significance of the environmental effect throughout the following assessment.

7.3.5 Baseline conditions for above and below-ground assets are described within a 350m-radius area around the centre point of the site, which is considered through professional judgement to be most appropriate to characterise the historic environment potential of the site. There are occasional references to important assets beyond the baseline area, for example, Westminster Palace, which lies within the World Heritage site approximately 580m to the southwest of the site, which contributes to the current understanding of the site and its environs in the later medieval period. The World Heritage site of the Palace of Westminster and Westminster Abbey including St Margaret’s Church (from here on referred to as the Palace of Westminster WHS) lies south of Bridge Street which is approximately 500m south of the site (Westminster City Council, 2007)[1].

7.3.6 The assessment area for the assessment of effects on the historic character and setting of above-ground heritage assets has been defined using professional judgement by identifying heritage assets within the Zone of Theoretical Visibility (ZTV), generated as part of the townscape and visual assessment, whose settings have the potential to be significantly affected by the proposed development. The setting of these assets is then described in the baseline. Where appropriate this assessment area extends beyond the 350m radius baseline area described above. In addition, Views of Heritage Value (VHV) considered important for understanding the historic character and setting of heritage assets have been identified. These are drawn from the Whitehall Conservation Area Audit (Westminster City Council) and from professional judgement based on observation and understanding of historic context and architectural purpose and design.

7.3.7 Site visits were carried out at low tide in March and April 2011 to identify assets on or adjacent to the site. Access to the river side of the river wall was not available so the site was viewed from Victoria Embankment and Hungerford Bridge. An additional site visit was carried out in January 2012 to identify assets for inclusion within the assessment of effects on setting.

Construction

7.3.8 The assessment methodology for the construction phase follows that described in Vol 2, Section 7. There are no site specific variations for undertaking the construction assessment of this site.

7.3.9 In terms of physical effects on above or below-ground assets, likely significant effects could arise throughout the construction phase. Effects arising from all stages of the construction period are therefore assessed. The construction assessment area for such effects is defined by the site boundary, or in the case of ground movement to the extent of settlement up to 1mm.

7.3.10 In terms of effects on the character and setting of above-ground heritage assets, while there would be effects throughout the construction period the peak construction phase is Site Year 2, when the shaft would be under construction and cranes would be present at the site. This has been used as the assessment year for effects on the character and setting of heritage assets. It should be noted that in some instances, the townscape and visual assessments may differ to the historic environment assessments despite the receptors being largely coincident. This is due to the different value / sensitivity that may be attributed to a receptor and also due to consideration of different factors when assessing the magnitude of change and significance of effect (the reasoning is explained in each assessment). The construction assessment area is as described in para. 7.3.6.

7.3.11 Section 7.5 details the likely significant effects arising from the construction at the Victoria Embankment Foreshore site. In addition to these, the works proposed by the Thames Tideway Tunnel project at the

Blackfriars Bridge Foreshore site would give rise to additional effects on the historic environment within the assessment area for this site. Therefore the combined effects of construction at Victoria Embankment Foreshore and Blackfriars Bridge Foreshore are considered in this assessment.

7.3.12 In terms of the construction base case, archaeological remains are a static resource, which have reached equilibrium with their environment and do not change (i.e., decay or grow) unless their environment changes as a result of human or natural intervention. At this site ongoing fluvial erosion may be changing the archaeological baseline within the foreshore area, only a small area of which is visible at low tide. However, the rate of erosion is not known so the base case is assumed to be as per the baseline. Whilst the baseline within the baseline area beyond the site may change as a result of any archaeological excavation and recording carried out as part of a standard programme of mitigation for other developments in the site development schedule (Vol 17 Appendix N), such information is unlikely to significantly change the current understanding of the historic environment of the site. Any changes to the surrounding baseline would not affect the assessment and are not detailed further within the construction base case. Furthermore none of the schemes in the site development schedule (Vol 17 Appendix N) would lead to physical changes in above or below-ground heritage assets within the Victoria Embankment Foreshore site.

7.3.13 None of the schemes included in the site development schedule (Vol 17 Appendix N) would change the existing baseline in terms of historic character and setting of above-ground assets given the relative scale and distance of these schemes from the site and the presence of intervening structures. The London Eye Pier Extension would occur on the other side of the river around 160m away from the site, and would not be of sufficient scale to alter the setting of nearby assets. The other schemes in the development schedule would also not change the baseline, as they are a minimum of 570m from the site and consist of large mixed use schemes in heavily built-up areas of central London. Therefore the construction base case remains as per the baseline detailed in Section 7.4.

7.3.14 As detailed in the site development schedule (Vol 17 Appendix N) no schemes have been identified within 1km of the site, which meet the criteria (see Vol 2 Section 3.8) for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken for the construction phase.

7.3.15 The assessment of construction effects on the character, setting and appearance of heritage assets also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year, for example due to changes in schemes which form part of the base case or cumulative assessment. In the case of buried heritage, as described above, whilst the baseline within the baseline area beyond the site may change as a result of any archaeological excavation and recording carried out as part of a standard programme of mitigation for other developments, such information is unlikely to significantly change the current understanding of the historic environment of the site. Therefore a delay to the Thames Tideway Tunnel project, with a consequent change in other schemes which may have been developed by the time of Thames Tideway Tunnel construction, would not lead to any change in the archaeological baseline and therefore no change in the assessment of effects on these assets.

Operation

7.3.16 The assessment methodology for the operational phase follows that described in Vol 2. There are no site specific variations for undertaking the operational assessment of this site which is based on an assessment in Year 1 of operation, when the development's full effect upon its surroundings would be evident. As with the construction assessment, it should be noted that in some instances the townscape and visual assessments may differ to the historic environment assessments of the operational phase, despite the receptors being largely coincident. This is due to the different value / sensitivity that may be attributed to a receptor and also due to consideration of different factors when assessing the magnitude of change and significance of effect (the reasoning is explained in each assessment). The operational assessment area is as described in para. 7.3.6 above.

7.3.17 As stated in para. 7.3.11 the proposed development at the Blackfriars Bridge Foreshore site would give rise to additional effects on the assessment of the historic environment at this site. Therefore the combined effects of the works at Victoria Embankment Foreshore and Blackfriars Bridge Foreshore sites are considered.

7.3.18 None of the schemes included in the site development schedule (Vol 17 Appendix N) would change the existing baseline in terms of the character and setting of above-ground heritage assets given the distance of these schemes from the site and the presence of intervening structures. As noted above the London Eye Pier Extension would occur on the other side of the river around 160m away from the site, and would not be of sufficient scale to alter the setting of nearby assets. The other schemes in the development schedule would also not change the baseline, as they are a minimum of 570m from the site and consist of large mixed use schemes in heavily built-up areas of central London. Therefore the operational base case remains as per the baseline detailed in Section 7.4.

7.3.19 As detailed in the site development schedule (Vol 17 Appendix N) no schemes have been identified within 1km of the site, which meet the criteria (see Vol 2 Section 3.8) for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken for the operational phase.

7.3.20 The assessment of operational effects on the character, setting and appearance of heritage assets also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year, for example due to changes in schemes which form part of the base case or cumulative assessment.

Assumptions and limitations

7.3.21 The assumptions and limitations associated with this assessment are presented in Vol 2. Site specific assumptions and limitations are detailed below.

Assumptions

7.3.22 The assessment of effects on buried heritage assets is based on the shaft and other below-ground structures being located anywhere within the zones identified on the permanent works plan for these structures (see Site works parameter plan, separate volume of figures - Section 1). For this site the assessment is not sensitive to variations in location within these zones because the desk-based assessment has not identified any buried heritage assets of high significance within the site, which would warrant preservation *in situ* and because any significant heritage assets would be archaeologically excavated and recorded after insertion of the temporary cofferdam.

7.3.23 A number of assumptions have been made regarding the likely depth of temporary construction works (e.g. footings for hoarding and service trench depths), based on professional knowledge of construction projects. Whilst the precise nature of construction effects on buried heritage would vary if the depths varied, the mitigation proposed to address any effects would remain as stated, as would the residual effects. These assumptions of likely depths are detailed in Section 7.2.

7.3.24 Vol 2 details assumptions made regarding the predicted impact of compression of potential archaeological assets within the foreshore from temporary cofferdam fill material. For the purposes of this assessment it has been assumed that where archaeological remains within the foreshore could contain voids, and/or are made of porous/organic material (timber structures/objects such as wattle, fishtraps, and peat), the compression predicted to occur is likely to cause some damage. Where such remains could be solid, non-porous or inorganic without voids, such as metal, stone, flint or brick, the compression is generally unlikely to lead to damage.

7.3.25 The assessment of effects on the historic character and setting of above-ground heritage assets is similarly based on the proposed above-ground structures being located anywhere within the zones for these structures. For this site the assessment is not sensitive to variations in location within these zones because of the open character of the surrounding townscape.

7.3.26 Assumptions relating to the assessment of effects arising from ground settlement are detailed in the project wide assessment in Vol 3 Section 7.

Limitations

7.3.27 A limitation of the assessment is that no intrusive archaeological investigation has been carried out on the site in the past and few investigations have been carried out in the immediate vicinity (ie, within

100m). Nevertheless the assessment is considered to be robust and in accordance with best practice.

7.3.28 There has also been little research into the effects of compression of buried heritage assets within foreshore alluvium from fill material placed on top of such deposits. Professional judgement has been used to estimate the likely impacts on different archaeological remains within the foreshore, and the assessment is considered to be robust.

7.4 Baseline conditions

7.4.1 The following section sets out the baseline conditions for the historic environment within and around the site. Future baseline conditions (base case), which would remain as per the baseline, are also described. The section comprises seven sub-sections:

a. a description of historic environment features within the 350m-radius baseline area

b. a description of statutorily designated assets within the site and baseline area. Locally designated assets and known burial grounds are included, where relevant, as described in Volume 2

c. a description of the site location, topography and geology

d. a summary of past archaeological investigation, providing an indication of how well the area is understood archaeologically

e. a chronological summary of the archaeological and historical background of the site and its environs

f. a statement of significance for buried heritage assets, taking account of factors affecting survival.

g. a statement of significance for above-ground assets within and around the site, describing the features which contribute to their significance, including historic character, appearance and setting.

Current baseline

Historic environment features

7.4.2 The historic environment features map (Vol 17 Figure 7.4.1, see separate volume of figures) shows the location of known above-ground and buried historic environment features within the baseline area, compiled from the baseline sources set out in the methodology in Vol 2. These have been allocated a unique historic environment assessment reference number (HEA 1, 2, etc), which are listed in the gazetteer in Vol 17 Appendix E.1. It should be noted that the baseline for the assessment of effects on the character, appearance and setting of heritage assets is informed by professional judgement and the ZTV, with assets described in 'Statement of significance: above-ground heritage assets' later in this section.

Designated assets

International and national designations

7.4.3 The site contains seven Grade II listed catenary lamp standards (HEA 1A), dating to c. 1900. These are cast-iron posts that were originally erected to supply electricity for roadside street lamps suspended between them as part of a series of such standards extending the full length of Victoria Embankment, on both sides of the road.

7.4.4 The site also contains part of the listed Grade II Victoria Embankment river wall including the 'sturgeon' lamp standards (HEA 1D). It was constructed between 1865 and 1870 to designs by Sir Joseph Bazalgette and formed part of his grand scheme which incorporated a new sewerage system, utility subway, public parks and new roads providing alternative routes for traffic to the Strand and Fleet Street. The river wall within the site includes the original sewer outfall, which is an arched structure. A series of cast-iron 'sturgeon' (also known as 'dolphin') lamp standards with globe lanterns and festoon lights along the line of the Embankment Wall, are included in the Embankment listing. The lamp standards were designed by Timothy Butler, and date to around 1870.

7.4.5 The site also contains four of a total of 21 Grade II listed decorative benches, installed 1872-1874 and designed by Lewis and GF Vulliamy, most of which have a sphinx design and one of which is of a camel design.

7.4.6 Other statutorily designated assets close to (within 100m of) the site include the Grade II listed memorials to Samuel Plimsoll (HEA 27), Sir W. S. Gilbert (HEA 28) and Sir Joseph Bazalgette (HEA 29), the Grade II listed statues of General Gordon (HEA 38), Sir Bartle Frere (HEA 39), Lord Trenchard (HEA 108), Sir James Outram (HEA 31) and William Tyndale (HEA 32) within Victoria Embankment Gardens (which is a registered park and garden), the Grade I listed Queen Mary's Steps (HEA 33) and Ministry of Defence building (HEA 34), the Grade II* listed National Liberal Club (HEA 35) and Whitehall Court (HEA 36), and the Grade II listed Playhouse Theatre (HEA 37), and Royal Air Force Memorial, Whitehall Stairs (HEA 40).

7.4.7 The Palace of Westminster WHS is an internationally designated asset. It lies approximately 500m to the south of the Thames Tideway Tunnel project site.

7.4.8 The Tattershall Castle is on the Register of Historic Ships. Although this designation has no statutory protection it is indicative of the ship's significance.

Local authority designations

7.4.9 The site lies within the Whitehall Conservation Area, a significant element of which is the riverfront and the Victoria Embankment. The adjacent Savoy Conservation Area includes that part of Hungerford Bridge which lies just to the north. The site falls within the Saxon Lundenwic and Thorney Island Area of Special Archaeological Priority. The significance of all relevant assets is described further in the 'Statement of Significance; above ground heritage assets' below in paras 7.4.36 - 7.4.58.

Known burial grounds

7.4.10 There are no known burial grounds within the site or adjacent to it.

Site location, topography and geology

7.4.11 The majority of the site lies within the River Thames, whilst its western boundary includes the Victoria Embankment river wall and the pedestrian pavement alongside (HEA 1D). Ground level on the road at the top of the embankment lies at approximately 104.6m ATD (above Tunnel Datum). The foreshore of the River Thames is not visible, even at very low tide, except at the southernmost end of the site, where it is exposed at around 97.8m ATD.

7.4.12 The landward part of the site was formerly within the Thames and has been reclaimed from the river during the 19th century construction of the Embankment. Geotechnical borehole data from the vicinity suggests that as a result, there is likely to be approximately 6.0m depth of made ground comprising 19th century and later infill, on the landward side, overlying possibly another 2.0–3.0m depth of earlier foreshore and alluvium, over terrace gravel. On the riverward side, the present lack of a substantial visible foreshore and the relatively low level ATD suggests that the original basal alluvium may no longer survive due to a combination of modern dredging and fluvial scour effects. However, a vibro core to the eastern limit of the site (VC6632) records a possible Mesolithic organic silty clay from approximately 94.4m ATD. If the sediment is of a prehistoric date it may only survive in very localised areas having been dredged or scoured out by river action. The site topography and geology is discussed in more detail in Vol 17 Appendix E.2.

Past archaeological investigations

7.4.13 No archaeological investigations have taken place within the site. The nearest investigation to the site comprised a watching brief during dredging of the River Thames, beneath Hungerford Bridge in 1996 (HEA 30). Most of the material proved to be modern, although some material was thought to be of earlier origin.

7.4.14 Work carried out by the Thames Archaeological Survey (TAS) in 1996/7 on the opposite bank of the Thames recorded remains of a Palaeolithic forest, Palaeolithic wood and associated deposits, various post-medieval foreshore structures and artefact scatters, and 19th century organic deposits (HEA 13). Further details of past archaeological investigations carried out within the site and baseline area are included in Vol 17 Appendix E.3.

Archaeological and historical background of the site

7.4.15 The following section presents a chronological summary of the archaeological and historical background of the site. Further detail is included in Vol 17 Appendix E.4.

7.4.16 The site lies at the edge of a large delta formed by the confluence of the former Tyburn and Tachbrook tributaries with the Thames. This river system cut through the earlier Kempton Park Gravel Terrace to the west and created the former Thorney Island, now the site of Westminster Abbey and the Houses of Parliament. River tributaries were important features which would have been attractive for prehistoric (700,000 BC–AD 43) hunters, foragers and settlers, especially at confluences with the major rivers, such as the Thames. River tributaries would have provided natural communications routes and sources of fish, game and reeds. Alluvial and colluvial sedimentary in-wash into tributaries would tend to have created areas with high potential for palaeoenvironmental remains as well as other items associated with waterways such as boats, jetties and fish traps. Despite this background potential there is little evidence of such features because there have been few systematic archaeological investigations nearby.

7.4.17 The Greater London Historic Environment Record (GLHER) notes the chance find of Lower Palaeolithic animal remains (HEA 99) approximately 200m northwest of the site, and a Neolithic axe (HEA 79) approximately 100m to the west. Other chance finds, including a Mesolithic axe (HEA 70), 70m to the southeast, a Bronze Age palstave or axe (HEA 6), approximately 170m to the northeast of the site, and a Bronze Age chisel (HEA 25), approximately 100m to the east, were recovered from within the Thames channel and are therefore probably outside of the context in which they were originally deposited.

7.4.18 Throughout the Roman period (AD 43–410), following rising water levels in the late prehistoric periods, the site would have been submerged. The landscape adjacent to the river would have been rural in nature with open fields, possibly used for agriculture or pasture. Evidence for Roman activity within the baseline area is limited to an isolated chance find of a coin recovered from the Thames (HEA 26). The nearest known major Roman road to the site was approximately 340m to the northwest of the site. It is thought that there was an early ford crossing of the Thames between Lambeth and Thorney Island, and evidence of Roman occupation has been recorded on Thorney Island, approximately 430m to the southwest of the site. In 2005–6, an archaeological excavation at St Martin in the Fields church, approximately 420m to the northwest of the site, found part of a large industrial Roman tile kiln.

7.4.19 During the medieval period (AD 410–1485) the site was located adjacent to a stretch of the riverfront between the settlements at Thorney Island, approximately 700m to the south, and the trading port of Lundenwic, in the area now occupied by Aldwych, the Strand and Covent Garden, approximately 300m to the north. Westminster Palace, the main London residence of the kings of England, was located approximately 580m to the south of the site. During this period successive attempts were made to reclaim the low-lying land to the south of the site and along the riverfront by the construction of river banks, digging drainage ditches, and dumping soil. It is likely that a river wall was built along this stretch of the river to the west of the site, with associated drainage and reclamation. The site would have lain within the River Thames channel, permanently submerged and some 100m away from the later medieval embankment.

7.4.20 During the post-medieval period (AD 1485–present) the site would have continued to lie within the channel of the River Thames, whilst its adjacent north bank became developed as part of the expanding City of Westminster. Between 1864 and 1870 the construction of the Victoria Embankment took place as part of the major public infrastructure sewage works of Sir Joseph Bazalgette. This work reclaimed extensive land from the river and involved substantial excavations. The works brought the river wall right out to its present position. The scheme included a uniform line of London plane trees along the pavement 20ft apart adjacent to the river wall. Immediately to the north of the site and on the other side of Hungerford Bridge, were the 'Charing Cross Piers'. These were part of Bazalgette's design and were probably floating pontoons. By the end of the 19th century, the pier immediately north of the site was used as a floating fire engine station and by the 1920s it had become a fire brigade service depot. It was removed by the mid 20th century and replaced with the current permanent structure and stairs that extend down to the water. The site has remained largely unchanged since the late 1940s other than by the construction of the mooring and the gangway to the permanently moored Tattershall Castle vessel (HEA 1B), within the site, in the 1980s. Immediately to the north of the site but outside of it is the permanently moored Hispaniola (HEA 113).

Statement of significance: buried heritage assets on the site

Introduction

7.4.21 The following section discusses past impacts on the site which are likely to have compromised asset survival, generally from late 19th and 20th century developments, e.g., building foundations, identified primarily from historic maps, the site walkover survey, and information on the likely depth of deposits.

7.4.22 In accordance with the National Policy Statement for Waste Water (Defra, 2012)[2], National Planning Policy Framework (DCLG, 2012)[3] and PPS5 Planning Practice Guide (DCLG, 2010)[4], (which remains extant), this is followed by a statement on the likely potential for and significance of buried heritage assets within the site, derived from current understanding of the baseline conditions, past impacts, and professional judgement.

Factors Affecting Survival

7.4.23 The majority of the site lies within the Thames and the absence of a foreshore at low tide for most of the site, along with the presence of the moored ships alongside the river wall, suggests that most of this section of the riverfront has been dredged.

7.4.24 Bathymetry data held by the Thames Tideway Tunnel project indicates that the riverbed below the site varies between 98.0m and 95.0m ATD (6.6–9.6 mbgl), generally becoming deeper from west to east. Deposits of Mesolithic date have occasionally been found to about 94.0m ATD in Central London; therefore alluvium and deposits of archaeological interest might exist at this depth but it is unlikely.

7.4.25 The current riverbed levels as indicated by bathymetry data are deeper than the levels shown on historic sections of the foreshore and channel prior to Victoria Embankment construction (Thames Water , 1863)[5], which show the top of the riverbed about 1.5m below Ordnance Datum (approximately 98.5m ATD) just east of the line of Embankment Wall (see Vol 17 Appendix E.5, Vol 17 Plate E.5). This supports the suggestion that the riverbed has been dredged subsequently by up to around 3.5m on the river side of the existing river wall. This is likely to have completely removed archaeological remains. Therefore archaeological potential on the riverside of the wall is very low.

7.4.26 Archaeological survival potential on the landward side of the riverside wall, along the Victoria Embankment is high for elements of the mid-19th century Bazalgette scheme, apart from where it has been superficially disturbed by service trenches beneath the pavement, and potentially moderate within any alluvium that survives beneath the substantial infilling (potentially up to 6.0m thick) used to create the embankment. The structures of the embankment are discussed in more detail below at para. 7.4.44.

7.4.27 Taking into account the impacts above, the archaeological survival potential of the site is generally considered to be low for remains earlier than post-medieval. Asset potential and significance by period is described below.

Asset potential and significance

7.4.28 The following statement of asset significance takes into account the levels of natural geology and the level and nature of later disturbance and truncation. It should be noted in para. 7.4.29 below, that survival on the foreshore side of the riverside wall is likely to be less than on the landward side for all periods until the post-medieval as discussed above (7.4.25).

Palaeoenvironment

7.4.29 The site has moderate potential to contain palaeoenvironmental remains. The deposits predicted within the site are expected to exemplify the well-known floodplain sequence of this part of the Thames, which have been shown, elsewhere, to hold a record of environmental change and evolving floodplain geomorphology stretching back to the Late Glacial period. Peat deposits have the potential to provide information which can be used to reconstruct the past ecology of the floodplain and environments within which prehistoric occupation occurred. Any fluvial or estuarine deposits also have the potential to preserve palaeoenvironmental remains, which can be used to reconstruct past fluvial regimes and indicate the onset of tidal inundations and the transition to an estuarine river environment. The significance of any such remains would be low and would be derived from their evidential value.

Prehistoric

7.4.30 The site has low potential for archaeological remains dating to the prehistoric period. No remains of occupation or major activity have been recorded in the baseline area. There is potential for isolated prehistoric finds, residually deposited outside their original context, within alluvial deposits. Such assets would be of low significance, based on their evidential value.

Roman

7.4.31 The site has a low potential for archaeological remains dating to the Roman period. No evidence of Roman activity or occupation has been recorded within the baseline area, and the site appears to have been located some distance from known areas of settlement. The site would have been located within the River Thames channel, and so would have been largely submerged during this period. The adjacent riverbank, some distance to the west, would probably have been open fields in arable use or pasture. There is some possibility of residual Roman finds of low significance within the alluvial deposits on the site, although no similar finds have been recorded in the immediately surrounding area.

Early medieval

7.4.32 The site has a low potential for archaeological remains dating to the early medieval period. It was located between the known settlements of Lundenwic approximately 300m to the north, and the religious community on Thorney Island, approximately 700m to the south. The site would have been located within the River Thames channel and would have been submerged during this period. There is potential for residual early medieval finds within the site, as such finds have been recovered nearby. Such redeposited finds would be of low significance which would be derived from their evidential and historical value.

Later medieval

7.4.33 The site has a low potential for later medieval remains. As in earlier periods, the site would have been located within the River Thames channel. Development continued along the western bank of the Thames, including medieval houses, wharfs, a beer house and Westminster Palace, approximately 580m to the south of the site. Evidence dating to this period within the site would comprise isolated finds. These would be of low significance, as derived from their evidential and historical value.

Post-medieval

7.4.34 The site has a high potential for buried archaeological remains dating to the post-medieval period on the landward side of the river wall and a low potential for such remains on the river side of the river wall. On the landward side, there is potential for buried remains associated with the Victoria Embankment, including ground consolidation and evidence of its construction (low significance), along with below-ground structures including ducts and the sewer itself, assets of medium significance, derived from their evidential and historical value.

7.4.35 Beneath ground consolidation on the landward side of the wall, previously unrecorded buried heritage assets of this date might include evidence for earlier piled structures, barge beds or jetties and piers not shown on historic maps and pre-dating the embankment. There is low potential for such remains within the river channel. Such remains are considered to be of low significance and would be derived from their evidential and historical value.

Statement of significance: above-ground heritage assets

Introduction

7.4.36 In accordance with *the National Policy Statement for Waste Water* and the associated guidance, the following section provides a statement of the likely significance of above-ground heritage assets based on professional and expert judgement. The significance of assets is a reflection of their value or importance, derived from their perceived historical, evidential, aesthetic and communal value. These terms are defined in Vol 2.

7.4.37 This section also describes the significance, historic character and setting of conservation areas and settings of listed buildings within the construction and operational Zones of Theoretical Visibility (ZTV) where their historic character, appearance and settings may be affected by the proposed development. Such assets are shown in Vol 17 Figure 7.4.2 (see separate volume of figures). This figure also shows the construction and operational ZTVs and Views of Heritage Value (VHV) which illustrate important views to and from heritage assets. There are no other heritage assets in the assessment area whose settings would be significantly adversely affected by the proposed development.

7.4.38 Some of the assets described below are grouped together for the purposes of the assessment in Section 7.5. This occurs when several assets are similarly affected by the proposals.

Within the site

Whitehall Conservation Area and associated heritage assets

7.4.39 The site is situated within the Whitehall Conservation Area, as designated by Westminster City Council. The conservation area is of high significance, derived from its aesthetic, evidential, historical and communal values. The Victoria Embankment is considered to be one of the great boulevards of London and includes a significant number of monuments, listed buildings and the embankment with a uniform line of London plane trees along its riverside pavement. The stretch of the Thames within the conservation area is part of an internationally recognised riverscape. The Conservation Area Audit (Westminster City Council, 2003)[6] notes that the area is of international renown with the Victoria Embankment providing a green space as well as an important pedestrian and vehicular route along the north side of the river. The embankment also lies within a primary routes and spaces category, as defined by Westminster City Council, due to its width and the combination of historic monuments and buildings along its route.

7.4.40 The Whitehall Conservation Area Audit identifies Victoria Embankment as a strongly defined urban area of particularly high cultural heritage value, characterised by the Grade I Ministry of Defence (HEA 34) and Queen Mary's Steps (HEA 33) , the Grade II* Whitehall Court (HEA 36) and National Liberal Club (HEA 36) ,and the Grade II Embankment Wall (HEA 69), catenary lamps (HEA 30), Bazalgette Memorial (HEA 29), Royal Air Force Memorial (HEA 40) and Playhouse Theatre (HEA 37). The Grade II Registered Park and Garden of Victoria Embankment Gardens (HEA 68) and associated statues (HEA 27, 31, 32, 39), together with the mature planting along Victoria Embankment, make a strong contribution to the character of the Whitehall Conservation Area. The majority of heritage assets date to the construction of the Victoria Embankment by Sir Joseph Bazalgette in the 1870s and subsequent development of the area in the late 19th and early 20th centuries. All are considered to be of high asset significance.

7.4.41 The part of the Whitehall Conservation Area within which the site is located is characterised by views along the Embankment to and from the Palace of Westminster WHS, principally from the pedestrian walkway alongside Hungerford Bridge. This is illustrated in View of Heritage Value 1 (see Vol 17 Figure 7.4.2, separate volume of figures) and Viewpoint 2.2 detailed in Section 11 Townscape and visual. Views into the Whitehall Conservation Area from the opposite bank of the River Thames are also characteristic of the area, as illustrated in View of Heritage Value 3 and Viewpoint 2.15 detailed in Section 11 Townscape and visual. The area is bounded by Hungerford Bridge to the north, which limits all but long distance views to the north from the southern end of the Embankment and Westminster Bridge, illustrated in View of Heritage Value 5 and Vol 17 Plate 7.4.6.

7.4.42 Views into the Whitehall Conservation Area include those from Hungerford Bridge southwards along the line of the Embankment towards the Houses of Parliament, illustrated in View of Heritage Value 1, and along the river northwards from Westminster Bridge (View of Heritage Value 5). Views towards the Whitehall Conservation Area from the opposite bank of the river (View of Heritage Value 3) and along the Thames from Westminster Bridge are defined by the alignment of the river, the formal line of the Embankment Wall and the vegetation behind, framed by the ornate upper storeys and roofline of Whitehall Court (HEA 36) and adjacent National Liberal Club (HEA 35), together with the more formal lines and massing of the Ministry of Defence building (HEA 34). This is illustrated in Vol 17 Plate 7.4.1.

7.4.43 As an ensemble group, the settings of the heritage assets within this part of the Whitehall Conservation Area are closely related. The setting of the listed Embankment Wall is defined by its relationship with the river on one side and the line of plane trees and Victoria Embankment Gardens on the other. The setting of Whitehall Court and the National Liberal Club is defined by the presence of the gardens and trees, and beyond that by the openness of the river frontage and at ground level by the Embankment Wall. The line of the Embankment Wall forms part of the wider setting of the Palace of Westminster WHS, framing significant views along the river towards the Houses of Parliament. The contribution of the setting of the Whitehall Conservation Area to its asset significance is therefore high. The site makes a moderate contribution to this setting by virtue of its position along the open embankment.

Vol 17 Plate 7.4.1 Historic environment - view north from Hungerford Bridge south west towards Whitehall Conservation Area

Victoria Embankment

7.4.44 The Victoria Embankment river wall (Grade II listed; HEA 1D) was built in 1864–70 by the Metropolitan Board of Works to designs by Sir Joseph Bazalgette as part of the great engineering works to improve London's drainage system (Vol 17 Appendix E.5, Vol 17 Plate E.7). The parapet has a heavy segmental rolled coping with regularly spaced dies surmounted by the ornately designed lamp standards. The cast iron "sturgeon" lamp standards (sometimes called “dolphin” lamp standards) with globe lanterns, most of them dated 1870, are included in the embankment listing (Vol 17 Appendix E.5, Vol 17 Plate E.8). The lamp standards follow the line of the embankment parapet wall and there are several of them within the site. The Cornish granite river wall is part of Bazalgette’s original scheme and its wall piers are decorated with bronze lion heads with mooring rings in their mouths. These are present throughout the embankment and the motif continues elsewhere on the Thames as far west as Vauxhall Bridge. An arched structure in the river wall is for an original sewer outfall. The river wall and its various components are integral to the engineering works which were undertaken to improve London’s drainage system and are of high historical and evidential value and thus are of high significance. Some elements of Bazalgette’s Victoria Embankment are not listed, including: the pavement, the Portland cement concrete fill between the embankment wall and the property boundaries to the west, the line of the Circle and District lines of the London Underground, the Northern Outfall Low Level Sewer (which forms part of the structure of the embankment wall), the road and pavement lines, and a subway beneath the pavement holding electricity and gas mains.

7.4.45 Bazalgette's designs included the provision of steamer piers either side of Charing Cross Bridge on the north bank. These can be seen on the Ordnance Survey 1st edition 25" mile map of 1862–1895 (Vol 17 Appendix E.5, Vol 17 Plate E.4), labelled as Charing Cross Piers. Two floating pontoons were used for mooring and secured by piled 'dolphins' in the river, which were not connected to the shore. These allowed the pontoon to rise and fall with the tide. One of these now survives on a square projecting bastion of the river wall. Bazalgette seems to have taken the opportunity to use this area for a sewer outflow which was incorporated into and effectively hidden within the pier design. Part of the southernmost of these two purpose-built piers extends on to the site from the north and may be deemed to be part of the Grade II listed structure and therefore an asset of high significance, because of its evidential, aesthetic, and architectural value.

7.4.46 Running along the Victoria Embankment roadside pavement is a series of Grade II Listed catenary lamp standards, seven of which lie within the site (HEA 1A). They are heritage assets of high significance. Gas lamps had been the predominant form of street lighting since the first examples in 1816. In 1878, a series of sixty electric lights were installed to supplement the light from the sturgeon lamps along the Victoria Embankment, the first experiment of its kind in Britain. However, they were found to be inefficient and expensive and by 1884 the Embankment returned to gaslight. Improvements in power generation led to the reintroduction of electricity with the installation of catenary lamps c. 1900. Cast-iron lamp standards along the pavement edge supplied electricity for street lights that hung above the roadway, supported by cables between each pair of posts. They are listed because of their special historic interest as surviving structures from the early provision of electric street lighting. They are also of special artistic interest for their uniqueness and quality and their design, which includes civic heraldry and Art-Nouveau elements. The lamp standards share group value with other notable historic features of high significance, such as Cleopatra's Needle, which lies approximately 300m to the northeast of (outside of) the baseline area, numerous riverside monuments, listed public benches with decorative frames dating from 1872–74 (HEA 1C), and the riverside wall with its sturgeon lamp standards with globe lanterns, several of which lie within the site. As a group, all these features enrich the streetscape through their broad connection to the original stylistic ideals of the Bazalgette embankment concept (Vol 17 Appendix E.5, Vol 17 Plate E.9).

7.4.47 The setting of the Embankment Wall (HEA 69) is characterised by the distinctive line of the its frontage along the River Thames, marked by the recurring sequence of regularly spaced sturgeon lanterns and bronze lion-headed mooring rings (HEA 69). The main road is lined with London plane trees and a series of catenary lamp standards (HEA 30), beyond which lies Victoria Embankment Gardens (HEA 68). This is illustrated in Vol 17 Plate 7.4.2. The setting of the Royal Air Force Memorial (HEA 40) is defined by its central position along the river frontage, and it is prominent in views to and within the Whitehall Conservation Area, as illustrated in Views of Heritage Value 1 and 4. The contribution of setting to the significance of the Embankment Wall and its associated assets is high. As the site lies along the line of the Embankment Wall it forms a part of its immediate setting.

Vol 17 Plate 7.4.2 Historic environment - view north-east from gangway of Tattershall Castle towards Embankment Wall

Tattershall Castle & Hispaniola

7.4.48 Moored within the site boundary is the Tattershall Castle vessel (HEA 1B). It is listed on the National Register of Historic Vessels, certificate no. 72 (National Historic Ships UK, 2011)[7]. Though not subject to statutory protection it is a heritage asset of low significance.

7.4.49 The moored Hispaniola vessel lies immediately north of the site (HEA 113). Though not included on the National Register of Historic vessels, the Hispaniola is a heritage asset of low significance due to its historic value.

7.4.50 The Tattershall Castle and the Hispaniola lie within the Whitehall Conservation Area and form part of the setting of the Embankment Wall. The Tattershall Castle has been moored in its current location since 1981 and the Hispaniola since 1973. Depending on the tide, their upper decks and funnels form a distinctive element in views of the area. This is illustrated in Vol 17 Plate 7.4.4. However, as moveable assets not originally associated with this part of the river, the contribution of their setting to their asset significance is low, although the site is one of the main components of their setting.

Within the assessment area

Victoria Embankment Gardens

7.4.51 A section of the Grade II* registered Victoria Embankment Gardens (HEA 68), known as Whitehall Gardens, lies approximately 15m to the west of the site on the opposite side of a busy carriageway. It was laid out on reclaimed land as one of four public gardens as part of Bazalgette's scheme in 1874, and is known as Whitehall Gardens. Within the various parts of the gardens are numerous statues and memorials to eminent historic figures such as Isambard Kingdom Brunel, composer Sir Arthur Sullivan, Robbie Burns, Sir Wilfred Lawson, the philanthropist Robert Raikes and the Imperial Camel Corps, whilst in the section to the south adjacent to the Ministry of Defence building are statues of military figures including General Gordon of Khartoum, Air Marshal Lord Trenchard, the 77th Indian Brigade or Chindits and Major General Orde Charles Wingate. The monuments within Victoria Embankment Gardens are all Grade II listed assets of high significance, and impacts on their settings are assessed below within the same section as the Gardens themselves.

7.4.52 The Whitehall Gardens section of Victoria Embankment Gardens (HEA 68) contributes strongly to the character of this part of the Whitehall Conservation Area. They form the backdrop and setting for the Embankment, and for Whitehall Court and the Liberal Club to the rear. Whitehall Gardens themselves are enclosed by planting with very few intended views out towards the river, although there are views from the middle entrance on Embankment to the east towards the site. This is illustrated in View of Heritage Value 2 as shown in Vol 17 Figure 7.4.2 (see separate volume of figures); and Viewpoint 2.22 in Section 11 Townscape and visual. The gardens are separated from the river frontage by the presence of the road, which experiences a high volume of traffic, and is also screened by mature trees and shrubs. The contribution of setting to the overall significance of the Victoria Embankment Gardens and its associated assets is high, and in terms of Whitehall Gardens this mainly consists of the openness of the east side to the river and sky, and the dramatic enclosure created on the west side by the grand architecture of Whitehall Court and the National Liberal Club. The embankment and site makes only a modest contribution to this setting due to the low level screening of the shrubs, the busy character of the wide carriageway, and the low level of the Embankment Wall parapet.

Vol 17 Plate 7.4.3 Historic environment - view north-east from within Victoria Embankment Gardens towards the site

Bazalgette Memorial

7.4.53 The Grade II listed Bazalgette Memorial of c. 1891, lies approximately 25m to the north of the site (HEA 29). This is a wall mounted bronze portrait bust in a roundel with a bronze cartouche below. A pediment of white marble surrounds the sculpture, resting on a plinth with relief carvings of foliage, fish, eels and a spade and pick axe, whilst squares, compasses and other engineering instruments are also depicted. The monument is fixed to a granite block upstream from Hungerford Bridge and presents a prominent memorial to the designer of the Embankment. It is a heritage asset of high significance. Although views to the memorial are limited to the close vicinity, its prominent position on the Victoria Embankment means that setting makes a moderate contribution to its significance. The site is located south of the memorial along the line of the embankment parapet, and so forms part of its wider setting. Since the memorial is part of the wider group of heritage assets along the Embankment Wall including the sturgeon lamp standards, river wall and parapet, the effects upon its setting are assessed below in the Embankment Wall section.

Royal Air Force Memorial

7.4.54 The Grade II Listed Royal Air Force Memorial (HEA 40), Whitehall Stairs, is situated approximately 90m to the south of the site and is one of the most prominent monuments along Bazalgette's boulevard, visible in views from Hungerford Bridge and from the South Bank Conservation Area. It was designed by Sir Reginald Blomfield c. 1920 for First World War pilots and is of Portland Stone surmounted by a globe and gilt bronze eagle.

The monument, one of many in the area, has value due to its meaning and association with the pilots of the RFC/RAF who died in the First World War as well as its historical and architectural merit. It is a heritage asset of high significance. The gilt bronze eagle on the summit makes the memorial particularly visible in views to and within the Whitehall Conservation Area. This is illustrated in Views of Heritage Value 1, 4 and 5 (as shown in Vol 17 Figure 7.4.2, see separate volume of figures) and Vol 17 Plate 7.4.4. Given its visual prominence on the frontage to the River Thames, setting makes a strong contribution to its significance, but since the site is some distance north of the memorial it has only a minor role in its setting. Due to the memorial forming part of the wider group of heritage assets along the Embankment Wall including the sturgeon lampstandards, river wall and parapet, the effects upon its setting are assessed below in the Embankment Wall section.

National Liberal Club & Whitehall Court

7.4.55 The National Liberal Club (HEA 35) and Whitehall Court (HEA 36) are each listed Grade II*, and together form a large roughly symmetrical block approximately 50m to the west of the site. The Club was built in 1884–1887 by Alfred Waterhouse in Portland stone with slate roofs. Whitehall Court is a block of flats constructed in 1884 by Thomas Archer and A. Green, in matching materials, with exuberant details inspired by the French Renaissance chateaux of the Loire valley. Both assets are of high significance. The two buildings form the backdrop to Victoria Embankment, with the upper storeys and elaborate roofline rising up above the trees within Victoria Embankment Gardens and mature London planes on the Embankment itself. They form a focal point in views from Hungerford Bridge and the South Bank Conservation Area. This is illustrated in View of Heritage Value 3 and Vol 17 Plate 7.4.1. The contribution of setting to their significance is therefore high. However as the site is screened by mature trees and shrubs, and stands on the far side of Whitehall Gardens and the busy wide carriageway, it makes only a modest contribution to the settings of these assets. As these buildings form part of the riverfront of the Whitehall Conservation Area, the impacts upon their settings are assessed in the sections for the Whitehall Conservation Area below.

Savoy Conservation Area

7.4.56 There are important views out from the Whitehall Conservation Area northwards along the Embankment towards the Savoy Conservation Area (a heritage asset of high significance) beyond Hungerford Bridge, focused on the prominent Art Deco Shell Mex Building. This is illustrated in View of Heritage Value 4 (see Vol 17 Figure 7.4.2, separate volume of figures), Viewpoint 2.20 in Section 11 Townscape and visual and Vol 17 Plate 7.4.4. The contribution of setting to the significance of the Savoy Conservation Area is high, but the site plays a very minor role in the asset's setting.

South Bank Conservation Area

7.4.57 The South Bank Conservation Area lies on the opposite bank of the Thames to the site, extending from Westminster Bridge in the south west to a point opposite Inner Temple Gardens. The conservation area is a heritage asset of high significance, and its riverside setting makes a strong contribution to its overall significance. The Victoria Embankment Foreshore site would be visible directly across the river from the public walkway running along the riverfront of Jubilee Garden. Meanwhile the Blackfriars Bridge Foreshore site would be visible from another part of the conservation area, to the north west beyond Waterloo Bridge. These two sites are located opposite different parts of this large conservation area, but nonetheless together they make a moderate contribution to the asset's significance due their location within the larger historic riverfront that can be viewed from the public riverside walkway

Vol 17 Plate 7.4.4 Historic environment - view north along Victoria Embankment towards Savoy Conservation Area. The Shell Mex Building is at the centre of the photograph.

Palace of Westminster WHS

7.4.58 The Palace of Westminster WHS lies around 500m to the south of the site, which lies within the WHS buffer zone. The WHS forms a prominent element in views south along the Embankment and from Hungerford Bridge. The line of the Embankment therefore forms part of its riverside setting. However, this specific view along the Embankment is not included within the *Palace of Westminster WHS Management Plan* or Mayor of London *Supplementary Planning Document on the Setting of London's World Heritage Sites*. There are views from the WHS northwards along the Embankment towards the site, albeit restricted by the intervening presence of Westminster Pier. This is illustrated in View of Heritage Value 5 (see Vol 17 Figure 7.4.2, separate volume of figures) and Vol 17 Plate

7.4.6. The contribution of these views to the asset significance of the WHS is moderate, although the site plays a minor role within these views.

Vol 17 Plate 7.4.5 Historic environment - view south from Hungerford Bridge along Victoria Embankment towards the Palace of Westminster WHS

Vol 17 Plate 7.4.6 Historic environment - view north from Westminster Bridge adjacent to the Palace of Westminster WHS towards Hungerford Bridge

Construction base case

7.4.59 As described in para.7.3.13, no developments identified within the site development schedule (Vol 17 Appendix N) would lead to any loss of or change in the buried heritage assets within the site. The base case for assessing physical construction effects on buried heritage assets within the site would therefore be the same as the baseline.

7.4.60 For the reasons outlined in para. 7.3.13, the base case in Site Year 2 of construction would remain as per the baseline for the assessment of effects on historic character, appearance and setting.

Operational base case

7.4.61 For the reasons outlined in para. 7.3.18 the base case in Year 1 of operation would remain as per the baseline for the assessment of effects on historic character, appearance and setting.

7.5 Construction effects assessment

Buried heritage assets

7.5.1 Effects of construction works are described in the following section, generally in the sequence in which they would occur, with the individual impacts from each phase described. The effects on heritage assets are summarised in Section 7.10, by chronological period.

Site setup

7.5.2 The removal of seven trees (young and middle-aged) and ground disturbance associated with it, local demolition of the river wall, and within footings for hoardings and new service trenches, would locally truncate buried remains associated with the 19th century Victoria Embankment, for example ground consolidation and evidence of embankment construction, of low asset significance, possibly extending to the buried Bazalgette service ducts (medium significance). This would locally reduce the asset significance to negligible. It is considered unlikely that there would be an impact on earlier archaeological remains due to the shallow depth of these works. Given their localised nature these impacts would comprise a low magnitude of impact and would result in a **minor adverse** effect for the asset of low significance, and a **moderate adverse** effect for assets of medium significance.

Construction of cofferdams, scour protection, outfall apron and campshed

7.5.3 Archaeological remains are potentially located within the foreshore alluvium and possibly cut into the underlying gravels. Within the area of the temporary cofferdam, soft material (ie alluvium) would be excavated down to the gravels adjacent to the perimeter of the temporary cofferdam and existing river wall (see assumptions in para.7.3.24), whilst foreshore deposits would be entirely removed from within the permanent cofferdam footprint. This would constitute a high magnitude of impact on any archaeological remains within and beneath the foreshore deposits.

7.5.4 The movement of small plant machinery used to lay the geotextile layer across the cofferdam footprints prior to infilling, and used to remove the geotextile layer subsequently, would have an impact upon any archaeological remains on the surface of the foreshore and within the upper part of the alluvium, within the cofferdam footprint, through rutting and compaction, resulting in a localised high magnitude of impact.

7.5.5 The placement of temporary cofferdam fill material is predicted to have a high magnitude of impact. This would arise from the compression of any remaining buried heritage assets within the foreshore alluvium and gravels where such remains are hollow (e.g. pottery vessels, hulked boats), and/or are made of porous/organic material (timber structures/objects such as wattle, fishtraps, and peat). Where remains are solid, non-porous or inorganic without voids, such as metal, stone, flint or brick, there is unlikely to be an impact.

7.5.6 A jack-up barge would be used to insert the sheet pile walls. This would have a localised impact any buried heritage assets within the footprint of its supports. Within the area of the campshed, foreshore deposits would be removed to an approximate depth of 0.3m, as assumed for the purposes of this assessment. Excavation to a depth of 1.5m within the footprint of permanent scour protection and outfall apron would remove any surviving buried heritage assets within the foreshore alluvium to this depth. These works would have a high magnitude of impact.

7.5.7 These activities would constitute a high magnitude of impact. As discussed in paras. 7.4.23–7.4.25, it is probable that all alluvial deposits and any archaeological remains in the channel beside the river wall have already been removed by past dredging and water action. Most of the channel deposits within the cofferdams are likely to have accumulated after foreshore dredging, post-dating the embankment wall construction, although there is a low potential for residual or displaced finds from other periods.

7.5.8 The environmental effect from construction of cofferdams and campsheds is as follows:

a. There is a moderate potential for palaeoenvironmental remains associated with the past environment of the river. These remains would be of low asset significance and their removal would reduce their significance to negligible and comprise a **minor adverse** effect.

b. There is low potential for isolated prehistoric finds of low asset significance. Removal of such remains would reduce their significance to negligible and constitute a **minor adverse** effect.

c. There is a low potential for isolated Roman artefacts of low asset significance. Removal of such remains would reduce their significance to negligible and constitute a **minor adverse** effect.

d. There is a low potential for early medieval artefacts of low asset significance. Removal of such remains would reduce their significance to negligible and comprise a **minor adverse** effect.

e. There is a low potential for later medieval artefacts of low asset significance. Removal of such remains would reduce their significance to negligible and comprise a **minor adverse** effect.

f. There is a low potential for post-medieval remains, such as remains of jetties or barge beds, which would be of low asset significance. The removal of such remains would reduce their significance to negligible and comprise a **minor adverse** effect.

Scour around temporary structures

7.5.9 Scour around the temporary cofferdams and campshed could have an impact upon any archaeological remains in the vicinity. The significance of any assets affected could be reduced to negligible, which would constitute a high magnitude of impact for these assets. The significance of effect on heritage assets would be as that of the cofferdam described in para. 7.5.8 above.

Construction of the CSO drop shaft and other below-ground infrastructure

7.5.10 Since all archaeological deposits from within the footprint of the permanent cofferdam are expected to have been removed, the construction of the CSO drop shaft and other permanent below-ground structures within it would have no further impact.

7.5.11 Below-ground structural remains that form an integral part of the Bazalgette embankment would also be locally removed by the overflow and interception weir chambers, service diversions, valve chamber, connection culvert and tunnel, storm overflow chamber and ventilation installations where these would straddle and extend through the present embankment wall. Tree planting and other landscaping works would also have an effect on the upper parts of these structures. The magnitude of impact on these underground structures, of medium asset significance, would result in a **moderate adverse** effect.

Above-ground heritage assets

Physical effects on above-ground heritage assets

7.5.12 The construction works would have a permanent physical impact on the Victoria Embankment. A section of parapet of the existing Grade II Listed river wall (HEA 1D) would be permanently removed to facilitate construction of the permanent foreshore structure, which would be topped with a new stretch of parapet wall. Removal, alterations and the permanent concealment of a section of river wall by the new foreshore structure would constitute a localised high magnitude of impact on the river wall, an asset of high significance. Seven London plane trees which form an integral part of the Bazalgette Embankment scheme (these are classed as young and middle aged and are possibly replacements) would be removed and subsequently be replaced by semi-mature plane trees in the same locations. Together, these works would result in a **major adverse** effect on Victoria Embankment.

7.5.13 The parapet of the riverside wall includes 49 ornamental sturgeon lamp standards (HEA 1D) three of which would be permanently removed during construction. These Grade II Listed features form an integral part of Bazalgette's Victoria Embankment and are of high asset significance. As this action involves the removal of part of an asset of high significance, the impact is deemed to result in a **moderate adverse** effect .

7.5.14 Three of the 34 Grade II listed catenary lamp standards (HEA1A) would be removed from the Embankment for the duration of the construction works to protect them from damage and reinstated within the LLAU after construction. As this action involves the temporary removal of part of an asset of high significance, the impact is deemed to result in a temporary **moderate adverse** effect, given the asset would be temporarily removed from its context.

7.5.15 Four of the 21 Grade II listed decorative benches (HEA1C) on the Embankment would be temporarily removed for the duration of the construction works to protect them from damage and reinstated afterwards. This action involves the temporary removal of part of an asset of high significance and would constitute a temporary **moderate adverse** effect, given the asset would be temporarily removed from its context.

7.5.16 The Grade II listed river wall is within the zone of ground movement resulting from the construction works. The damage assessment report for Victoria Embankment Foreshore predicts a maximum of 4mm vertical settlement, resulting in crack widths of up to 0.1mm. This level of damage is deemed to have no structurally significant effects. Although the asset is of high significance, the magnitude of change is very low, and therefore the effects of ground movement on this heritage asset are assessed as **minor adverse**.

7.5.17 The Grade II listed lamp standards and benches within the site area have not been assessed in relation to ground movement, as they are by nature insensitive to such effects, having small footprints.

7.5.18 The Tattershall Castle vessel (HEA 1B) would be moved to an alternate location just south of the site. There would be no physical impact on the vessel, resulting in a **negligible** effect.

Effects on historic character, appearance and setting of heritage assets

7.5.19 The NPS recognises in paragraph 1.4.4 that nationally significant infrastructure projects are likely to take place in mature urban environments, with adverse construction effects on historic environment receptors likely to arise. Construction works similar to those proposed are commonplace in London, and therefore the following assessment should be viewed in this context. It should also be noted that construction effects are temporary in nature and, as assessed, relate to the peak construction phase. Effects during other phases of works are likely to be lower due to reduced levels of plant being required and a reduced intensity of construction activity.

Whitehall Conservation Area and associated heritage assets

7.5.20 The temporary cofferdam, hoarding and cranes would form prominent features within views south from Hungerford Bridge along the

Embankment within the Conservation Area (see Viewpoint 2.2 detailed in Section 11 Townscape and visual), and from the opposite bank of the River Thames into the Whitehall Conservation Area (see Viewpoint 2.15 detailed in Section 11 Townscape and visual). This would constitute an adverse change in the character of this part of the Conservation Area, but in relation to the asset as a whole the magnitude of adverse effect would be low. The listed buildings in the Conservation Area which have a view of the site include the Ministry of Defence, Queen Mary's Steps, Whitehall Court, the National Liberal Club and the Playhouse Theatre, and the settings of these buildings would experience a low magnitude adverse effect as they are a short distance from the site and are mostly screened by trees or shrubs and the busy traffic of the embankment. The high significance of the receptors, combined with the low magnitude of change, would result in a **moderate adverse** effect.

Embankment Wall and associated heritage assets

7.5.21 Hoarding around the construction site along the Embankment would obstruct views to the river wall along the riverside walkway. The removal of three sturgeon lamp standards and seven plane trees would also adversely affect the character of the Embankment Wall. The temporary cofferdam would affect the setting of the Embankment Wall, and of associated assets including the lamp standards, decorative benches and monument to Sir Joseph Bazalgette, and would also affect to a lesser extent the setting of the Royal Air Force Memorial some distance to the south. While the Embankment Wall and nearby assets would be adversely affected by these works, in the context of whole stretch of wall from Westminster Bridge to Blackfriars there would be a medium magnitude of change. Together with the high significance of the receptors, this would result in a **moderate adverse** effect.

Victoria Embankment Gardens and associated heritage assets

7.5.22 The construction works would largely be screened from the Whitehall Gardens section of Victoria Embankment Gardens, and from the listed monuments within it, by the presence of surrounding vegetation and mature trees along the Victoria Embankment. However, the construction works would be clearly evident in views out through the garden entrances. The magnitude of this impact would be limited by the high volume of traffic along Victoria Embankment that separates the gardens from the Embankment Wall, and by the fact that other sections of Victoria Embankment Gardens lie on the other (north) side of Hungerford Bridge, or some distance to the south, and would experience little or no adverse effect. The high significance of the Gardens and listed monuments, combined with a low magnitude of change, would result in a **minor adverse** effect. The separate townscape and visual assessment (section 11) concludes that the works would have a major adverse effect upon the conservation area. The difference between the two assessments derives from their different methodologies: one considers the effect of the change to setting on the heritage value of the Gardens and associated assets, of which only a part is affected by the proposals while some key areas are completely unaffected, with the result that the gardens would mostly retain their significance; whereas the other considers the effect upon the townscape of the Gardens, which includes non-heritage factors.

Tattershall Castle and Hispaniola

7.5.23 The construction works would include the relocation of the Tattershall Castle. The Hispaniola would remain in situ, but its setting would be impinged upon by the presence of the construction works. Given the low contribution of setting to the significance of these historic assets, the magnitude of change would be low, resulting in a **minor adverse** effect.

Savoy Conservation Area

7.5.24 The construction works would detract from views from the Embankment towards the Savoy Conservation Area (see Viewpoints 2.19 and 2.20 detailed in Section 11 Townscape and visual). However, given the relative distance from the site, and the fact that most of the Conservation Area is entirely screened by Hungerford Bridge, the magnitude of change to the setting of the Conservation Area would be low, resulting in a **minor adverse** effect.

South Bank Conservation Area

7.5.25 The construction works at the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites would combine to affect the setting of this conservation area, through the erection of site hoardings, office and welfare accommodation, temporary and permanent cofferdams within the river, and the presence of cranes and other plant. As the riverfront of the South Bank Conservation Area offers wide public views from the riverside walkway, there would be a medium magnitude of impact upon this highly significant asset, leading to a **moderate adverse** effect.

The Palace of Westminster WHS

7.5.26 The construction works would detract from views towards the Palace of Westminster WHS from Hungerford Bridge (see Viewpoint 2.2 detailed in Section 11 Townscape and visual) and from views northwards along the Embankment from within the WHS (see Viewpoint 2.18 detailed in Section 11 Townscape and visual). Given the relative distance from the site, the magnitude of change to the WHS would be low, resulting in a **minor adverse** effect.

Sensitivity test for programme delay

7.5.27 For the assessment of historic environment effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above. This is because of the distance, relative scale and the presence of intervening structures between the schemes in the development schedule and the site.

7.6 Operational effects assessment

Above-ground heritage assets

Effects on the historic character and setting of above-ground heritage assets

Whitehall Conservation area

7.6.1 The operational development would result in a change to the historic character of the Whitehall Conservation Area, primarily to its river frontage along Victoria Embankment. It would alter the form and character of the Embankment and so introduce a new element within views to and along this part of the Whitehall Conservation Area. However, the position of the foreshore structure at the same height as the existing Embankment Wall and the presence of intervening mature trees would mean the magnitude of change to the overall character of the Whitehall Conservation Area would be low. The listed buildings facing the river front part of the conservation area include the Ministry of Defence building, Queen Mary's Steps, Whitehall Court, the National Liberal Club and the Playhouse Theatre. These are largely screened by trees and shrubs from the proposed riverfront structure, which would in any case be low in height and relatively inconspicuous when viewed from these buildings which are some distance away. The magnitude of effect upon the settings of these listed buildings would therefore be low.

7.6.2 Given the design, use of materials, height and position of the foreshore structure in relation to the Embankment Wall, the overall composition of views towards this part of the Whitehall Conservation Area from the opposite bank of the River Thames would also be subject to a low magnitude of change. In summary, the high significance of the Whitehall Conservation Area, combined with the low overall magnitude of change, would result in a **minor adverse** effect.

Embankment Wall

7.6.3 The line and regularity of the Embankment Wall when viewed from the western end of Hungerford Bridge (see Viewpoint 2.2 in Section 11 Townscape and visual) would be interrupted by the permanent foreshore structure projecting into the River Thames. The operational development has been designed to minimise adverse effects, for example, the edge of the foreshore structure would be at the same height as the Embankment Wall and the wall's shadow gap would emphasise the line and primacy of the embankment wall. In addition the changes would affect only a part of the entire stretch of the listed Embankment Wall, which runs from Westminster Bridge to Blackfriars. The Bazalgette memorial just north of the site would have its setting affected since there would be a larger break in the line of the parapet when viewed from the south; the same would also affect the setting of the decorative benches and nearby lamp standards. The relocation of the Tattershall Castle would affect views along the Embankment from Hungerford Bridge towards the Royal Air Force Memorial (View of Heritage Value 1). It would also affect the line of sight towards the Embankment from along Horse Guards Avenue, although the effect would in part be reduced by the presence of intervening trees (View of Heritage Value 6).

7.6.4 In summary, the fact that only a part of the Embankment Wall would be affected by the changes and the sensitive design of the foreshore structure, mean that the overall adverse effect would be of a low magnitude. This, combined with the high significance of the Embankment Wall and its associated heritage assets, would result in a **minor adverse** effect on the historic character of the Embankment Wall and settings of its associated features.

Victoria Embankment Gardens

7.6.5 Given the presence of intervening planting in most views out of this part of Victoria Embankment Gardens and the fact that the development would be at the same height as the Embankment Wall (aside from the slender ventilation column which would not have an appreciable impact), the magnitude of change to the setting of Victoria Embankment Gardens and the listed monuments within it would be negligible, resulting in a **minor adverse** effect.

Tattershall Castle and Hispaniola

7.6.6 The proposed development would reduce the openness of the water around the Hispaniola, but since the vessel's setting forms only a minor part of its significance this would form a low magnitude adverse change, resulting in a **minor adverse** effect. There would be no effect on the setting of the relocated Tattershall Castle as its relation with the Embankment Wall would remain.

South Bank Conservation Area

7.6.7 The operational structures at the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites would combine to affect the setting of this conservation area, by changing the riverscape in two places visible from the riverside walkway. The sites would generally not rise above the parapet of the existing river wall in views from the conservation area, leading to a low magnitude of impact upon this highly significant asset, giving a **minor adverse** effect. Most of this effect would come from the Blackfriars Bridge foreshore site, due to its greater prominence.

Palace of Westminster WHS

7.6.8 The operational site would be visible in views from Hungerford Bridge along the Embankment to the Palace of Westminster WHS (see View of Heritage Value 1; and Viewpoint 2.2 in Section 11 Townscape and visual). The presence of the structure and height of the ventilation column would present a very minor distraction from views towards the Palace of Westminster WHS, but would not appreciably affect its setting nor reduce its significance. Views from within the Palace of Westminster WHS at the western end of Westminster Bridge (see Viewpoint 2.18 in Section 11 Townscape and visual) northwards along the Embankment would include the operational site. Given the distance from the site (approximately 450m) and the presence of existing infrastructure along the Embankment (notably Westminster Pier), this would not adversely affect the line of the

Embankment Wall and repeating pattern of lanterns. Overall, the high significance of the asset, combined with the negligible magnitude of change, would result in a **minor adverse** effect.

Savoy Conservation Area

7.6.9 Views towards the Savoy Conservation Area from the southern end of the Embankment walkway (Views of Heritage Value 4 and 5; and Viewpoints 2.19 and 2.20 described in Section 11 Townscape and visual) would include the operational site. Although the majority of the structure in this view would lie beneath the level of Hungerford Bridge, the ventilation column would distract slightly from views towards Shell Mex House. This would constitute a negligible magnitude of change, resulting in a **minor adverse** effect**.**

Sensitivity test for programme delay

7.6.10 For the assessment of historic environment effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above. This is because of the distance, relative scale and the presence of intervening structures between the schemes in the development schedule and the site.

7.7 Cumulative effects assessment

7.7.1 As detailed in the site development schedule (Vol 17 Appendix N) no schemes have been identified within 1km of the site which meet the criteria (see Vol 2 Section 3.8) for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken.

Sensitivity test for programme delay

7.7.2 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, this is not likely to materially affect assessment findings in respect of the historic environment and, therefore, would not lead to a requirement to assess cumulative construction or operational effects.

7.8 Mitigation

7.8.1 As per the NPS (para 4.10.19), a documentary record of a heritage asset is not as valuable as retaining the heritage asset, and it should not be a factor in the decision as to whether or not development consent is given. Nevertheless, it is the most appropriate form of mitigation available and in EIA terms serves to reduce the significance of the adverse effect, as has been agreed with English Heritage.

Buried heritage assets

7.8.2 Based on this assessment, no buried heritage assets of high significance are anticipated that would merit a mitigation strategy of permanent preservation *in situ*. It is therefore considered that the minor to moderate environmental effects of the proposed development could be successfully mitigated by a suitable programme of archaeological investigation and recording before and during construction, to achieve preservation by record through advancing understanding of asset significance.

7.8.3 Subject to the findings of field evaluation, mitigation of adverse effects on archaeological remains is likely to include the following:

a. An archaeological watching brief during site preparation and construction to mitigate impacts upon buried remains of low and medium asset significance associated with the Embankment, arising from service diversions and foundations for offices and welfare on the landward side of the existing river wall.

b. Monitoring of material removed from the foreshore within the cofferdams for residual finds

7.8.4 Both evaluation and mitigation would be carried out in accordance with a scope of works (*Site Specific Archaeological Written Scheme of Investigation [SSAWSI]*), based on the principles in the *Overarching Archaeological Written Scheme of Investigation (OAWSI)*, to ensure that the scope and method of fieldwork are appropriate. The *SSAWSI* would be submitted in accordance with the application for development consent (the 'application') requirement.

7.8.5 Construction phase scour around the temporary cofferdam would be mitigated through a programme of monitoring and the provision of scour protection if required, as detailed in the *CoCP* Part A (Section 12).

Above-ground heritage assets

7.8.6 The major adverse effect on the Grade II listed Victoria Embankment Wall, an asset of high significance, would be partially mitigated by standing structure survey and photographic recording of the affected sections of river wall, to the appropriate English Heritage standard.

7.8.7 The moderate adverse effect resulting from the removal of three ornamental sturgeon lamp standards would be mitigated by standing structure survey and photographic recording to English Heritage Level 1 standard (photographic record) prior to removal.

7.8.8 The moderate adverse effect from the temporary removal of three Grade II listed catenary lamp standards before their reinstatement following construction works would be mitigated by standing structure survey and photographic recording to English Heritage Level 1 standard (photographic record) prior to removal.

7.8.9 The moderate adverse effect from the temporary removal of four Grade II Listed bench seats before their reinstatement after construction works would be mitigated by standing structure survey and photographic recording to English Heritage Level 1 standard (photographic record) prior to removal.

7.8.10 The minor adverse effect of ground movement on the listed Victoria Embankment river wall within the site would be mitigated by a programme of repair to significant cracks caused by the construction works following the conclusion of the works.

7.8.11 All measures embedded in the proposed development and *CoCP* of relevance to the assessment of effects on the historic character and setting of above-ground heritage assets during construction are summarised in Section 7.2. No further mitigation during construction is possible for significant adverse effects due to the highly visible nature of the construction activities.

Operation

7.8.12 All measures embedded in the proposed design of relevance to the assessment of effects on the historic character and setting of above-ground heritage assets during operation are summarised in Section 7.2. No further mitigation during operation is required as no significant adverse effects are predicted.

7.9 Residual effects assessment

Construction effects

7.9.1 With the mitigation described above in place, the residual construction effects on buried heritage assets would be **negligible**. All residual effects are presented in Section 7.10.

7.9.2 The physical impact of the removal of part of the stone parapet of the listed Embankment Wall would be partially mitigated by a programme of structure recording and photographic survey to form preservation by record. The residual effect would be **moderate adverse**. As no mitigation is proposed for the minor adverse effect of ground movement on the listed Embankment Wall the residual effect would remain as **minor adverse**.

7.9.3 Residual effects on the Embankment wall from ground movement would be **negligible**.

7.9.4 The relocation of one of the ornamental sturgeon lamps to another location on the embankment would result in a **minor adverse** residual effect.

7.9.5 With the mitigation described above in place, the residual construction effects on other above-ground heritage assets (including underground structural elements of Bazalgette infrastructure) would be **negligible**.

7.9.6 As no mitigation measures are required for effects on the historic character, appearance and setting of above-ground heritage assets beyond those embedded in the proposed development and *CoCP*, the residual construction effects on the setting of heritage assets would remain as described in Section 7.5. All residual effects are presented in Section 7.10.

Operational effects

7.9.7 As no mitigation measures are required beyond those embedded in the proposed development, the design principles and COCP for effects on the historic character, appearance and setting of above-ground heritage assets, the residual operational effects on the setting of heritage assets would remain as described in Section 7.6. All residual effects are presented in Section 7.10.

7.10 Assessment summary

Vol 17 Table 7.10.1 Historic environment – summary of construction assessment

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Buried heritage assets				
Moderate potential for palaeoenvironmental remains (Low asset significance)	Assets affected by the construction of cofferdams, scour protection, outfall apron and campshed. Assets removed by scour around temporary cofferdam. Asset significance reduced to negligible.	Minor adverse	Environmental sampling during archaeological investigation.	Negligible
Low potential for isolated prehistoric finds. (Low asset significance)	Assets affected by the construction of cofferdams, scour protection, outfall apron and campshed. Assets removed by scour around temporary cofferdam. Asset significance reduced to negligible.	Minor adverse	Archaeological investigation and recording of the area within the cofferdams and campshed footprint (preservation by record). Monitoring of scour effects and implementation of scour protection measures if needed as agreed	Negligible
Low potential for isolated Roman finds. (Low asset significance)	Assets affected by the construction of cofferdams, scour protection, outfall apron and campshed. Assets removed by scour around temporary cofferdam. Asset significance reduced to negligible.	Minor adverse		Negligible
Low potential for isolated early medieval finds.	Assets affected by the construction of cofferdams, scour protection, outfall apron and campshed.	Minor adverse		Negligible

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
(Low asset significance)	Assets removed by scour around temporary cofferdam. Asset significance reduced to negligible.		with statutory consultees.	
Low potential for isolated later medieval finds. (Low asset significance)	Assets affected by the construction of cofferdams, scour protection, outfall apron and campshed. Assets removed by scour around temporary cofferdam. Asset significance reduced to negligible.	Minor adverse		Negligible
High potential for 19th century ground consolidation and evidence of embankment construction (Low asset significance)	Assets removed by ground disturbance from site setup. Asset significance locally reduced to negligible.	Minor adverse	Archaeological watching brief to form preservation by record.	Negligible
High potential for buried structures associated with the Victoria Embankment, eg ducts and sewer (Medium asset significance)	Assets removed by ground disturbance from site setup. Asset significance locally reduced to negligible.	Moderate adverse		Negligible
	Assets removed by construction of the valve chambers, overflow weir chamber, connection culverts and ventilation chambers. Asset significance locally reduced to negligible.	Moderate adverse		Negligible
Low potential for post-	Assets affected by the construction of	Minor	Archaeological	Negligible

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
medieval remains of features such as barge beds, jetties and piers or other piled structures, beneath the embankment fill and within the channel. (Low asset significance)	cofferdams, scour protection, outfall apron and campshed. Assets removed by scour around temporary cofferdam. Asset significance reduced to negligible.	adverse	investigation and recording of the area within the cofferdams and campshed footprint (preservation by record). Monitoring of scour effects and implementation of scour protection measures if needed as agreed with statutory consultees.	
Above-ground heritage assets				
Victoria Embankment wall (High asset significance)	Permanent alteration to the stone parapet of the listed river wall by removal of part of it; localized removal of upper part of wall to accommodate connection chambers and culverts. Asset significance reduced locally.	Major adverse	Standing structure recording (preservation by record) before and during construction.	Moderate adverse
	Ground movement resulting from construction works, surface cracking of up to 0.1mm predicted. No impact on the asset significance.	Minor adverse	Any significant damage resulting from ground movement would be repaired using	Negligible

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
			appropriate conservation techniques following the conclusion of significant settlement.	
Embankment Wall and associated heritage assets including the decorative benches, sturgeon lamp standards, Bazalgette memorial and Royal Air Force Memorial (High asset significance)	The construction works would cause an adverse change to the setting of the Embankment Wall between Hungerford Bridge and Westminster Bridge, and the associated lamp standards, benches, Bazalgette memorial and Royal Air Force Memorial. In the context of the asset as a whole this would have a medium adverse impact.	Major adverse	No mitigation possible further to that embodied within the proposed design and the *Code of Construction Practice* and design principles	Major adverse
Sturgeon (or dolphin) lamp standards listed as part of the riverside wall) (High asset significance)	Removal of three sturgeon lamp standards, which form part of the Embankment wall listing, during construction works. Reuse of the permanently removed lamp standard would be sought in accordance with the *Heritage Statement*. Asset significance reduced locally.	Moderate adverse	Photographic recording prior to removal.	Minor adverse for the permanent removal of one lamp standard and negligible for the two to be reinstated

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Catenary lamp standards (High asset significance)	Temporary removal of three lamp standards during construction works followed by reinstatement within the site. Asset significance reduced locally.	Moderate adverse	Photographic recording prior to removal	Negligible
Decorative benches (High asset significance)	Temporary removal of four benches during construction works followed by reinstatement Asset significance reduced locally.	Moderate adverse	Photographic recording prior to temporary removal	Negligible
Whitehall Conservation Area (High asset significance)	The presence of hoardings, cranes and the temporary cofferdam on part of the river frontage would lead to a medium magnitude of change to this part of the Whitehall Conservation Area. This would result in a low magnitude of change to the asset overall. The listed buildings in the Conservation Area which are close to the site include the Ministry of Defence, Queen Mary's Steps, Whitehall Court, the National Liberal Club and the Playhouse Theatre, and the effect upon their settings would be at most of low magnitude due to the screening effect of trees and shrubs and their distance from the site.	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *Code of Construction Practice* and. design principles	Moderate adverse
Victoria Embankment Gardens (High asset significance)	The construction works would affect the setting of the Whitehall Gardens section, causing a low magnitude of change to the setting of Victoria Embankment Gardens as a whole. The listed monuments within the gardens would suffer at	Minor adverse	No mitigation required further to that embodied within the proposed design	Minor adverse

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
	most a low magnitude adverse change, since they would be screened from the site by intervening trees and shrubs, and the site in any case forms a minor part of their settings.		and the *Code of Construction Practice* and design principles	
Savoy Conservation Area (High asset significance)	The construction works would have a low magnitude adverse change upon the setting of the Savoy Conservation Area due to their location near the Hungerford Rail Bridge and consequent effect on views northwards towards this part of the asset.	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and design principles	Minor adverse
South Bank Conservation Area (High asset significance)	The construction works at Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites would combine to cause a medium magnitude of change to the setting of the South Bank Conservation Area.	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and design principles.	Moderate adverse
The Tattershall Castle vessel (Low asset significance)	Vessel is to be relocated nearby.	Negligible	None	Negligible
Tattershall Castle and Hispaniola (Low asset significance)	The construction works would have a low magnitude change upon the setting of the vessels by changing their relationship to the riverside. The location of the Tattershall Castle would be changed, although its location does not contribute strongly to its significance	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and	Minor adverse

Receptor (heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
			design principles	
Palace of Westminster, Westminster Abbey and St Margaret's Church World Heritage Site (High asset significance)	The construction works would cause a low magnitude adverse change to views towards the WHS from limited points along Hungerford Bridge, and upon views along the Embankment from the WHS.	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and design principles	Minor adverse

Vol 17 Table 7.10.2 Historic environment – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Above-ground heritage assets				
Whitehall Conservation Area (High asset significance)	Given the design, use of materials, low height and position of the foreshore structure in relation to the Embankment Wall, the character and appearance of the Whitehall Conservation Area as a whole would be subject to a low magnitude of change. The setting of the Conservation Area and of the listed buildings near the site, including the Ministry of Defence, Queen Mary's Steps, Whitehall Court, National Liberal Club and Playhouse Theatre, would also experience a low magnitude adverse effect as they are some distance from the site and are partly screened from the site by intervening trees and shrubs.	Minor adverse	No mitigation required further to that embodied within the proposed design and design principles	Minor adverse
Embankment Wall including the decorative benches, sturgeon lamp standards, Bazalgette memorial and Royal Air Force Memorial (High asset significance)	The proposed development would alter the historic character of the Embankment Wall in the northern part of the stretch between Hungerford Bridge and Westminster Bridge, through removing a section of the wall. When combined with the relocation of the Tattershall Castle this would affect the setting of the wall and associated assets close to the site when viewed along the river frontage. However the magnitude of change to the wall as a whole would be low, due to the nature of the design and use of materials.	Minor adverse	No mitigation required further to that embodied within the proposed design and design principles	Minor adverse
Victoria	The presence of intervening planting in most views	Minor adverse	No mitigation	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Above-ground heritage assets				
Embankment Gardens (High asset significance)	out of Whitehall Gardens, and the low height of the development, would lead to a negligible change to the setting of Victoria Embankment Gardens as a whole. The settings of the listed monuments within the Gardens near to the site would also experience a negligible adverse effect since the site forms a minor part of their settings and they would be screened from it by trees and shrubs, while the works would be of a low scale and appear relatively inconspicuous from the monuments.		required further to that embodied within the proposed design and design principles	
South Bank Conservation Area (High asset significance)	The operational structures at Blackfriars Bridge Foreshore and Victoria Embankment Foreshore would combine to cause a low magnitude of change to the setting of the South Bank Conservation Area.	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and design principles.	Minor adverse
Tattershall Castle and Hispaniola (Low asset significance)	The proposed development would move the Tattershall Castle and introduce a new structure into the river, causing a low magnitude effect upon the setting of the two ships. The location of the Tattershall Castle would be changed, although its location does not contribute strongly to its significance	Minor adverse	No mitigation required further to that embodied within the proposed design and design principles	Minor adverse
Palace of Westminster, Westminster	Given the scale and form of the development, and its distance from the WHS, the magnitude of change to the setting of the WHS would be	Minor adverse	No mitigation required further to that embodied	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Above-ground heritage assets				
Abbey and St Margaret's Church World Heritage Site (High asset significance)	negligible.		within the proposed design and design principles	
Savoy Conservation Area (High asset significance)	The proposed development would lead to a negligible magnitude of change to the setting of the Savoy Conservation Area as a whole, partly due to the intervening presence of Hungerford Bridge in views towards the conservation area.	Minor adverse	No mitigation required further to that embodied within the proposed design and design principles	Minor adverse

References

[1] City of Westminster. *Westminster World Heritage Site Management Plan* (2007).

[2] Department of Environment, Food and Rural Affairs. *National Policy Statement for Waste Water (*2012)

[3] Communities and Local Government. *National Planning Policy Framework* (March 2012)

[4] Department of Communities and Local Government, English Heritage & Department for Culture, Media and Sport. *PPS5 Planning for the Historic Environment: Historic Environment Planning Practice Guide* (March 2010)

[5] Thames Water. *Abbey Mills Books. Book 90 Thames Embankment Contract No 1*, Drg no. 4 (1863).

[6] City of Westminster. *Document ID 2473* (2003).

[7] *National Historic Ships UK website*. Available at: www.nationalhistoricships.org.uk. Accessed May 2011.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 8: Land quality

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 8: Land quality

List of contents

Page number

8 Land quality ... 1
8.1 Introduction ... 1
8.2 Proposed development relevant to land quality ... 2
8.3 Assessment methodology ... 4
8.4 Baseline conditions ... 6
8.5 Construction effects assessment ... 7
8.6 Operational effects assessment ... 11
8.7 Cumulative effects assessment ... 11
8.8 Mitigation ... 11
8.9 Residual effects assessment ... 11
8.10 Assessment summary ... 12
References ... 14

List of tables

Page number

Vol 17 Table 8.5.1 Land quality – source-pathway-receptor summary (construction) 8
Vol 17 Table 8.10.1 Land quality − summary of construction assessment ... 12

This page is intentionally blank.

8 Land quality

8.1 Introduction

8.1.1 This section presents the findings of the assessment of the likely significant land quality effects of the proposed development at the Victoria Embankment Foreshore site.

8.1.2 The scope of the land quality assessment is to:

a. describe the condition of the site in terms of contaminant history and likely presence and magnitude of soil/sediment and liquid contamination (such as groundwater or perched water within the Made Ground), in addition to unexploded ordnance (UXO) and the presence of Japanese Knotweed, an invasive plant species which can be regarded as a soil contaminant.

b. describe and assess the impacts and significant effects of the interaction between these contaminants and the built environment, human and environmental receptors as a result of construction of the proposed development (taking into account any embedded measures).

8.1.3 There are a number of interfaces between land quality and other topic sections, as summarised below:

a. Section 13 Water resources – groundwater assesses the likely significant effects to water resources from soil, perched water and groundwater contamination. The land quality assessment considers potential risks to human health receptors (eg, construction workers) from contaminated perched water and groundwater, including free phase[i] contamination.

b. Section 4 Air quality and odour assesses the likely significant effects to the air quality during the construction and operation of the site. The land quality assessment considers potential risks from, for example, the generation of dust and soil vapour from exposed ground and soils during construction.

c. Section 5 Ecology – aquatic and Section 14 Water resources – surface water, these sections consider the mobilisation of sediments associated with in-river construction. The surface water section also considers the likely significant effects to controlled waters from land contamination (eg, contaminated run-off) and use of contaminating substances during construction. No further assessment of these impacts and effects is made in the land quality section.

8.1.4 Operational land quality effects for this site have not been assessed. This is on the basis of the embedded measures adopted during the

[i] Free phase contamination - hydrocarbons that form a discrete layer within groundwater, either floating on the groundwater surface or at the base of a groundwater body.

construction and operational phases (refer to Section 8.2 and Vol 2 Section 8.6). No significant operational effects are considered likely and for this reason only information relating to construction is presented in the assessment of effects on land quality.

8.1.5 The assessment of the likely significant effects of the project on land quality has considered the requirements of the National Policy Statement for Waste Water (Defra, 2012)[1] section 4.8. The risk posed by construction on previously developed land is addressed in the following assessment and through measures embedded in the *Code of Construction Practice* (*CoCP*) (further details can be found in Vol 2 Section 8, Vol 3Table 8.3.1). The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

8.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

8.2 Proposed development relevant to land quality

8.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to land quality are set out below.

Construction

8.2.2 The elements of the proposed development relevant to land quality would consist of the following:

a. dredging and construction of a temporary cofferdam, including connection to existing river wall and connection of campsheds

b. partial demolition of existing river wall, construction of new section and

c. construction of new CSO outfall apron

d. construction of pits, chambers, ducts and pipes for cables, pipes, utility connections and diversions and drainage

e. combined sewer overflow (CSO) drop shaft, the invert of which would be located at a depth of approximately 50m below ground level (bgl)

f. Regent Street connection tunnel would be constructed between the drop shaft and the main tunnel

g. construction of an interception chamber, CSO overflow structures, valve/weir chambers and culverts

h. construction of structures for air management plant and equipment including filter and ventilation columns and associated below ground ducts and chambers.

8.2.3 The above works would involve extensive below ground construction, resulting in the excavation and removal of Made Ground and natural soils below.

8.2.4 An area is also required for construction logistics, such as materials handling and storage areas and site welfare and offices (as shown in the

Victoria Embankment Foreshore site construction plans - see separate volume of figures).

Code of Construction Practice

8.2.5 The embedded design measures relevant to land quality at the site are set out in Section 9 of the *CoCP* and are summarised below. Reference should be made to the *CoCP* Part A (Section 9) for full details.

8.2.6 There are no site specific *CoCP* measures which are relevant to this land quality assessment.

8.2.7 Land quality issues would be managed in close liaison with the local authority Westminster City Council and the Environment Agency (EA) prior to and during construction.

Pre-construction

8.2.8 The proposed development has been characterised and assessed with respect to land quality through the application of the following steps (which are dictated by the regulatory framework outlined in Section 9 of the *CoCP*):

a. completion of a desk study which includes a review of available information sources (see Vol 17 Appendix F.1) as well as review of site specific ground investigation data and the production of an initial conceptual site model

b. undertaking of specialist site surveys, such as Japanese Knotweed and UXO, which to date has included a site-specific desk study for part of the Victoria Embankment Foreshore site (see Vol 17 Appendix F.2).

c. drilling of boreholes and assessment of soil and groundwater quality.

8.2.9 In view of the lack of contaminative history within the site area, the results of the preliminary ground investigation and the low risk current land use (River Thames foreshore for main works and a section of road and pavement along the A3211 Victoria Embankment for other works), it is judged that specific remediation works for land quality purposes in advance of the main construction works would be unnecessary.

8.2.10 It is however likely that the information used to produce this *Environmental Statement* would be reformatted into preliminary risk assessment compliant with the guidance set out in BS10175 (British Standards Institution, 2011)[2] and CLR11 *Model procedures for the management of land contamination* (EA, 2004)[3] for submission to the regulators prior to construction works.

Construction

8.2.11 Health and safety measures for the protection of construction workers with respect to land quality issues would, as standard, include:

a. the provision of adequate training for all construction site workers to recognise and appropriately respond to potential land quality issues

b. site welfare facilities and where appropriate, decontamination units (ie, dirty in, clean out welfare units)

c. use of standard construction site personal protective equipment (PPE) (eg, high visibility clothing, safety boots, hard hat, safety glasses gloves and respiratory equipment)

d. robust emergency procedures (eg, with respect to UXO, or previously unidentified contamination), which are periodically reviewed. In the event of previously unidentified conditions being encountered, works would be suspended, the work area evacuated and specialist advice obtained. Where appropriate, additional risk assessments would be undertaken and additional control measures implemented prior to any works recommencing.

8.2.12 During construction, effective material management procedures, such as the storage and handling of excavated soils, fuels and other chemicals (as detailed further in the surface water section of the *CoCP*), would be implemented).

8.2.13 Although it is unlikely to be specifically required due to poor soil quality, site control measures would as a standard be implemented to reduce dust (see air quality section of the *CoCP*) and the spread of mud by vehicles (see public access, the highway and river transport section of the *CoCP*).

8.2.14 Monitoring of excavations would be undertaken by a UXO specialist due to the high risk of encountering UXO within the foreshore environment.

8.3 Assessment methodology

Engagement

8.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of land quality are presented here.

8.3.2 Westminster City Council was specifically consulted with respect to any land quality data they hold at the site and surrounding area. Westminster City Council did not hold any information on land quality at or within the search area of the site.

Baseline

8.3.3 The baseline methodology follows the methodology described in Vol 2. There are no site-specific variations for identifying the baseline conditions for this site.

Construction

8.3.4 The assessment methodology for the construction phase follows that described in Vol 2. There are no site-specific variations for undertaking the construction assessment of this site.

8.3.5 The construction assessment area considered for the assessment of land quality includes the limits of land to be acquired or used (LLAU) plus an additional 250m buffer area. This assessment area has been selected in order to take account of any off-site sources that could impact on the land quality of the site as well as any nearby sensitive receptors.

8.3.6 The construction assessment has been undertaken for Site Year 1 of the construction phase.

8.3.7 The base case and cumulative assessment in Site Year 1 of construction takes into account the schemes described in Vol 17 Appendix N. The baseline is not anticipated to change between the base case year and Site Year 1 of construction (2016) as there are no developments within the 250m buffer area pertinent to land quality. In addition, there are no proposed developments expected to commence during Site Year 1 of construction and as a result there would be no cumulative effects on land quality.

8.3.8 Para. 8.4.13 details the likely significant effects arising from the construction at the Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on land quality within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

Development of conceptual model

8.3.9 The assessment of land quality effects is based on the development of a source-pathway-receptor (SPR) conceptual model. This model aims to understand the presence and significance of potentially complete pollutant linkages.

8.3.10 The SPR conceptual model is based on guidance given in CLR113. This type of assessment specifically relates to risk assessment and management of land contamination and has been used to inform the environmental impact assessment (EIA) which seeks to identify the likely significant effects of the proposed development.

8.3.11 The impact assessment considers the anticipated level of contamination likely during Site Year 1 of construction using the categories of receptor sensitivity and impact magnitude described in Vol 2 Section 8.4 and Vol 2 Section 8.5 respectively.

8.3.12 The significance of effects has been determined using the generic matrix given in given in Vol 2 Section 3.7. A description of the significance criteria is presented in Vol 2 Section 8.5.

8.3.13 The methodology for undertaking both source-pathway-receptor analysis and the impact assessment is provided in Vol 2 Section 8.

Assumptions and limitations

8.3.14 The assumptions and limitations associated with this assessment are presented in Vol 2, Section 8. Assumptions and limitations specific to the site are detailed below.

Assumptions

8.3.15 There are no site specific assumptions for Victoria Embankment Foreshore.

Limitations

8.3.16 There is limited site-specific data on soil and groundwater quality available within some parts of the LLAU, however it is considered that there is sufficient information currently available to provide a robust assessment.

8.4 Baseline conditions

8.4.1 The following section sets out the baseline conditions for land quality within and around the site. Future baseline conditions (base case) are also described.

Current baseline

Introduction

8.4.2 A full list of the data sets drawn upon in this assessment is presented in Vol 2.

8.4.3 A baseline report is presented in Vol 17 Appendix F.1 which details the data obtained for this site and identifies the contamination sources that may have affected the site. In addition to Vol 17 Appendix F.1, this section should also be read in conjunction with Vol 17 Figure F.1.1, Vol 17 Figure F.1.2 and Vol 17 Figure F.1.3 (see separate volume of figures).

Summary of baseline conditions

Geology

8.4.4 The site is underlain by Alluvium extending to 2m bgl. This is underlain (in turn) by River Terrace Deposits, London Clay Formation, and Lambeth Group (see Vol 17 Appendix F.1, Vol 17 Table F.3 for the full geological succession).

Contamination

8.4.5 The area within the LLAU has not been subject to major contaminative history. No contamination sources were identified with the site boundaries or in the immediate vicinity of the site.

8.4.6 The site comprises the current River Thames foreshore. The Thames foreshore sediments within the tidal reaches have been found to contain low levels of polycyclic aromatic hydrocarbons (PAHs) and metals from historic activities within the wider River Thames and coliforms from sewage discharges (see sediment sampling report Vol 2 Appendix F.2).

8.4.7 The levels of various potential contaminants in the sediments are relatively low in terms of risk to human health (when compared to widely used screening values (Defra/EA, 2012[4], Chatered Institute of Environmental Health, 2009[5]) and are relatively immobile (not readily leachable). These sediments are also restricted to the upper part of the proposed excavation works (less than one metre in thickness). The majority of the excavated materials at the site from the CSO drop shaft would therefore be essentially uncontaminated.

8.4.8 Overall on the basis of the current information it is considered that the site has a very low risk of containing contaminated soils or groundwater.

UXO

8.4.9 A desk based assessment for UXO threat was undertaken for the proposed development site. The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA). The report is presented in Vol 17 Appendix F.2.

8.4.10 The report identified that there were 'opportunistic' targets were located in the vicinity of the site and the Westminster Metropolitan borough had a notable bombing density for London.

8.4.11 The site was therefore given a high risk rating.

Summary of receptors

8.4.12 The receptors identified at this site from the baseline survey (see Vol 17 Appendix F.1) and their corresponding sensitivity following the criteria set out in Vol 2 are as follows:

a. construction workers: low sensitivity for general above ground site workers such as staff in site offices and delivery drivers and high sensitivity for those site workers involved in below ground excavation works and associated activities

b. adjacent land-users: residential land-users (high sensitivity), recreational users, such as those within the Victoria Embankment Gardens and Whitehall Gardens (medium sensitivity) and workers in the adjacent administrative, commercial, retail and entertainment properties and Thames Path users (low sensitivity)

c. built environment: listed structures, such as Victoria Embankment river wall and associated features, (high sensitivity) and commercial, administrative, retail, entertainment and residential properties and the non listed sections of river wall (all low sensitivity)

Construction base case

8.4.13 For land quality, the assessment of construction effects is based on the conditions which are likely to be experienced in Site Year 1 of construction (base case).

8.5 Construction effects assessment

Construction assessment case

8.5.1 Land quality baseline conditions are unlikely to have changed from those described above by the commencement of the construction phase. This is primarily due to the majority of works being located within the foreshore environment but also applies to other areas due to the lack of contaminative land use history and low potential for harmful levels of contamination to be present within the LLAU.

Development of conceptual model

Interactions between source-pathway-receptor

8.5.2 The following sections outline how the contamination sources summarised in paras.8.4.5 to 8.4.8 may interact with the receptors identified during the construction phase (see para. 8.4.12) following the application of the embedded measures (see Section 8.2).

8.5.3 The main land quality SPR interactions are considered to be from the exposure of potential contamination to:

a. construction workers (receptor) via dermal contact, ingestion, inhalation of dust and soil vapours/soil gas and direct contact

b. adjacent land users, including members of the public (receptor) via off-site migration of soil vapour (by diffusion or due to wind) and wind-blown dust contaminant pathways and UXO

c. the built environment (on and off-site receptors) via the accidental detonation of previously unidentified UXO

8.5.4 The SPR impacts are summarised in

8.5.5 Vol 17 Table 8.5.1. For simplicity the various sources identified have been grouped together into the different phases which they may be found (ie, solid, liquid, and gaseous), as these interact with receptors in a similar manner.

Vol 17 Table 8.5.1 Land quality – source-pathway-receptor summary (construction)

Receptors / Generic sources	Construction workers	Adjacent land users	Built environment
Contaminated soils / sediments	Inhalation, dermal contact, ingestion	Wind -blown dust, inhalation, vapour migration (and subsequent ingestion or inhalation)	N/A
UXO	UXO detonation	UXO detonation	UXO detonation

N/A =Not applicable

Impacts and effects

8.5.6 The following section discusses the potential impacts and likely significant effects on receptors as a result of the land quality conditions at the site.

8.5.7 The assessment focuses on those linkages between sources, pathways and receptors that could generate significant effects and is based on available information and professional judgement.

Construction workers

8.5.8 A number of embedded measures set out in the *CoCP* (Section 9) are designed to effectively manage any potential land quality impacts to construction workers associated with the construction phase of the proposed development (measures are summarised in Section 8.2).

Contamination

8.5.9 Desk based information suggests that the soils/sediments at the site are unlikely to be substantially contaminated and thus are unlikely to pose a risk to construction workers via direct contact pathways. There may however be some minor risks from bacteriological contamination associated with the sewage outfall which could impact them through the ingestion pathway (such risk are easily mitigated through observance of basic hygiene principles).

8.5.10 Given the low risk nature of the site and the measures to be adopted as part of the *CoCP* (Section 9) (such as the use of PPE, risk assessments and welfare facilties), the overall magnitude of the impact to construction workers (both below and above ground) is assessed to be negligible.

8.5.11 This would result in a **negligible** effect on above ground construction workers and a **minor adverse** effect on those involved in intensive below ground works (although the effect is defined as minor adverse, it is considered unlikely that the effect would occur).

UXO

8.5.12 The management of UXO risk comprises advice from a specialist contractor who is experienced at managing such risks. This would include an initial assessment of UXO being present at the site (such as that already undertaken) and a proportional response to this risk. With a high risk site such as Victoria Embankment Foreshore, this is likely to include of site-specific risk assessments, safe methods of work/tool box talks and emergency response procedure as well as a UXO watching brief as excavations progress.

8.5.13 These measures are successfully utilised in major construction schemes within London on regular basis. Therefore with these measures in place, the overall magnitude of the impact to construction workers (both below and above ground) is assessed to be negligible.

8.5.14 This would result in a **negligible** effect on above ground construction workers and a **minor adverse** effect on those involved in intensive below ground works (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

Adjacent land-users

Contamination

8.5.15 As previously stated it is unlikely that contaminated soils would be encountered during the works at Victoria Embankment Foreshore.

8.5.16 In addition there are a number of standard measures within the *CoCP* (Section 9) that reduce the potential for the off-site migration of dusts or vapours for air quality purposes. These would include the damping down of excavations, storage of potentially contaminated soils in secure (covered) areas, wheel washes at site entrance and the maintenance, construction and cleaning of hardstanding.

8.5.17 As such the impacts to adjacent land users from existing contamination being spread through dust or vapour migration are considered to be negligible.

8.5.18 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the adjacent administrative, commercial, retail, entertainment and Thames Path users and recreational users, such as those within Victoria Embankment Gardens and Whitehall Gardens and a **minor adverse** effect on the adjacent residential land-users (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

UXO

8.5.19 Impacts on adjacent land-users could occur via accidental detonation of UXO during below ground works. The embedded measures are set out in the *CoCP* (Section 9), such as the use of specialised UXO contractors offering site-specific advice and where necessary on-site monitoring. These measures are designed to effectively manage any impacts to the adjacent land-users associated with the construction phase of the proposed development.

8.5.20 With these measures in place the overall magnitude of the impact to all adjacent land-users is assessed to be negligible.

8.5.21 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the adjacent administrative, commercial, retail, entertainment and Thames Path users and recreational users, such as those within Victoria Embankment Gardens and Whitehall Gardens and a **minor adverse** effect on the adjacent residential land-users (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

Built environment

8.5.22 Impacts from existing land quality relate to the accidental detonation of UXO during preliminary surveys or main construction works.

8.5.23 A number of embedded design measures set out in the *CoCP* (Section 9), as summarised in Section 8.2, are designed to effectively manage any land quality impacts (eg, from UXO) to the built environment associated with the construction phase of the proposed development.

8.5.24 With these measures in place the overall magnitude of the impact to the built environment is assessed to be negligible.

8.5.25 Based on the assessed impact magnitude and the receptor sensitivity, the proposed development is considered to present a **negligible** effect to the adjacent residential, administrative, retail, entertainment and commercial buildings and non-listed sections of the river wall, and a **minor adverse** effect to listed structures such as Victoria Embankment river wall and associated features (although the effect is defined as minor adverse it is considered unlikely that the effects would occur).

8.6 Operational effects assessment

8.6.1 Operational effects have not been assessed for land quality (see para. 8.1.4).

8.7 Cumulative effects assessment

8.7.1 As described in Section 8.3 there are no schemes in Vol 17 Appendix N which meet the project criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken.

8.8 Mitigation

8.8.1 The assessment presented above does not identify the need for mitigation during construction over and above those measures set out in the *CoCP* (Section 9). No further mitigation, enhancement or monitoring is required.

8.9 Residual effects assessment

8.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in para. 8.4.13. All residual effects are presented in Section 8.10.

8.10 Assessment summary

Vol 17 Table 8.10.1 Land quality – summary of construction assessment

Receptor (sensitivity)	Effect	Significance of effect	Mitigation	Significance of residual effect
Construction workers – general above ground site staff (Low)	Health effects from exposure to contaminated soils, sediments soil gases / vapours	Negligible	None	Negligible
	Health effects from detonation of UXO	Negligible	None	Negligible
Construction workers – below ground site staff (High)	Health effects from exposure to contaminated soils / sediments, liquids, soil gases / vapours	Minor adverse	None	Minor adverse*
	Health effects from detonation of UXO	Minor adverse	None	Minor adverse*
Adjacent land- users, workers within retail/entertainment, administrative and commercial properties and Thames Path users (Low)	Health effects from exposure to wind-blown dust or vapours	Negligible	None	Negligible
	Health effects from detonation of UXO	Negligible	None	Negligible
Adjacent land-users, recreational users such as Victoria Embankment Gardens and Whitehall Gardens users (Medium)	Health effects from exposure to wind-blown dust or vapours	Negligible	None	Negligible
	Health effects from detonation of UXO	Negligible	None	Negligible
Adjacent land-users, residential properties, (High)	Health effects from exposure to wind-blown dust or vapours	Minor adverse	None	Minor adverse*
	Health effects from detonation of UXO	Minor adverse	None	Minor adverse*
Built environment – administrative, retail commercial, entertainment	Damage to structures from detonation	Negligible	None	Negligible

Receptor (sensitivity)	Effect	Significance of effect	Mitigation	Significance of residual effect
and residential properties and non listed sections of river wall (Low)	of UXO			
Built environment –listed structures (such as Victoria Embankment river wall and associated features) (High)	Damage to structures from detonation of UXO	Minor adverse	None	Minor adverse*

**Although the effect is minor adverse, it is considered unlikely that the effect would occur.*

References

[1] Defra. *National Policy Statement for Waste Water* (2012).

[2] British Standards Institution. *BS10175 Investigation of potentially contaminated sites: Code of Practice* (2011).

[3] Environment Agency. *Model procedures for the management of land contamination: Contaminated Land Report 11* (2004).

[4] Defra/ Environment Agency. *Soil Guidance Values 2009 and supporting documents.* Available from: http://www.environment-agency.gov.uk/research/planning/64015.aspx. Accessed 11th October 2012.

[5] Land Quality Management/Chatered Institute of Environmental Health. *Generic Assessment Criteria for the Assessment of Human Health*, 2nd Edition, Land Quality Press (2009).

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 9: Noise and vibration

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 9: Noise and vibration

List of contents

Page number

9 Noise and vibration ... 1

9.1 Introduction ... 1

9.2 Proposed development relevant to noise and vibration ... 1

9.3 Assessment methodology ... 4

9.4 Baseline conditions ... 9

9.5 Construction effects assessment ... 12

9.6 Operational effects assessment ... 23

9.7 Cumulative effects assessment ... 26

9.8 Mitigation and compensation ... 27

9.9 Residual effects assessment ... 27

9.10 Assessment summary ... 29

References ... 33

List of tables

Page number

Vol 17 Table 9.3.1 Noise and vibration – consultation comments ... 4

Vol 17 Table 9.4.1 Noise and vibration – sensitive receptors and noise levels ... 10

Vol 17 Table 9.4.2 Noise – residential receptors and assessment categories ... 11

Vol 17 Table 9.5.1 Noise – impacts at residential receptors (high sensitivity) ... 13

Vol 17 Table 9.5.2 Noise – impacts at non-residential receptors ... 14

Vol 17 Table 9.5.3 Vibration – impact and magnitude of human response to vibration impacts ... 20

Vol 17 Table 9.5.4 Vibration – building vibration impacts and their magnitudes ... 22

Vol 17 Table 9.6.1 Noise – operational airborne noise impacts ... 24

Vol 17 Table 9.10.1 Noise – summary of construction assessment 29
Vol 17 Table 9.10.2 Vibration – summary of construction assessment 30
Vol 17 Table 9.10.3 Noise – summary of operational assessment 31
Vol 17 Table 9.10.4 Vibration – summary of operational assessment 32

9 Noise and vibration

9.1 Introduction

9.1.1 This section presents the findings of the assessment of the likely significant noise and vibration effects of the proposed development at the Victoria Embankment Foreshore main site.

9.1.2 The proposed development has the potential to affect noise and vibration levels at receptors due to:

a. construction site activities (noise and vibration)

b. construction traffic on roads outside the site (noise)

c tugs pulling river barges conveying materials to and from the site (noise)

d. operation of the proposed development (noise and vibration).

9.1.3 Each of these is considered within the assessment.

9.1.4 The tunnel drive for the main tunnel does not run beneath the shaft at this location. Groundborne noise and vibration from the tunnelling activities associated with the main tunnel, long connection tunnels and certain short connection tunnels are considered in Volume 3 Project-wide effects assessment[i].

9.1.5 The assessment of noise and vibration presented in this section has considered the requirements of the National Policy Statement for Waste Water Section 4.9 (noise and vibration) (Defra, 2012)[1]. Further details of these requirements can be found in Volume 2 Environmental assessment methodology Section 9.3.

9.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore figures).

9.2 Proposed development relevant to noise and vibration

9.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to noise and vibration are set out below.

[i] Surface activities to facilitate construction of the short connection tunnel are considered within this assessment. Construction of the short connection tunnel at this site is not considered within Volume 3 as the connection tunnel would be constructed beneath the river away from sensitive receptors and effects from groundborne noise and vibration are therefore not considered likely

Construction

Construction traffic

9.2.2 During construction cofferdam fill (both import and export), shaft and other excavated material (export) would be transported by barge. For the noise assessment it has been assumed that 90% of these materials would be taken by river. This allows for periods that the river is unavailable and material unsuitable for river. All other materials would be transported by road. Estimated barge and vehicle numbers are presented in Vol 17 Sections 3.3 and 12.2.

Construction activities

9.2.3 Vol 17 Section 3.3 sets out the assumed construction duration and programme for the Victoria Embankment Foreshore site.

9.2.4 The construction works at this location would involve the following activities that have the potential to affect noise and vibration levels in the vicinity of the site:

a. utility diversions

b. hoarding and site setup

c. demolition

d. cofferdam construction

e. shaft construction

f. connection tunnel construction

g. shaft secondary lining

h. interception and culvert works

i. landscaping (including construction and fit-out of permanent facility).

9.2.5 Further detail on the plant used in these construction stages is given in Vol 17 Appendix G.

9.2.6 Working hours would be subject to consultation and agreement with the local authority, however for the purpose of the assessment it is considered reasonable to assume that activities would be carried out during the following periods:

a. standard (core) hours (08.00-18.00 weekdays and 08.00-13.00 Saturdays) as identified in the *Code of Construction Practice (CoCP)*.

b. continuous working (24 hours a day, 7 days a week) for the construction of the short connection tunnel from the shaft to the main tunnel. This would be carried out over a period of approximately four months.

Code of Construction Practice

9.2.7 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

9.2.8 The *CoCP Part A* (Sections 4.3 and 6.4) specifies the use of best practicable means (BPM) to reduce noise and vibration effects. Generic measures include:

a. careful selection of construction plant construction methods and programming

b. equipment would be suitably sited so as to minimise noise impact on sensitive receptors

c. use of site enclosures, and temporary stockpiles to provide acoustic screening

d. choice of routes and programming for the transportation of construction materials, excavated material and personnel to and from the site

e. careful programming so that activities which may generate significant noise would be planned with regard to local occupants and sensitive receptors.

f. hoarding would be of a height and extent to achieve appropriate noise attenuation.

9.2.9 Site specific measures incorporated into the *CoCP Part B* (Sections 4 and 6) to reduce noise and vibration effects include:

a. the site hoarding on the western boundary would be 3.6m high

b. 2.4m noise barrier on the northern and southern boundary of the temporary cofferdam, to screen receptors on the water

c. the loading and unloading of barges would only be carried out during standard working hours

d. baseline noise studies would be required for the worksite. Agreement of action levels and permanent noise monitoring locations would be required with the local authority as part of the Section 61 process

Operation

9.2.10 Ventilation columns and a kiosk would be constructed to contain plant and filter equipment. The operational plant installed would have the potential to create noise impacts, and these are considered in the assessment.

9.2.11 During tunnel filling events water would descend via a vortex structure through the drop shaft to the connection shaft below. The potential for noise generated by this movement of water through the shaft has been assessed.

Environmental design measures

9.2.12 The operational plant associated with the surface structures would incorporate environmental design measures to control noise emission to the nearest noise sensitive receptors to acceptable noise limits. These are as defined by the Local Authority in which the receptor lies; at Victoria Embankment Foreshore, all receptors lie within the City of Westminster (see para. 9.3.17). The environmental design measures have considered the following noise sources:

a. hydraulic plant for penstock operation (pumps, motors)

b. uninterruptable power supply (UPS) plant.

9.2.13 In considering the noise from the above items, the sound insulation of the housing for the equipment has been taken into consideration.

9.2.14 The design of the drop shaft would control the descent of water by channelling the flow around the internal face of a vortex drop tube within the drop shaft, rather than allowing the water to free fall. The vortex design allows large volumes of water to descend with less noise generation than a falling cascade design.

9.3 Assessment methodology

Engagement

9.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of noise and vibration are presented here.

9.3.2 The survey methodology and monitoring locations were agreed with Westminster City Council. The limits for plant noise from the operation of the site were also obtained from Westminster City Council.

9.3.3 Additional consultation on the survey methodology was undertaken with Westminster City Council with regards to the need for continuous monitoring locations. For this site it was agreed that representative data could be obtained by leaving two unattended continuous monitoring kits securely within Whitehall Gardens (part of Victoria Embankment Gardens) overnight for a typical weekday and weekend.

9.3.4 Written confirmation on the survey methodology was received from the Westminster City Council on 1st November 2011.

9.3.5 Consultation comments relevant to this site for the assessment of noise and vibration are presented in Vol 17 Table 9.3.1. There were no other site specific comments from stakeholders in relation to noise and vibration raised at scoping or other consultation stages.

Vol 17 Table 9.3.1 Noise and vibration – consultation comments

Organisation	Comment	Response
Westminster City Council, scoping response. March 2011	The impact of utility and traffic diversions should be considered as part of the construction activities and their effects assessed in relation to traffic flow, air quality, odour and dust, noise and vibration.”	Utility diversions have been taken into account in the assessment. Traffic diversions are covered in Section 12 *Transport.*
Westminster City Council,	The construction impact of the connecting tunnel	The assessment takes account of construction of

Organisation	Comment	Response
scoping response. March 2011	should be considered as part of the assessment”	the connection tunnel.
Westminster City Council, scoping response. March 2011	An assessment of the use of river transport for access, construction and post construction works and activities compared to alternative modes of transport should be included in the ES”	The assessment considers the use of river transport where the logistics strategy indicates potential for this. Sensitivity testing, comparing alternative modes of transport has been included in the Transport Assessment.
Westminster City Council, Phase two response. February 2012	The City Council agrees with the use of temporary fences for more mobile and changing worksites, especially for some utilities diversion activities. However we would wish to see a list of the anticipated activities and how noisy activities will be mitigated through the use of e.g. acoustic barriers.	Utilities diversions have been taken into account in the assessment where necessary. A list of the construction activities which have been assessed is included in Section 9.2, and the *CoCP Parts A and B* contain further information on the hoarding which would be used around the site, as summarised in Section 9.2.
Westminster City Council, Phase two response. February 2012	The City Council will require that each process is quantified by monitoring to ensure that limits are adhered to, as well as further monitoring at suitable intervals or when complaints are lodged. These monitoring results and those associated with complaints should be forwarded to the City Council for their inspection and records. A site Section 61 will be used to condition this process.	Monitoring activities and the process for obtaining Section 61 agreements are outlined in the *CoCP Part A*.
Westminster City Council, Phase two	The assessment methodology is standard and follows main national	A design rating level of 10dB below the background noise level

Organisation	Comment	Response
response. February 2012	guidelines (BS5228[2], BS4142[3] and BS6472[4]). The City Council is discussing the requirements for the monitoring regime with Thames Water and will continue to do so.	has been adopted at this site which is compliant with Westminster City Council requirements. An assessment of the noise associated with the tunnel filling is presented in this chapter.
Westminster City Council, Phase two response. February 2012	The noise data predicted for this site indicates that the construction noise will generally be below ambient values except in the enabling phase where it marginally exceeds it (ambient being 65-68dB L_{Aeq}). This suggests minimal noise impact for this site. The City Council would wish to see traffic noise data for this site due to increased traffic resulting from the proposals.	An assessment of traffic noise is included within this volume and is based on data provided by the traffic and transport team.
English Heritage, phase two response. February 2012	English Heritage requests that the National Liberal Club be identified as a receptor for noise and vibration in tables 9.4.1, 9.4.2 and 9.4.3 on pages 109-111	The National Liberal club has been included as receptor by association with the residences at Whitehall Court (see para 9.5.7)

Baseline

9.3.6 The baseline methodology follows the methodology provided in Vol 2 Section 9. There are no site specific variations for this site.

Construction

9.3.7 The assessment methodology for the construction phase follows that described in Vol 2 Section 9. There are no site specific variations for undertaking the construction assessment of this site.

9.3.8 Section 9.5 details the likely significant effects arising from the construction at Victoria Embankment Foreshore. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on noise and vibration within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

9.3.9 The construction noise and vibration assessment has considered the effects across the whole duration of the construction phase and the worst-case exposure levels are reported. The development case (with the Thames Tideway Tunnel project) has been assessed against the base case (without the Thames Tideway Tunnel project).

9.3.10 Of the schemes identified in the development schedule (Vol 17 Appendix N), the London Eye Pier extension development is considered relevant for the construction assessment base case as is it assumed to be complete and operational before or during the Thames Tideway Tunnel construction period. It is included in the assessment by reference to other receptors which are closer to the site.

9.3.11 None of the schemes outlined in the site development schedule (see Vol 17 Appendix N) are considered relevant to the construction cumulative assessment as they are either assumed to be complete and operational by Site Year 1 of construction or are located outside of the 300m assessment area.

9.3.12 Traffic flows on construction traffic routes have been examined to determine if there are any routes where there is the potential for traffic noise changes of 1dB(A) or more. This is according to the flow, speed or composition change criteria specified in Vol 2 Section 9. The results show that there are no traffic changes on the road network associated with this site which meet the relevant criteria. This is discussed further in the assessment section from para 9.6.1.

9.3.13 The assessment of construction effects also considers the extent to which the effects on noise and vibration would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Construction assessment area

9.3.14 As described in Vol 2 Section 9 the assessment area considers unscreened receptors up to a maximum of 300m from the site boundary based on professional judgement of the likelihood of significant effects. The assessment primarily concentrates on those receptors closest to the site which would generally be most affected, rather than those further away which would be well screened by intervening buildings. Effects at more distant receptors beyond those closest to the site have been considered where necessary by reference to the impacts determined at the primary (closest) receptors.

Operation

9.3.15 The operational phase assessment methodology follows the methodology provided in Vol 2 Section 9. Site specific variations to this methodology are set out below.

9.3.16 All residential receptors at this site fall within the City of Westminster. Westminster City Council requires that building services plant noise emission limits are set relative to background noise levels for residential receptors.

9.3.17 For this site, Westminster City Council requires that noise emissions from this type of source are designed to meet a rating level (as defined in BS4142[2]) which is 10dB below the typical background noise level over the operational period of the plant at 1m from the facade of the nearest residential receptor.

9.3.18 The operational assessment year is taken to be Year 1 of operation.

9.3.19 Section 9.6 details the likely significant effects arising from the operation of the Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on noise and vibration within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

9.3.20 All the schemes outlined in the site development schedule (see Vol 17 Appendix N) are due to have been completed by Year 1 of the operational period. Of the schemes which lie within the assessment area, all are represented by other receptors closer to the site. As such, there are no additional operational base case receptors included in this assessment.

9.3.21 None of the schemes outlined in the site development schedule (see Vol 17 Appendix N) are considered relevant to the operational cumulative assessment, because due to their use, none are expected to generate significant noise or vibration levels during their operation.

9.3.22 Based on the traffic flow, speed or composition change criteria specified in Vol 2 Section 9, there are no routes where potential for operational traffic noise effects would occur.

9.3.23 The assessment of operational effects also considers the extent to which the effects on noise and vibration would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Operational assessment area

9.3.24 Operational effects are considered up to 300m from the site boundary, although the focus is on those receptors closest.

Assumptions and limitations

9.3.25 The generic assumptions and limitations associated with this assessment are presented in Vol 2 Section 9. The site specific assumptions are presented in the following section. There are no limitations to the assessment at this site.

Assumptions

9.3.26 The working hours assumed for the assessment are as described in para. 9.2.6.

Limitations

9.3.27 There are no limitations associated with this site-specific noise and vibration assessment.

9.4 Baseline conditions

9.4.1 The following section sets out the baseline conditions for noise and vibration within and around the site. Future baseline conditions (base case) are also described.

Current baseline

9.4.2 The current baseline noise conditions are as described in the baseline survey. The specific details of this survey, such as the measurement times, locations measured, results and local conditions are described in Vol 17 Appendix G. Vol 17 Table 9.4.1 below shows that the noise levels for the daytime period fall within a relatively small range, the noise levels being generally dominated by road traffic noise from the Victoria Embankment, other roads in the vicinity and rail traffic on the Hungerford Bridge.

Receptors

9.4.3 This section describes the setting and receptor characteristics of the site for the purposes of this assessment.

9.4.4 The closest noise and vibration sensitive receptors selected for the noise and vibration assessment are identified in Vol 17 Table 9.4.1 below (and shown in plan view in Vol 17 Figure 9.4.1 – see separate volume of figures). These were selected as they are representative of the range of noise climates where sensitive receivers are situated around the site. The approximate number of residential properties affected at each location (where known) is indicated in Vol 17 Table 9.4.2.

9.4.5 The nearest residences are located west of the development at Whitehall Court and are within the City of Westminster. The non-residential noise sensitive receptors selected for assessment are The Playhouse Theatre on Craven Street, Whitehall Gardens, Jubilee Gardens (across the River Thames), Ministry of Defence Offices to the south of Horse Guards Avenue, and two moored bar/restaurant vessels, the Tattershall Castle and the Hispaniola. These vessels are moored upstream of the Hungerford Bridge and adjacent to Victoria Embankment. The Hispaniola would remain in its current position throughout the construction period and the Tattershall Castle would be relocated upstream during the construction phase and then moved permanently to a new location just upstream of its original mooring.

9.4.6 Beyond these closest receptors there are other non-residential locations, generally office buildings, which are screened from the site by intervening buildings. These include the Metropole buildings and the Royal Festival Hall which have been considered as secondary receptors in the assessment.

Receptor sensitivity

9.4.7 The noise and vibration sensitive receptors have been assessed according to their sensitivity, using the methodology outlined in Vol 2

Section 9. The sensitivities of all assessed receptors are presented in Vol 17 Table 9.4.1.

Vol 17 Table 9.4.1 Noise and vibration – sensitive receptors and noise levels

Ref	Receptor addresses	Sensitivity	Local authority	Measured average ambient noise level, day/ evening/ night, dBL_{Aeq*}	Noise survey location**
VE1	Whitehall Court (residential)	High	Westminster City Council	64/66/57	VEF01
VE2	Whitehall Gardens (park)	Medium	Westminster City Council	66/NA/NA	VEF02
VE3	Jubilee Gardens (park)	Medium	London Borough of Lambeth	67/NA/NA	VEF03
VE4	Ministry of Defence (offices)	Medium	Westminster City Council	64/66/57	VEF01
VE5	Playhouse Theatre	High	Westminster City Council	69/75/66	VEF02 (daytime), VEF04 (evening and night)
VE6	The Hispaniola (bar/ restaurant)	Medium	Westminster City Council	69/75/66	VEF02 (daytime), VEF04 (evening and night)
VE7	Tattershall Castle (bar/ restaurant)	Medium	Westminster City Council	69/71/66	VEF02 (daytime), VEF04 (evening and night)

** Noise level includes correction for façade acoustic reflection unless receptor position is an open outdoor space (eg park)*

9.4.8 The baseline noise level is considered representative of the relevant receptor. Consideration has been given to the distance of the measurement location to the receptor, the orientation of the primarily affected façade and location of the controlling noise source(s). For VE5, VE6 and VE7, the ambient noise levels have been taken from more than one location in order to adequately represent each time period.

9.4.9 The criteria for determining the significance of noise effects at residences from construction sources are partly dependent upon the existing ambient noise levels. From the ambient noise levels measured during the baseline survey, the assessment category and assessment noise threshold levels for the residential receptors near the Victoria Embankment site are as shown in Vol 17 Table 9.5.2.

9.4.10 The assessment of significance at non-residential receptors is made according to the construction noise level relative to the ambient noise level (see Vol 17 Table 9.5.2) using the impact criteria described in Vol 2 Section 9.5 (where appropriate) and other factors described in Volume 2.

Vol 17 Table 9.4.2 Noise – residential receptors and assessment categories

Ref	Noise sensitive receptor (No. of dwellings)	Ambient noise level, rounded to nearest 5dBL_{Aeq}* day/ evening/ night	Assessment category* day/ evening/ night	Significance criterion threshold level*, day, dB$L_{Aeq\ 10hour}$/ evening dB$L_{Aeq\ 1hour}$/ night, dB$L_{Aeq\ 1hour}$
VE1	Whitehall Court (120)	65/65/55	B/C/C	70/66/57

* *From 'ABC' method – BS5228:2009*

Construction base case

9.4.11 The construction base case taking into account the schemes described in Section 9.3 would change as the London Eye Pier Extension would be complete. It has been included in the assessment by reference to another closer receptor.

9.4.12 The noise levels, as measured during the baseline noise survey in 2011, are assumed for the base case. However, there is the potential for variations to occur in the ambient noise levels between 2011 and the base case year. If the noise levels were to vary, it is considered likely that they would increase compared to the measured data from 2011 due to natural traffic growth. The estimated traffic increases for the construction base case in Site Year 1 are such that noise levels would be expected to increase by less than 1dB(A) from those measured in 2011. The assessment based on data from 2011 therefore presents a worst-case assessment.

9.4.13 It is considered that there are no other circumstances at this location that would cause the baseline noise levels at the receptor locations to change significantly between 2011 and the first year of construction.

9.4.14 There are no major vibration sources immediately alongside the site on The Embankment. However, the Bakerloo line runs under the river to the north of the site and between receptors on Northumberland Avenue (The Playhouse Theatre and MoD offices). Also, the District and Circle line runs underneath the Embankment and the overground line passes along Hungerford Bridge over the Embankment running into Charing Cross Station just to the north of Northumberland Avenue. It is considered that vibration levels are unlikely to change between the present time and the base case.

9.4.15 As mentioned in Section 2 of this volume, the Tattershall Castle would be relocated upstream prior to the commencement of construction works, and this location has been used in the assessment of impacts. The development case is therefore assumed to be the base case as identified in 2011 with the relocated Tattershall Castle.

Operational base case

9.4.16 The base case in Year 1 of operation taking into account the schemes described in Section 9.3 includes the London Eye Pier Extension, which is included by reference to a closer receptor.

9.4.17 The operational base case has been estimated from traffic flow expectations for the Year 1 of the operational phase as result of natural growth and new development in the vicinity. The estimated traffic increases for the operational base case in year one of operation are such that noise levels would be expected to increase by less than 1dB(A) from those measured in 2011.

9.5 Construction effects assessment

Noise

9.5.1 The results of the assessment of construction noise are presented in Vol 17 Table 9.5.1 and Vol 17 Table 9.5.2. The tables show the range of predicted construction noise levels during the entire period of the works and a typical monthly construction noise level. The typical monthly level is the most frequently occurring monthly noise level during the works. The tables also show the total number of months across all construction stages that the noise level would be likely to exceed the impact criterion threshold level indicating potential significance. The final columns in the tables show the worst-case excess above the impact criterion together with the duration of the worst-case noise level. In cases when the impact criterion is exceeded (as marked by an asterisk in Vol 17 Table 9.5.1), further assessment of the likely noise ingress to the interior of the building has been carried out to more precisely estimate the resulting noise impact on the occupants. The noise ingress would depend on the degree of façade noise insulation of the particular buildings which is considered in further detail in these cases.

9.5.2 To illustrate the predicted variation in construction noise levels at each receptor position across the duration of the construction phase, Vol 17 Appendix G Plates G.6 to G.12 show the estimated noise levels plotted month-by-month over the duration of the works. The appendix also lists the construction plant and operations assumed for the calculations. The predicted impacts and assessed effects at each representative receptor location are described below.

Impacts at residential receptors

9.5.3 The results for residential receptors are shown below.

Vol 17 Table 9.5.1 Noise – impacts at residential receptors (high sensitivity)

Ref/ receptor[a] (No. of noise sensitive properties)	ABC impact criterion threshold level (potential significance for residential), dBL_{Aeq}[b]	Range of construction noise levels, dBL_{Aeq}[c,d]	Typical[e] monthly construction noise levels, dBL_{Aeq}	Magnitude		
				Total duration above criterion for all works, months	Worst-case excess above criterion, dBL_{Aeq}[f] (*further assessment undertaken for excess above criterion)	Duration of worst-case excess above criterion, months
VE1 Whitehall Court (120)	70	55-70 (day)	64	0	0	0
	66	42-62 (eve)	42	0	-4	0
	57	56-56 (night)	56	0	-1	0

[a] *Floors subject to highest noise level assessed – not necessarily the highest floor level*

[b] *The potential significance threshold is based on the ambient noise level as defined in Volume 2*

[c] *Construction noise only, excludes ambient noise. Refer to Volume 2 Section 9.5*

[d] *Noise level includes correction for façade acoustic reflection*

[e] *Most frequently occurring monthly construction noise level during works*

[f] *Positive value indicates exceedance, negative value indicates noise below criterion*

Whitehall Court (VE1)

9.5.4 Whitehall Court is a large ten storey building. The upper floors, from the second floor and above, would directly overlook the site, albeit at a distance of some 65m from the site boundary, and due to the height of the building would not be screened by the site hoardings. The predicted noise levels at these dwellings due to construction activities are shown in Vol 17 Table 9.5.1. The typical daytime noise levels (most frequently occurring monthly level) is $64dBL_{Aeq}$. The site establishment and the construction of the cofferdam and the river wall works are expected to cause the worst-case noise level of $70dBL_{Aeq}$ for a total of three months.

9.5.5 During the evening and night-time, the construction of the main tunnel is expected to cause the worst-case noise levels of 62dBL_{Aeq} and 56dBL_{Aeq} respectively.

9.5.6 The construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor at any time during the day, evening or night. The effect is therefore **not significant**.

9.5.7 On the western boundary of Whitehall Gardens, adjacent to Whitehall Court are the National Liberal Club and the Royal Horseguards Hotel. In addition to the rooms at the hotel, it is understood that the National Liberal Club includes some sleeping accommodation in the building, but not for permanent residential use. The eastern façade of these buildings would be subject to approximately the same ambient noise and predicted construction noise levels as Whitehall Court. The hotel, offices and the club are categorised as medium sensitivity. As the construction noise levels do not exceed the ambient noise levels, any increase in noise levels inside the building is not expected to cause disturbance to users. This is therefore assessed as **not significant**.

9.5.8 To the north of the National Liberal Club lie the Metropole buildings (Royal Horseguards Hotel) which are used as a hotel/spa, which is also classified as a medium sensitivity receptor. These buildings would be largely screened by the National Liberal Club, and also lie further from the development than Whitehall Court. The impact to this building would be lower than either Whitehall Court or the National Liberal Club, and therefore the effect is **not significant**.

Impacts at non-residential receptors

9.5.9 The results for non-residential receptors are shown below.

Vol 17 Table 9.5.2 Noise – impacts at non-residential receptors

Ref/receptor	Receptor sensitivity[a]	Range of construction noise levels, dBL_{Aeq}[b,c,d]	Ambient baseline noise level, dBL_{Aeq}[d]	Typical[e] monthly construction noise levels, dBL_{Aeq}	Magnitude	
					Total duration above ambient for <u>all</u> works, months	Worst-case excess above ambient, dBL_{Aeq}
VE2 Whitehall Gardens	Medium	53-68 (day)	66	51	1	+2
VE3 Jubilee Gardens	Medium	47-66 (day)	67	60	0	-1
VE4 Ministry of Defence	Medium	57-73 (day)	64	64	18	+9

Ref/receptor	Receptor sensitivity[a]	Range of construction noise levels, dBL_{Aeq}[b,c,d]	Ambient baseline noise level, dBL_{Aeq}[d]	Typical[e] monthly construction noise levels, dBL_{Aeq}	Magnitude	
					Total duration above ambient for <u>all</u> works, months	Worst-case excess above ambient, dBL_{Aeq}
(offices)						
VE5 Playhouse (theatre)	High	49-63 (day)	69	56	0	-6
		46-46 (eve)	75	43	0	-29
VE6 The Hispaniola (bar/ restaurant)	Medium	60-75 (day)	72	67	2	+3
		57-57 (eve)	75	41	0	-18
VE7 The Tattershall Castle (bar/ restaurant)	Medium	58-80 (day)	70	65	8	+10
		64-64 (eve)	71	64	0	-7
		64-64 (night)	66	64	0	-2

[a] *Assumed typical façade transmission loss and appropriate internal noise guidelines*

[b] *Floors subject to highest level assessed – not necessarily the highest floor level*

[c] *Construction noise only, excludes ambient noise. Refer to Volume 2*

[d] *Noise level includes correction for façade acoustic reflection unless receptor position is an open outdoor space (eg park)*

[e] *Most frequently occurring monthly construction noise level during works*

Whitehall Gardens VE2

9.5.10 The centre of the gardens is approximately 45m from the boundary of the site. The typical daytime construction noise level (ie most commonly occurring level) is 51dBL_{Aeq} shown in Vol 17 Table 9.5.2. The worst-case noise level of 68dBL_{Aeq} would occur once in the first month of the works during site set up. The ambient noise level is exceeded by 2dB(A) for one month over the duration of the works.

9.5.11 The ambient noise levels are currently above guideline noise levels for outdoor public open spaces. An increase of 5dB(A) above ambient noise level is described in BS5228[1] as a significance threshold for public open spaces; in this case the ambient noise level is exceeded by 2dB(A). The receptor is not considered to be as sensitive as a residential location.

Given the level of impact and the nature of use, the effect is assessed as **not significant**.

Jubilee Gardens VE3

9.5.12 This location is over 200m from the boundary of the works although the gardens are largely unscreened from the site across the river. The typical daytime construction noise level (ie most commonly occurring level) is 60dBL_{Aeq} shown in Vol 17 Table 9.5.2. The worst-case noise level of 66dBL_{Aeq} would occur for two months over the duration of the works. The construction noise levels are always below daytime ambient noise levels and effects would be **not significant**.

9.5.13 The London Eye Pier extension lies on the south bank of the River Thames, by Jubilee Gardens, at a location further from the development than the receptor point considered here. This would therefore be subject to lower noise levels than the gardens.

9.5.14 To the north of this receptor position, on the north side of Hungerford Bridge (on the south side of the River Thames) is the Royal Festival Hall which is approximately 300m from the site boundary. Given that construction noise levels at receptor VE3 are below ambient noise levels during the daytime and evening period, construction would not be expected to cause disturbance at the Royal Festival Hall.

9.5.15 For this open area on the opposite side of the river, the daily construction noise levels would be well below average ambient noise levels. For this area, the London Eye Pier Extension and the Royal Festival Hall, the effects are assessed as **not significant**.

Ministry of Defence VE4

9.5.16 This office building is approximately 80m from the boundary of the works. The typical daytime construction noise level (ie most commonly occurring level) is 64dBL_{Aeq} shown in Vol 17 Table 9.5.2. The worst-case noise level of 73dBL_{Aeq} would occur for three months of the works during the demolition and cofferdam construction, at third floor and above.

9.5.17 Over the duration of the works, the ambient noise level is expected to be exceeded for a total of 18 months. During other construction activities the noise levels are predicted to be lower than during the demolition and cofferdam works.

9.5.18 Although the noise level would increase relative to the ambient noise level and this could be noticeable inside the building, the increase in average noise levels inside the building is not expected to exceed guideline noise levels for general office use based on typical noise insulation for a façade of this type. Hence, the increase in noise levels here is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

Playhouse Theatre VE5

9.5.19 The Playhouse is approximately 100m from the boundary of the works. The typical daytime noise level (ie most commonly occurring level) is 56dBL_{Aeq} shown in Vol 17 Table 9.5.2. The worst-case daytime noise level of 63dBL_{Aeq} would occur in the first month of the works during site set up. The worst-case evening noise level of 46dBL_{Aeq} would occur during the connection tunnel construction.

9.5.20 Daytime construction noise levels would be well below daytime ambient noise levels. During the evening, the noise levels are also below the ambient noise level. Construction noise would not be expected to result in disturbance to occupants during either the day or evening.

9.5.21 It is not expected that construction noise would be intrusive in the theatre or exceed the guideline internal levels given in BS8233[5] for theatre auditoria. Construction noise is assessed as **not significant**.

The Hispaniola VE6

9.5.22 The bar/restaurant ship the Hispaniola is moored immediately to the north of the proposed works site boundary. The ship comprises of outdoor and indoor dining areas which would face towards the site. The indoor conference room is also located toward the construction site. The vessel rises and falls with the tide, and so the ship benefits from more screening effects from noise at low tide. At the highest tide, the top deck (outdoor area) would still be screened from the worksite.

9.5.23 The typical daytime noise level (ie most commonly occurring level) is 67dBL_{Aeq} shown in Vol 17 Table 9.5.2. The worst-case noise level of 75dBL_{Aeq} would occur only for one month of the works during the demolition works. The ambient noise level is exceeded for a total of two months over the duration of the works.

9.5.24 During the daytime, the estimated noise transmitted to the restaurant interior of the ship is not expected to exceed guideline noise levels given in BS8233 for restaurant use. However, the guideline noise levels for conference facilities would be exceeded.

9.5.25 The Hispaniola has an upper deck restaurant area which is not within the main dining area. The ambient noise levels at this location exceed the guideline noise levels given in BS8233, and it is likely that daytime construction noise may at times cause some disturbance to users of the deck area depending on construction activities in progress, particularly during the two month period where construction noise levels are above the ambient noise level.

9.5.26 Given the degree of impact during the daytime and the level of construction noise ingress to the receptor, this is assessed as **significant**. The Hispaniola is advertised as being open until 11pm. The assessment has considered the impacts of evening works to this receptor. The worst-case evening noise level of 57dBL_{Aeq} would occur during construction of the connection tunnel. This is below the existing ambient noise level.

9.5.27 During the evening period, the degree of impact from construction noise to the receptor is considered **not significant**.

The Tattershall Castle VE7

9.5.28 The Tattershall Castle bar/restaurant ship would be relocated approximately 100m further upstream. The lowest deck of the ship which faces the site forms the kitchen and back of house areas of the ship. The aft of the main deck forms an entertainment and bar area, with the upper deck an outdoor bar area with seating.

9.5.29 The typical daytime noise level (ie most commonly occurring level) is 65dBL_{Aeq} shown in Vol 17 Table 9.5.2. The worst-case noise level of 80dBL_{Aeq} would occur for one month during the cofferdam piling. The ambient noise level would be exceeded for a total of eight months over the entire duration of the works. This average noise increase over the day would be noticeable relative to average ambient noise.

9.5.30 The re-located Tattershall Castle would lie slightly closer to the noisiest elements of the construction works than the Hispaniola and so would be subject to a slightly larger rise in daily noise level relative to the average ambient level. The estimated noise transmitted to the bar area in the interior of the ship is expected to exceed guideline noise levels given in BS8233[5] for a restaurant.

9.5.31 The Tattershall Castle also has an open deck bar area which faces the Victoria Embankment worksite. The ambient noise levels at this location exceed the guideline noise levels given in BS82335, and the daytime construction noise levels are well in excess of the daytime ambient noise levels. It is likely that daytime construction noise would at times cause disturbance to users of the bar depending on construction activities in progress.

9.5.32 The Tattershall Castle is advertised as open until at least 2am. The assessment has considered the impacts of evening and night-time construction works. The worst-case evening and night-time noise levels of 64dBL_{Aeq} would occur during construction of the connection tunnel. This is below the existing ambient noise level for both evening and night-time periods.

9.5.33 Given the impact level, duration of impact and level of construction noise ingress, this is assessed as **significant**.

Road-based construction traffic

9.5.34 The location of the site adjacent to Victoria Embankment provides direct access to the major road network through London. The construction programme would result in varying traffic generation over a period of four and a half years. During the peak construction period the traffic generation is forecast to average 14 heavy vehicles (HGVs) per day (equivalent to 28 movements a day).

9.5.35 The major road links adjacent to and leading to the site are Victoria Embankment, Northumberland Avenue, Whitehall, Cockspur Street and Strand. Vehicles would not use other local roads such as Horse Guards Avenue and Whitehall Place.

9.5.36 A flow change of about 25% is required to cause a change in noise level of 1dB and by 100% to cause a change of 3dB, which is considered to be the minimum change perceptible to the human ear. Additionally, a change in HGV composition of 5% is also considered to cause a change in noise level of 1dB.

9.5.37 The traffic modelling shows that the 18 hour Annual Average Weekday Traffic (AAWT) flow on Victoria Embankment, adjacent to the site is currently more than 44,000 vehicles per day (vpd), with average speeds of 14mph (22kph). Of this, 6% are HGVs. The total number of HGVs is therefore over 2,600 per day.

9.5.38 The section of Victoria Embankment, which is to the North East of Northumberland Avenue has nearly 60,000 vpd with 5.7% HGVs. The other roads have less than a third of these flows but a much higher proportion of HGVs.

9.5.39 The modelling of construction traffic on these links shows that the highest percentage increase in total flow due to construction HGVs would occur on the section of Victoria Embankment which is adjacent to the site. The current flow is above 44,000 vpd. The average daily number of construction HGVs on this link during the peak month of construction is 24 and the daily number of worker cars and office/operational light vehicles is anticipated to be up to 30, with the number of cars and light vehicles consistent across the construction period. This represents a percentage increase in flow of just above 0.1%.

9.5.40 Additionally, the modelling of the construction traffic on these links shows that the highest increase in HGV composition would also occur on the same section of Victoria Embankment. The average daily number of construction HGV movements on this link during the peak month of construction is 24, which, taking into account the number of worker cars and office/operational light vehicles, represents an increase in HGV composition of less than 0.1%.

9.5.41 The impact of road-based construction traffic on nearby receptors is therefore **not significant**.

9.5.42 The existing volume of traffic on these links during the daytime far exceeds the predicted number of heavy vehicles associated with construction of the Thames Tideway Tunnel and therefore there is no impact from the road-based construction traffic.

9.5.43 The need for occasional evening or night-time deliveries would be under particular circumstances, ie, large concrete pours or abnormal loads. Later night-time deliveries for abnormal loads would be exceptional and would be arranged on agreement with local authority and noise impacts dealt with accordingly.

River-based construction traffic

9.5.44 The use of river craft for the transport of materials to and from the site could result in noise impacts at nearby receptors.

9.5.45 The movement of these craft would be at appropriate stages in the tide. In between times, and during standard working hours, the moored craft, assumed to be an open barge, would be unloaded or loaded. Noise measurements for such activities have been reported in other studies[6] and are included above as part of the construction activities in the construction works assessment. The engine noise from movement of the barges, on the River Thames is limited[7] to 75dB(A) at 25m.

9.5.46 Tugs handling up to two barges would operate twice a day with the tide. Each movement (delivery and removal) would be 20 minutes, totalling 80 minutes over two periods in one day.

9.5.47 The operation, loading and removal of the river barges which takes place within the site boundary has been considered in the construction noise assessment above.

9.5.48 The operation of the tugs on the river outside of the site boundary have been assessed in relation to the nearest residential receptor, Whitehall Court and the nearest non-residential receptors, the Hispaniola and Tattershall Castle.

9.5.49 Whitehall Court is approximately 50m from the barge loading area which would result in a noise level of 65dBL_{Aeq} (see Vol 17 Appendix G Table G.12) at the closest point, equal to the measured noise level at the measurement location, which is therefore considered to be **not significant**.

9.5.50 The Hispaniola and Tattershall Castle are moored along Victoria Embankment. These could be considered to be a minimum of 30m from the tug. The noise level from moving the barges would be 71dBL_{Aeq} over two 40 minute periods through the day. The baseline noise level has been measured as 70-75dBL_{Aeq} (see Vol 17 Appendix G Table G.12) and the receptor is considered to be of medium sensitivity, hence the effect on these receptors is considered to be **not significant**.

Vibration

9.5.51 The assessment of construction vibration considers events which have the potential to cause human disturbance, or damage to buildings and structures. The assessments of human disturbance and effects on building structures are carried out separately using different parameters.

9.5.52 The assessment has been conducted using the methodology defined in Vol 2 Section 9.

9.5.53 The assessment of human disturbance due to construction vibration impacts at neighbouring receptors has been assessed using the predicted estimated Vibration Dose Value (eVDV). The results from the assessment are presented in Vol 17 Table 9.5.3.

Vol 17 Table 9.5.3 Vibration – impact and magnitude of human response to vibration impacts

Ref	Receptor	Impact (highest predicted eVDV across all activities, $m/s^{1.75}$)*	Value/ sensitivity	Magnitude
VE1	Whitehall Court	<0.2	High	Below “low probability of adverse comment” - No

Ref	Receptor	Impact (highest predicted eVDV across all activities, $m/s^{1.75}$)*	Value/ sensitivity	Magnitude
				impact
VE2	Whitehall Gardens	<0.1	Medium	Below “low probability of adverse comment” - No impact
VE3	Jubilee Gardens	<0.1	Medium	Below Low probability of adverse comment” - No impact
VE4	Ministry of Defence	<0.1	Medium	Below Low probability of adverse comment - No impact
VE5	Playhouse Theatre	<0.1	High	Below Low probability of adverse comment - No impact
VE6	The Hispaniola	<0.1**	Medium	Below Low probability of adverse comment - No impact
VE7	Tattershall Castle	<0.1**	Medium	Below Low probability of adverse comment - No impact

**Most affected floor*

*** Predicted vibration levels assume groundborne transmission. For boats moored in the river it is expected that vibration transmission would be reduced and the vibration levels would be lower than those estimated*

9.5.54 All of the predicted eVDV levels at each of the receptor locations fall below the ‘Low probability of adverse comment’ band, as described in Vol 2 Section 9 and therefore significant effects are not anticipated. These predicted levels are based upon the highest anticipated exposures during the most intense vibration activities within the site.

9.5.55 The assessment of potential construction vibration effects at adjacent buildings / structures has been assessed using the predicted Peak Particle Velocity (PPV), according to the criteria given in Vol 2 Section 9. The results of the assessment of construction vibration are presented in Vol 17 Table 9.5.4.

Vol 17 Table 9.5.4 Vibration – building vibration impacts and their magnitudes

Ref	Receptor	Impact (highest predicted PPV across all activities, mm/s)	Value/ sensitivity	Magnitude
VE1	Whitehall Court	<1.0	High	Below threshold of cosmetic damage - No impact
VE2	Whitehall Gardens	<2.0	Medium	Below threshold of cosmetic damage - No impact
VE3	Jubilee Gardens	<0.5	Medium	Below threshold of cosmetic damage - No impact
VE4	Ministry of Defence	<0.5	Medium	Below threshold of cosmetic damage - No impact
VE5	Playhouse Theatre	<0.5	High	Below threshold of cosmetic damage - No impact
VE6	The Hispaniola	<1.0*	Medium	Below threshold of cosmetic damage - No impact
VE7	Tattershall Castle	<1.0*	Medium	Below threshold of cosmetic damage - No impact

** Predicted vibration levels assume groundborne transmission. For boats moored in the river it is expected that vibration transmission would be reduced and the vibration levels would be lower than those estimated.*

9.5.56 The vibration levels reported here are well below the levels likely to cause cosmetic building damage according to the criteria described in Vol 2 Section 9.

9.5.57 Vibration effects are **not significant** to any receptors.

Sensitivity test for programme delay

9.5.58 For the assessment of noise and vibration effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing and proposed receptors. Based on the site development schedule (see Vol 17 Appendix N), there would be no new receptors, within the assessment area, requiring assessment as a result of a one year delay.

9.6 Operational effects assessment

Impacts from potential noise and vibration sources

9.6.1 The following section describes the potential noise and vibration effects from various sources identified for assessment.

Noise from operational plant at above ground structures

9.6.2 The prediction method and assumptions are described in Vol 2 Section 9.

9.6.3 A passive ventilation system is to be installed at Victoria Embankment Foreshore and therefore there is no requirement to install active ventilation equipment for the drop shaft at this location

9.6.4 The appropriate emission limits are shown below in Vol 17 Table 9.6.1, based on local authority requirements to ensure that no adverse effects would occur. As there is no active ventilation plant for the drop shaft to generate noise at this site, these limits would only apply to any minor plant equipment. If cooling fans for the kiosks are required this equipment would be controlled to meet the criteria in Vol 17 Table 9.6.1 although such equipment would be expected to have a relatively low noise emission (approximately 45dB(A) at 3m).

9.6.5 There would be a pump to maintain hydraulic pressure in the hydraulic pipe-work and rams for the penstocks although the noise emission would be short and infrequent. It is expected that this would produce a whirring noise about once a week with a duration of approximately 30 seconds to two minutes depending on the size of the penstock and hydraulic system. The plant would be operated for testing purposes once every three months. The power pack, pump and motor would be located within the kiosk and would be shielded with an acoustic surround if necessary to meet the requirements in Vol 17 Table 9.6.1.

9.6.6 Vol 17 Table 9.6.1 shows, for each receptor, that the estimated plant noise level.

Vol 17 Table 9.6.1 Noise – operational airborne noise impacts

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
VE1	Whitehall Court	Night-time: $48dBL_{A90, 15 minutes}$	Plant noise emission rating level at receptor less than $38dBL_{Ar,Tr}$	High	Plant noise level below night-time local authority limit*,– no adverse impact
VE2	Whitehall Gardens	Daytime: $54dBL_{Aeq, 15 minutes}$	Plant noise emission level at receptor less than $54dBL_{Aeq.}$	Medium	Plant noise level below ambient daytime level – no adverse impact
VE3	Jubilee Gardens	Daytime: $48dBL_{Aeq, 1 hour}$	Plant noise emission level at receptor less than $48dBL_{Aeq}$	Medium	Plant noise level below ambient daytime level – no adverse impact
VE4	Ministry of Defence	Daytime: $57dBL_{Aeq, 1 hour}$	Plant noise emission level at receptor less than $57dBL_{Aeq}$	Medium	Plant noise level below ambient daytime level – no adverse impact
VE5	Playhouse Theatre	Evening: $66dBL_{Aeq, 1 hour}$	Plant noise emission level at receptor less than $66dBL_{Aeq}$	High	Plant noise level below ambient evening level – no adverse impact**
VE6	The Hispaniola	Evening: $66dBL_{Aeq, 1 hour}$	Plant noise emission level at receptor less than $66dBL_{Aeq}$	Medium	Plant noise level below ambient evening level – no adverse impact

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
VE7	Tattershall Castle	Evening: 66dB$L_{Aeq,\ 1\ hour}$	Plant noise emission level at receptor less than 66dBL_{Aeq}	Medium	Plant noise level below ambient evening level – no adverse impact

* *Limit referred to is that identified for the Local Authority in which the receptor is located (see para.9.3.17).*
***Plant noise expected to be substantially below ambient noise level*

9.6.7 The results given in Vol 17 Table 9.6.1 show that there are no adverse impacts and the effects of plant noise at these emission levels is assessed as **not significant**. In the case of the residential receptor, this is based on compliance with the local authority requirements (see para. 9.3.17) to prevent disturbance. For the non-residential receptors the noise levels are below ambient noise levels and therefore considered to result in no significant effects.

Noise and vibration from tunnel filling

9.6.8 Measurements taken during storm and non-storm events at operational drop structures in the United States, equivalent to those being considered for the Thames Tideway Tunnel, have been used to inform the assessment of noise and vibration during tunnel filling events. These studies (Jain, SC and Kennedy, JF., 1983)[8] are described in Vol 2 Section 9. The highest noise level measured on a mesh grille directly over a similar drop shaft, during this study, was 61dBL_{Aeq} during a severe storm event.

9.6.9 These events are not typical and only occur during severe rain storms. At Victoria Embankment Foreshore, the drop shaft would be enclosed and any noise at the surface would be attenuated by the structure or the carbon filters and vent building. At the surface the noise level would be approximately 46dBL_{Aeq}, which is less than the prevailing ambient noise level at this site.

9.6.10 The highest PPV measured directly at the existing drop shaft sites used in the case studies as described in Vol 2 Section 9 was 0.034mm/s. These measured PPV values are well below the levels for vibration to be just perceptible, according to the criterion given in Vol 2 Section 9. Similarly, the levels are well below the transient and continuous vibration guideline criterion for building damage.

9.6.11 The noise and vibration from tunnel filling events would occur only occasionally during heavy rainfall events and, in any case, is predicted to be not perceptible/ less than the ambient noise level at the receptors. Therefore this is assessed as **not significant**.

Operational maintenance

9.6.12 As part of the operation of the tunnel, there would need to be routine but infrequent maintenance carried out at the site. Two cranes would be required for ten yearly shaft inspections. This would be carried out during normal working hours, using equipment which is likely to increase ambient noise levels. Given the infrequency of this operation, it is considered that a significant noise effect would not occur.

9.6.13 Routine inspections, lasting approximately half a day, would occur every three to six months and would not require heavy plant. As this would be carried out during the daytime with minimal noisy equipment operating over short periods of time, it is considered that further assessment of noise generated by this activity is not required.

9.6.14 As no impacts have been identified from the operation of the site, this is assessed as **not significant**.

Noise from operational traffic

9.6.15 Additional traffic associated with operation of the site would be limited to vehicles used by maintenance and inspection workers. This is likely to be a number of light commercial vehicles used during routine inspection visits every three to six months and shaft inspections approximately every ten years.

9.6.16 As a proportion of the existing traffic on the road network these vehicles would not contribute to the traffic noise level and the noise effects of these movements are assessed as **not significant**.

Sensitivity test for programme delay

9.6.17 For the assessment of noise and vibration effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing and proposed receptors as the operational effects of the Thames Tideway Tunnel are considered to be not significant. Based on the site development schedule (see Vol 17 Appendix N), there would be no new receptors, within the assessment area, requiring assessment as a result of a one year delay.

9.7 Cumulative effects assessment

Construction effects

9.7.1 None of the projects described in Section 9.3, are considered relevant to the construction cumulative assessment at Victoria Embankment Foreshore as they are either assumed to be complete and operational by Site Year 1 of construction or are located outside of the 300m assessment area. As such, no cumulative construction noise or vibration effects are identified. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

Operational effects

9.7.2 None of the projects described in Section 9.3, are considered relevant to the operational cumulative assessment at Victoria Embankment Foreshore as due to their use, they are not expected to generate significant noise or vibration levels during their operation. As such, no cumulative operational noise or vibration effects are identified. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

9.8 Mitigation and compensation

Construction

9.8.1 The above assessment has concluded that there are significant adverse noise effects during the construction phase at the Tattershall Castle and Hispaniola, however no further practicable on site noise mitigation can be adopted in addition to those measures identified in the *CoCP*.

9.8.2 The owners of the Tattershall Castle and Hispaniola may be eligible to apply for compensation through the *Thames Tideway Tunnel compensation programme* (see Schedule 2 of the *Statement of Reasons*, which accompanies this application) which has been established to address claims of exceptional hardship or disturbance. The measures set out in the programme are not considered to be mitigation as there is no guarantee that the property in question would be eligible for compensation or that the compensation would be accepted by the affected party. Therefore residual effects reported in the *Environmental Statement* for this receptor do not take the offsetting effect of the compensation programme into account.

Operation

9.8.3 As there are no significant effects at this site, no further mitigation is required.

Monitoring

9.8.4 Monitoring of construction noise would be carried out as described in the *CoCP*. It is not anticipated that there would be any need for monitoring of operational noise.

9.9 Residual effects assessment

Construction effects

9.9.1 As discussed at para 9.8.2, the owners of the Tattershall Castle and Hispaniola may be eligible to apply for compensation under the *Thames Tideway Tunnel project compensation programme*. For the purpose of the assessment the residual effects reported in the ES do not take the offsetting effects of the compensation programme into account and therefore the construction noise effects would remain as presented in Section 9.5.

Operational effects

9.9.2 As no mitigation measures are proposed, the residual operational effects remain as presented in Section 9.6.

9.10 Assessment summary

Vol 17 Table 9.10.1 Noise – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Surface construction noise				
VE1 - Whitehall Court	Noise	Not significant	None	Not significant
VE2 - Whitehall Gardens	Noise	Not significant	None	Not significant
VE3 - Jubilee Gardens	Noise	Not significant	None	Not significant
VE4 - Ministry of Defence	Noise	Not significant	None	Not significant
VE5 - Playhouse Theatre	Noise	Not significant	None	Not significant
VE6 - The Hispaniola	Noise	Significant	No further mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.2)
VE7 - Tattershall Castle	Noise	Significant	No further mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.2)
Road-based construction traffic				
Residential and non-residential properties adjacent to the proposed vehicle route	Noise	Not significant	None	Not significant
River-based construction traffic				
Whitehall Court	Noise	Not significant	None	Not significant
Hispaniola/Tattershall Castle	Noise	Not significant	None	Not significant

Vol 17 Table 9.10.2 Vibration – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
VE1 - Whitehall Court	Vibration	Not significant	None	Not significant
VE2 - Whitehall Gardens	Vibration	Not significant	None	Not significant
VE3 - Jubilee Gardens	Vibration	Not significant	None	Not significant
VE4 - Ministry of Defence	Vibration	Not significant	None	Not significant
VE5 - Playhouse Theatre	Vibration	Not significant	None	Not significant
VE6 - The Hispaniola	Vibration	Not significant	None	Not significant
VE7 - Tattershall Castle	Vibration	Not significant	None	Not significant

Vol 17 Table 9.10.3 Noise – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
VE1 - Whitehall Court	Noise	Not significant	None	Not significant
VE2 - Whitehall Gardens	Noise	Not significant	None	Not significant
VE3 - Jubilee Gardens	Noise	Not significant	None	Not significant
VE4 - Ministry of Defence	Noise	Not significant	None	Not significant
VE5 - Playhouse Theatre	Noise	Not significant	None	Not significant
VE6 - The Hispaniola	Noise	Not significant	None	Not significant
VE7 - Tattershall Castle	Noise	Not significant	None	Not significant

Vol 17 Table 9.10.4 Vibration – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
VE1 - Whitehall Court	Vibration	Not significant	None	Not significant
VE2 - Whitehall Gardens	Vibration	Not significant	None	Not significant
VE3 - Jubilee Gardens	Vibration	Not significant	None	Not significant
VE4 - Ministry of Defence	Vibration	Not significant	None	Not significant
VE5 - Playhouse Theatre	Vibration	Not significant	None	Not significant
VE6 - The Hispaniola	Vibration	Not significant	None	Not significant
VE7 - Tattershall Castle	Vibration	Not significant	None	Not significant

References

[1] Defra. *National Policy Statement for Waste Water* (2012) Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf. Accessed November 2012

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

[3] British Standards Institution, *BS 4142 Method for rating industrial noise affecting mixed residential and industrial areas* (1997)

[4] British Standards Institution, *BS 6472-1 Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting* (2008)

[5] British Standards Institution, BS 8233 *Sound insulation and noise reduction for buildings* (1999)

[6] Peter Brett Associates on behalf of Lafarge Cement UK, *Northfleet Works Bulk Aggregates Import Terminal. Document 2h: Environmental Statement Volume 3 Appendices*: Appendix D.3.

[7] Draft *Thames Freight Operations Vessel Standards*, Port of London Authority

[8] Jain, SC and Kennedy, JF. *Vortex-Flow Drop Structures for the Milwaukee Metropolitan Sewerage District Inline Storage System*. Iowa Institute of Hydraulic Research. IIHR Report No 264 (Jul 1983).

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 10: Socio-economics

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 10: Socio-economics

List of contents

Page number

10 Socio-economics 1
10.1 Introduction 1
10.2 Proposed development relevant to socio-economics 1
10.3 Assessment methodology 4
10.4 Baseline conditions 7
10.5 Construction effects assessment 17
10.6 Operational effects assessment 27
10.7 Cumulative effects assessment 28
10.8 Mitigation and compensation 28
10.9 Residual effects assessment 29
10.10 Assessment summary 30
References 32

List of tables

Page number

Vol 17 Table 10.2.1 Socio-economics – construction worker numbers 2
Vol 17 Table 10.3.1 Socio-economics – stakeholder engagement 4
Vol 17 Table 10.4.1 Socio-economics – receptor values / sensitivities 15
Vol 17 Table 10.10.1 Socio-economics – summary of construction assessment 30
Vol 17 Table 10.10.2 Socio-economics – summary of operational assessment 31

This page is intentionally blank

10 Socio-economics

10.1 Introduction

10.1.1 This section presents the findings of the assessment of the likely significant socio-economic effects of the proposed development at the Victoria Embankment Foreshore site.

10.1.2 At this site effects during construction are considered on businesses with moorings on the River Thames within the area of the limits of land to be acquired or used (LLAU) including the Tattershall Castle, on the Hispaniola, on users of the Thames Path National Trail and Right of Way (Thames Path), on users of Whitehall Gardens, on tourism, on nearby residents, on the Royal Horseguards Hotel and on the National Liberal Club. Effects during the operational phase have been considered on users of the Thames Path and the associated future public amenity space that would be created as a result of the project.

10.1.3 The likely significant project-wide socio-economic effects, including employment generation, stimulation of industry, and leisure and recreation related effects on users of the River Thames are described in Volume 3 Project-wide effects assessment.

10.1.4 The assessment of socio-economics presented in this section has considered the requirements of the National Policy Statement for Waste Water Sections 4.8 (land use) and 4.15 (socio-economic) (Defra, 2012)[1]. Further details of these requirements can be found in Volume 2 Environmental assessment methodology Section 10.3.

10.1.5 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

10.1.6 This assessment has drawn on the findings of the air quality and odour, noise and vibration and townscape and visual assessments (Sections 4, 9 and 11 respectively within this volume).

10.2 Proposed development relevant to socio-economics

10.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to socio-economics are set out below.

Construction

10.2.2 A temporary cofferdam would extend into the river requiring the relocation of a business, the Tattershall Castle bar / restaurant vessel. During the construction phase, the Tattershall Castle would be temporarily relocated approximately 120m upstream of its current location. The Tattershall Castle would be permanently relocated in the operational phase approximately 30m downstream of its temporary mooring position (ie, approximately 90m from its current mooring). The Hispaniola restaurant ship would, however, be able to remain in its existing location.

10.2.3 A service mooring (used by Mainstream Leisure) would be permanently relocated during the construction phase. Another service mooring (used by City Cruises) would be temporarily relocated during the construction phase and reinstated in its current mooring position at the end of construction.

10.2.4 The Thames Path National Trail and Public Right of Way (Thames Path) would be temporarily diverted for the duration of the construction period.

10.2.5 Works at the site are expected to last approximately four and a half years. For detail on construction working hours, see Section 3.3 of this volume.

10.2.6 Construction related activities, including traffic and lorry movements, could result in amenity effects (caused by air quality impacts, construction dust, noise, vibration, and visual impacts) being experienced by a range of sensitive socio-economic receptors in proximity to the proposed activities (refer to Volume 2 Environmental assessment methodology for further information on the amenity assessment methodology).

Direct employment creation on site

10.2.7 Construction is expected to require a maximum workforce of approximately 65 workers at any one time, ie, during the daytime shift. The number and type of workers is shown in Vol 17 Table 10.2.1.

Vol 17 Table 10.2.1 Socio-economics – construction worker numbers

Contractor		Client
Staff*	**Labour****	**Staff*****
08:00-18:00	**08:00-18:00**	**08:00-18:00**
30	25	10

**Staff Contractor – engineering and support staff to direct and project manage the engineering work and site.*
***Labour – those working on site doing engineering, construction and manual work.*
****Staff Client – engineering and support staff managing the project and supervising the Contractor.*

Code of Construction Practice

10.2.8 Measures applicable to all sites incorporated into the *Code of Construction Practice (CoCP) Part A* to limit significant adverse air quality, construction dust, noise, vibration, and visual impacts would help to avoid socio-economic impacts, particularly amenity impacts.

10.2.9 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (*Part A*), and site-specific requirements for this site (*Part B*).The *CoCP Part A* also confirms that all land, including highways, footpaths, public open spaces, river embankments / waterways, loading facilities or other land occupied temporarily would be made good to the satisfaction of Thames Water[i] and the local authority where required. This would be in accordance with the Ecology and landscape management plan and the approved landscape design for the site (see Section 4 within the *CoCP Part A*).

10.2.10 Further site-specific measures, which would reduce socio-economic effects and particularly amenity effects, are incorporated into the *CoCP Part B*. See the *Code of Construction Practice* sections in the air quality and odour, noise and vibration, and townscape and visual construction effect assessments (Sections 4.2, 9.2 and 11.2 respectively within this volume) for details on the type of measures that would be employed.

10.2.11 The *CoCP Part A* and *Part B* confirm that the length and duration of the diversion of the Thames Path would be minimised, that advance notice of the diversion would be given and that it would be adequately signed (see Section 5.3 within the *CoCP Part A* and Section 5 within the *CoCP Part B*).

Operation

10.2.12 The installation of above-ground structures, as described in Section 3, would result in the extension of the existing river wall out into the River Thames. These structures would be within the parameter areas shown on the Site works parameter plan (see separate volume of figures – Section 1).The new public realm would be of high quality and designed to positively enhance the surrounding environment and provide a lasting legacy.

Environmental design measures

10.2.13 Measures which have been incorporated into the design of the proposed development (described in the *Design Principles* report) include the following:

a. provision of a new foreshore structure that would be publicly accessible except during essential maintenance when they would be closed to the public and when the eastern (front projecting area) part of the structure would be occasionally flooded at the highest tides

b. planting of additional trees on the structure to provide shade and improve the microclimate

c. provision of viewing platforms to create views towards the Palace of Westminster World Heritage Site

d. positioning of seating to maximise views towards the Palace of Westminster World Heritage Site

e. reinstatement of semi mature London plane trees along Victoria Embankment

f. reinstatement of the Sphinx benches along Victoria Embankment as far as possible

[i] Thames Water Utilities Ltd (TWUL). The Draft Development Consent Order (DCO) contains an ability for TWUL to transfer powers to an Infrastructure Provider (as defined in article 2(1) of the DCO) and/or, with the consent of the Secretary of State, another body.

g. replacement of any moorings which are affected by the works, where practicable and unless otherwise agreed with the Port of London Authority.

10.3 Assessment methodology

Engagement

10.3.1 Vol 2 Section 10 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of socio-economic effects are presented in Vol 17 Table 10.3.1.

Vol 17 Table 10.3.1 Socio-economics – stakeholder engagement

Organisation	Comment	Response
Environment Agency, April 2011	It is considered that the use of foreshore sites is likely to lead to a number of detrimental effects in relation to flood risk management, biodiversity and recreation.	Consideration of the impact of the proposed development on recreational facilities has been considered within this socio-economic assessment as appropriate.
Westminster City Council, January 2012	Any works to the proposed worksite should mitigate for any adverse impacts on tourism, buses, taxis, parking and access to the river.	Tourism has been considered as part of this socio-economic assessment. In addition relevant information is included within the transport assessment for this site (see Section 12 Transport).
Westminster City Council, January 2012	Objection to the proposed repositioning of the Tattershall Castle	Throughout the design of the Victoria Embankment Foreshore site, several options for the Tattershall castle have been looked at. The relocation of the Tattershall Castle has been put forward as it is deemed the least disruptive option for the business. Consideration of the effects of repositioning of the Tattershall Castle is included within this assessment (see Section 10.5).
English Heritage, February 2012	English Heritage notes the absence of assessment of impacts on the National Liberal Club in relation to the	The National Liberal Club has been included as a receptor in this socio-economic assessment.

Organisation	Comment	Response
	Victoria Embankment Foreshore site.	
English Heritage, February 2012	English Heritage considers that, at the least, tourists are sub-sets of other receptors such as users of the Thames Path. However, impact on tourism is probably better described as a business. It is important that tourism is assessed as Victoria Embankment is the scene of events that attract tourism such as the New Year's Eve fireworks display and the Diamond Jubilee River Pageant.	Tourists have been considered within the assessments on the Thames Path, Whitehall Garden, and restaurant / bar businesses, and the tourism sector has been considered within its own right within this volume.
London Councils, February 2012	The noise, pollution and congestion caused by site traffic will impact on quality of life for local residents.	Consideration of the impact of the proposed development on residential amenity has been considered as part of this assessment.
Greater London Authority (incl. Transport for London), February 2012	The impact of the proposed diversion of the Thames Path will need assessing and appropriate mitigation put forward, including pedestrian crossings, diversionary signage etc which will need to be discussed further with TfL.	Safe pedestrian crossing facilities and diversionary signposting, etc, for diverted sections of the Thames Path is provided for within Section 5.3 of the *CoCP Part A*. Consideration of the effect on users of the Thames Path from its diversion is included in this socio-economic assessment.

Baseline

10.3.2 The baseline methodology follows the methodology described in Vol 2 Section 10. There are no site-specific variations for identifying the baseline conditions for this site.

Construction

10.3.3 For this site, the base case is the peak year of construction works. The assessment area is as set out in Vol 2 Section 10.

10.3.4 The assessment methodology for the construction phase follows that described in Vol 2 Section 10. There are no site-specific variations for undertaking the construction effects assessment for this site.

10.3.5 Section 10.5 details the likely significant effects arising from the construction at Victoria Embankment Foreshore site. Another nearby Thames Tideway Tunnel project site which could give rise to additional effects at this site on the Thames Path is Blackfriars Bridge Foreshore. This site is therefore included in this assessment.

10.3.6 Of the developments listed in the site development schedule (see Vol 17 Appendix N) there are none which would increase the number of sensitive receptors in the base case within the assessment areas relevant to the assessments that have been undertaken for this site.

10.3.7 Of the developments listed in the site development schedule (see Vol 17 Appendix N) there are none which would be under construction within the assessment area at the same time as the Thames Tideway Tunnel project at this site. Therefore, there would not be any cumulative construction effects.

Operation

10.3.8 The base case is Year 1 of operation. The assessment area is as set out in Vol 2 Section 10.

10.3.9 The assessment methodology for the operational phase follows that described in Vol 2 Section 10. There are no site-specific variations for undertaking the operational assessment of this site.

10.3.10 Section 10.6 details the likely significant effects arising from the operation of the proposed development at Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on socio-economics within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

10.3.11 Of the developments listed in the site development schedule (see Vol 17 Appendix N), there are none would introduce new receptors into the operational base case; significantly alter circumstances for those receptors covered by the operational assessment, or give rise to cumulative effects. This is because the only receptor covered in the operational assessment is users of the new public amenity space and none of the developments would affect those users.

Assumptions and limitations

10.3.12 The assumptions and limitations associated with this assessment are presented in Vol 2, Section 10. The following assumptions are specific to the assessment of this site:

a. It is assumed that the Tattershall Castle and Hispaniola bar / restaurant ships rely on trade which is generated largely by their setting and location.

b. It is assumed that service moorings are more widely available on the River Thames than moorings with shore access, as a link to the shore is not required for service moorings.

10.3.13 There are no limitations specific to the assessment of this site.

10.4 Baseline conditions

Current baseline

10.4.1 The following section sets out the baseline conditions for socio-economics within and around the site, including a description of the local social and economic context, and a description of the receptors relevant to this assessment. Future baseline conditions (base case) are also described.

Local context

10.4.2 The immediate local area (within 250m) and wider local area (within 1km) surrounding the site predominantly comprise a variety of office based employment premises (with a considerable number of government offices), tourism and leisure uses, and smaller retail and food and drink units (as shown Vol 17 Figure 2.1.2, see separate volume of figures). These are occasionally interspersed with residential dwellings, mainly on the upper floors of retail or office premises and in purpose built blocks, although residential use within 250m of the site is very limited. There are also a number of recreational land uses of city wide importance within the immediate area surrounding the site, including the River Thames and Thames Path.

Community profile

10.4.3 A detailed community profile is provided in Vol 17 Appendix H.1[ii]. The following points provide a summary of the community profile and provide context for this socio-economic assessment:

a. The resident population was approximately 150 people within 250m of the site and approximately 10,475 within 1km of the site at the time of the last census for which data is available[iii].

b. The proportion of under 16 year olds within 250m (8.3%) is somewhat lower than within 1km (10.6%) and considerably lower than within Greater London (20.2%).

c. The proportion of over 65 year olds within 250m (23.3%) is considerably higher than within 1km (10.6%) and Greater London (12.4%).

d. There is a moderately higher proportion of White residents within 250m (91.6%) than within 1km (72.3%) and Greater London (71.2%).

e. There is a slightly lower proportion of residents suffering from long term limiting illnesses within 250m (14.0%) than within 1km (15.2%) and Greater London (15.5%). The proportion of disability allowance claimants within 1km (4.8%) and borough-wide (5.1%) is in line with Greater London (4.5%). However within 250m, it is much lower (1.0%).

[ii] Information sources are provided in the appendix.

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

f. General health is good at a borough level, with low rates of obesity and a high instance of adult residents undertaking physical exercise. Obesity and low rates of exercise are prevalent in under 16 year olds however. Death rates caused by illness are amongst the lowest in Greater London and male and female life expectancy amongst the highest in Greater London.

g. Within 250m there is no recorded income deprivation or overall deprivation. Levels of income deprivation within 1km (6.8%) are considerably lower than within the whole of the City of Westminster (21.5%) and Greater London (30.8%). Overall deprivation within 1km (9.7%) is also considerably lower than it is borough-wide (18.3%) and within Greater London (24.5%).

10.4.4 The above community profile suggests that local residents within 250m are almost all of White ethnic backgrounds and are predominantly older adults who experience good health and high life expectancy. Residents experience lower than average levels of deprivation in comparison to Greater London.

Economic profile

10.4.5 An economic profile (based on 2012 data) is outlined in Vol 17 Appendix H.2. The following points are notable and relevant for consideration in relation to this socio-economic assessment:

a. Within 250m of the site there are approximately 13,900 jobs and 280 businesses [iv].

b. The three largest sectors as measured by employment within approximately 250m are; Public Administration and Defence; Professional Scientific and Technical Activities, and Accommodation and Food Services.

c. The three largest sectors as measured by number of businesses within approximately 250m are; Accommodation and Food Services Activities; Professional Scientific and Technical Activities; and Wholesale and Retail Trade.

d. At all geographical levels, most businesses fall within the smallest size band (1 to 9 employees). However, within 250m of the site there are a considerably greater proportion of larger businesses than within either the City of Westminster or Greater London overall.

e. The two businesses recorded within the Public Administration and Defence sector employ over 250 employees each and account for 40% of employment within 250m, and are likely to be associated with

---

[iv] Source: Experian 2012. Data is aggregated for seven digit post-code units falling wholly or partially within a 250m boundary of the LLAU, including post code units on the opposite side of the River Thames if relevant. Employee data reflect a head count of workers on-site rather than Full Time Equivalent (FTE) jobs. The count of businesses relates to business 'locations' or 'units'; an enterprise may have a number of business locations / units.

the concentration of central government offices nearby around Whitehall.

Receptors

Businesses – The Tattershall Castle and Hispaniola

10.4.6 There are two restaurant / bar premises situated at the site on permanently moored vessels: the Tattershall Castle (located within the proposed construction site) and the Hispaniola (moored immediately adjacent to the proposed construction site).

10.4.7 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of these receptors.

10.4.8 Both vessels have pedestrian access ramps from Victoria Embankment, the Tattershall Castle offering bar, restaurant and entertainment facilities similar to a pub and the Hispaniola offering restaurant facilities. Both vessels have internal and external (on deck) seating areas with views across the Thames.

10.4.9 The main factor affecting the sensitivity of the Tattershall Castle to the temporary loss of its moorings, and incurring a subsequent economic loss, is the availability of an alternative location (ie, an alternative river mooring) that can enable the business to continue to be a viable operation.

10.4.10 Another, related factor is the degree to which the business relies on its current location to attract custom. Given the Tattershall Castle's reliance on passing trade for a significant proportion of its customers and its prominent location which provides it with access to a steady stream of passing tourist and visitor trade, the business is likely to be restricted in terms of the alternative locations from which it would be able to operate.

10.4.11 The sensitivity of both businesses to amenity effects is directly linked to the sensitivity of their customers to amenity effects. If customers are sufficiently deterred from dining and drinking at the Tattershall Castle and Hispaniola by amenity impacts such as noise, dust or unpleasant views, then the businesses could suffer deterioration in trade. As these businesses have substantial outdoor, on-deck drinking and dining areas that contribute to their appeal to customers, the businesses would have limited options available to them to avoid such effects. In terms of the sensitivity of employees working at the two businesses, the hotel, catering and leisure industry typically employs high rates of part time staff and has one of the highest UK labour turnover rates (People 1st, 2011)[2].

10.4.12 Taking account of these factors, it is considered that the sensitivity of the businesses to impacts associated with the project would be medium.

Business – Mainstream Leisure

10.4.13 There is a service mooring used by Mainstream Leisure for the Golden Salamander vessel situated at the site, approximately 15m south west of the Tattershall Castle's current position.

10.4.14 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.15 The mooring is used exclusively for vessel servicing purposes rather than passenger transfer or other directly related passenger functions and there are no employees whose jobs relate directly and exclusively to activities at this location.

10.4.16 The main factor affecting Mainstream Leisure's sensitivity to the permanent loss of their existing mooring is the availability of alternative river moorings that can fulfil the same requirements. The main requirement in this regard is likely to be for the alternative moorings to be situated within an accessible distance to the business' operating routes, so as to enable convenient access and utilisation.

10.4.17 The Golden Salamander can operate out of most piers in central London (Thames River Boats, undated)[3]. It is therefore likely that the mooring could be fairly easily relocated to an alternative position in the River Thames along their operating route which remains accessible to the business. It is understood and assumed that there is some availability of alternative service moorings (without a landward connection) on the River Thames.

10.4.18 Taking account of these factors, it is considered that the sensitivity of Mainstream Leisure to their mooring being permanently relocated would be low.

Business – City Cruises

10.4.19 There is a service mooring used by City Cruises situated at the site, approximately 50m southwest of the Tattershall Castle's current position.

10.4.20 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.21 The mooring is used exclusively for vessel servicing purposes rather than passenger transfer or other directly passenger related functions and there are no employees whose jobs relate directly and exclusively to activities at this location.

10.4.22 The main factor affecting City Cruises' sensitivity to the temporary loss of their existing moorings is the availability of alternative river moorings that can fulfil the same requirements. The main requirement in this regard is likely to be for the alternative moorings to be situated within an accessible distance to the business' operating routes, to enable convenient access and utilisation.

10.4.23 City Cruises operate services between Westminster Pier and Greenwich Pier (City Cruises, 2012)[4]. It is therefore likely that the mooring could be fairly easily relocated to an alternative position in the River Thames along their operating route which remains accessible to the business. It is understood and assumed that there is some availability of alternative service moorings (without a landward connection) on the River Thames.

10.4.24 Taking account of these factors, it is considered that the sensitivity of City Cruises to the relocation of their mooring would be low.

Thames Path

10.4.25 The Thames Path is a recreational asset and national trail. It follows the river for almost its entire length, and in central London it runs on both sides of the river. At this location the Thames Path runs along the pavement of Victoria Embankment. It connects users with several high profile visitor attractions, as well as the Jubilee pedestrian bridges and Westminster Bridge.

10.4.26 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.27 Victoria Embankment in this location is a busy four lane A-road with accommodation for coach parking. Mature trees line the length of the pavement (abutting the path). In addition, bench seats on raised platforms are found along this stretch, allowing users views over the River Thames.

10.4.28 The open space usage surveys (see Vol 17 Appendix H.3) found the path to be well used, with a peak usage of the Thames Path of 840 pedestrians per hour during the weekday surveys and 1,125 pedestrians per hour on the weekend. Users were mainly walking (approximately 80% of total users) or jogging (approximately 15%) along the Thames Path. Commuters in particular appeared to fall within the 18-39 year old category. Many pedestrians appeared to be recreational users, although commuter use was also evident. During lunchtime and peak evening travel periods (12pm to 2pm and 4pm to 5pm) there appeared to be a high number of local office workers. Based on the appearance and behaviour of walkers, the Thames Path in this location appeared to be well used by tourists.

10.4.29 The usage surveys (see Vol 17 Appendix H.3) are corroborated by the pedestrian surveys undertaken as part of Section 12 of this volume. These recorded a peak hourly usage of 525 southbound pedestrians and 418 northbound pedestrians walking past the site during the PM peak hour. Pedestrian movements during PM peak hours (as above) were higher than at other times (approximately 90 pedestrians in each direction being recorded in the AM peak hour).

10.4.30 The main factor affecting the sensitivity of users of the Thames Path is the availability of alternatives. The Thames Path is a metropolitan wide recreational asset and users have access to alternative and comparable stretches of the Thames Path on both sides of the river across central London. More locally, with regard to the section of the path that runs past the site, there are alternative routes available, the most obvious being the pavement on the other side of Victoria Embankment. Pedestrians could use Northumberland Avenue, Whitehall Place / Whitehall Court, Horse Guards Avenue and Whitehall.

10.4.31 In terms of their sensitivity to amenity impacts, users of the Thames Path are only likely to be near the site for the time it takes them to walk past the area. The usage surveys (see Vol 17 Appendix H.3) recorded that walkers and joggers were the predominant users of the path, all passing though the area in under five minutes. Therefore, the duration for which users are likely to experience amenity effects would be limited.

10.4.32 Taking account of the above factors, the sensitivity of users of the Thames Path to impacts that would cause a loss of access to the existing path or a reduction in amenity would be low.

Public amenity space (future) associated with the Thames Path

10.4.33 An area of public amenity space would be created as part of the proposed development.

10.4.34 In terms of the value of this space and the consequent sensitivity of users, the availability of alternative similar spaces is a key factor to consider.

10.4.35 Public amenity space in central London is at a premium and the adjacent Thames Path is well used (see Vol 17 Appendix H.3). However, the river in this location (ie, downstream from Westminster Bridge and upstream from Blackfriars Bridge) is flanked on both sides by public amenity areas associated with the Thames Path, nearby open spaces and arts and tourism precincts. As a result, there are numerous opportunities in the vicinity of the proposed new amenity space for passive recreation (eg, Whitehall Garden) and for sitting and taking in views of the River Thames from the Thames Path.

10.4.36 Taking account of these factors, it is considered that the sensitivity of users of the future riverside public amenity space to the creation of additional public amenity space would be low.

Public Open Space – Victoria Embankment Gardens: Whitehall Garden

10.4.37 Victoria Embankment Gardens are a series of segmented linear gardens running parallel to the River Thames between Blackfriars Bridge and Westminster Bridge situated on the west side of the Victoria Embankment carriageway. The segment of garden opposite the proposed construction site is Whitehall Garden.

10.4.38 Whitehall Garden is a Grade II listed public open space, approximately 0.88ha in size, which in turn forms a part of the 4.18ha Victoria Embankment Gardens. In isolation, Whitehall Garden is classified as a ‘small open space’ under the Greater London Authority (GLA) Open Space Hierarchy[v].

10.4.39 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.40 This garden is grassed and attractively landscaped, with formal flower beds, mature trees and footpaths; it primarily offers opportunities for passive recreation. It is also fenced, with five access gates, and is open to the public daily from dawn to dusk.

10.4.41 The usage surveys (see Vol 17 Appendix H.3) found that Whitehall Garden is moderately used during weekdays and weekends, primarily by people using bench seats and by pedestrians walking through the garden.

---

[v] A small open space can be up to 2ha according to the GLA Open Space Hierarchy.

10.4.42 The main factor affecting the sensitivity of users of Whitehall Garden is the availability of other open spaces offering similar functionality and levels of amenity. Additional alternative areas of public open space close by include further sections of Victoria Embankment Gardens located approximately 15m away from Whitehall Garden beyond Horse Guards Avenue to the south and approximately 115m beyond Embankment Underground Station and Villiers Street to the north. The recently remodelled Jubilee Gardens, although across the river, is also within 400m of the site[vi].

10.4.43 Taking account of these factors, the sensitivity of the users of Whitehall Garden to any reduction in amenity would be low.

Residential

10.4.44 There are existing residential developments near the proposed construction site as identified in the air quality and odour, noise and vibration and visual assessments.

10.4.45 Land that is predominantly used for residential development is shown in the land use plan for this site; see Vol 17 Figure 2.1.2 (see separate volume of figures).

10.4.46 It is considered that the sensitivity of nearby residents to overall amenity effects would vary by time of day, with residents being somewhat less sensitive to amenity effects, particularly noise, during the day and more sensitive to such effects during the evening and night.

10.4.47 Therefore, as outlined in the methodology for this socio-economic impact assessment (see Vol 2) the sensitivity of nearby residential receptors to amenity impacts would be medium during the day and high during the evening and night.

Private members facility – National Liberal Club

10.4.48 The National Liberal Club, a private members facility, is situated in Whitehall Court, approximately 65m from the proposed construction site. The club's premises face east on to Whitehall Garden and it has a partially obscured view of the River Thames due to the trees planted along Victoria Embankment and within Whitehall Garden.

10.4.49 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.50 The club offers annual memberships and has dining and event facilities for members. It is open during weekdays, with private hire facilities available during weekends. The club has balconies on the eastern and western facades of the building and an outdoor terrace on the upper floor fronting on to Whitehall Garden which is available for use by members during club opening times.

[vi] Consistent with the accessibility parameter guidance set out in the GLA Open Space Hierarchy for such size spaces.

10.4.51 The main factor affecting the sensitivity of the National Liberal Club is the degree to which members may be deterred from using the facility and the availability of alternative club facilities.

10.4.52 The club is not likely to rely on passing trade to the same degree as other businesses offering such facilities (eg, restaurants), though members renew their subscriptions annually. Club members are, as part of their annual subscription, able to use the dining and recreational facilities at three other central London clubs (National Liberal Club, 2012)[5].

10.4.53 Given the nature of the facility and club members' access to alternative facilities, it is considered that the overall sensitivity of the National Liberal Club to amenity impacts would be low.

Business – Royal Horseguards Hotel

10.4.54 The Royal Horseguards Hotel is situated in Whitehall Court, approximately 70m west of the proposed construction site. The hotel faces east on to Whitehall Garden and west on to Whitehall Court.

10.4.55 Vol 17 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.56 The hotel offers year round overnight accommodation, dining facilities for hotel guests and members of the public and event space for private hire. The hotel has an outdoor terrace adjoining function rooms on the upper floor and balconies on the eastern and western facades of the building.

10.4.57 The main factors affecting the sensitivity of the hotel business are:

a. While the hotel has outdoor terrace areas that contribute to its appeal, the majority of hotel activities (eg, provision of overnight accommodation and restaurant facilities) take place indoors, which would limit exposure to certain types of amenity impact.

b. If customers were sufficiently deterred from staying at the hotel by amenity impacts such as noise, dust or unpleasant views, then the hotel would in turn suffer deterioration in trade, which in turn could lead to a reduction in the number of employees required by the hotel.

c. In terms of the sensitivity of the hotel's employees, the hotel, catering and leisure industry typically employs high rates of part time staff and has one of the highest UK labour turnover rates (People 1st, 2011)2.

10.4.58 Given the nature and location of the facility, it is considered that the overall sensitivity of the Royal Horseguards Hotel to amenity impacts would be medium.

Tourism

10.4.59 There are several major tourist destinations near the site including the Houses of Parliament, the Southbank, the London Eye, several theatres and the River Thames. Views available from the Thames Path and Hungerford Bridge also draw tourists.

10.4.60 The Accommodation and Food Services sector is the third largest sector as measured by employment within approximately 250m of the site and the largest sector as measured by the number of businesses within approximately 250m (see Appendix H.3). It is considered likely that many of these businesses be heavily orientated towards the tourist market.

10.4.61 The site lies between Westminster Pier and Embankment Pier and opposite London Eye Pier and Festival Pier on the south bank of the River Thames. As such there are several access and egress points for river transport services in the area which are likely to be heavily utilised by tourists.

10.4.62 Embankment and Westminster underground stations also lie within walking distance of the site. There is provision for approximately fifteen coach parking spaces along the kerb on the south bound side of Victoria Embankment.

10.4.63 Usage surveys (see Vol 17 Appendix H.3) identified that a high number of users of the Thames Path in this location appeared to be tourists, taking in views of the river or taking photographs. The majority were in the area for under five minutes at a time.

10.4.64 Tourists generally use the area for sightseeing, recreational walking, and travelling between transport links and tourist attractions. There are occasionally major, high profile events such as the New Year Fireworks which draw a substantial number of visitors.

10.4.65 The Tattershall Castle and the Hispaniola bar / restaurant boats are likely to draw a lot of trade from passers-by including tourists; these receptors are considered separately in para. 10.4.6.

10.4.66 Given the nature of the tourist attractions within the surrounding area, it is considered that the overall sensitivity of the tourism sector to changes resulting from the proposed development would be medium.

Summary

10.4.67 A summary of receptors as described in the baseline and their sensitivity is provided in Vol 17 Table 10.4.1.

Vol 17 Table 10.4.1 Socio-economics – receptor values / sensitivities

Receptor	Value / sensitivity and justification
Businesses – The Tattershall Castle and Hispaniola	Medium – an alternative mooring close by would allow the Tattershall Castle to replicate its current business model. The businesses would have limited ability to avoid any possible amenity impacts.
Businesses – Mainstream Leisure	Low – it is likely that suitable alternative mooring positions would be available for use by the business.
Businesses – City Cruises	Low – it is likely that suitable alternative mooring positions would be available for use by the business.

Receptor	Value / sensitivity and justification
Users of the Thames Path	Low – alternative and comparable routes are available including the west side of Embankment roadway and the South Bank promenade. Most users would be near the site for a short duration.
Users of the public amenity space (future) associated with the Thames Path	Low – future users have access to several alternative areas of public amenity and open space within 400m of the proposed new amenity space.
Users of the public Open Space – Victoria Embankment Gardens: Whitehall Garden	Low – users have access to several alternative areas of public open space within 400m of Whitehall Garden.
Residents	Medium / High – residents would have limited opportunity to avoid effects; however they would have medium sensitivity to amenity effects overall during the day and high sensitivity to amenity effects overall during the evening and night.
Private members facility – National Liberal Club	Low – the club is not directly exposed to the site and its business model is likely to mean it is less dependent on passing trade.
Business – Royal Horseguards Hotel	Medium – if customers were sufficiently deterred from staying at the hotel by amenity impacts then the hotel could suffer deterioration in trade. This could in turn affect employees, however the hotel sector typically experiences high staff turnover.
Tourism	Medium – while there are a limited number of major tourist attractions within the immediate local area, the central London location and proximity to high profile visitor destinations attracts many tourists to the wider local area and tourism is an important economic sector.

Construction base case

10.4.68 The construction assessment year and area are as set out in para. 10.3.3.

10.4.69 As described in Section 10.3, there are no developments which would alter the construction base case.

10.4.70 Businesses based on the Tattershall Castle and Hispaniola vessels could change between the current time and the base case year. However, it is likely that the type of business activities currently in existence would be similar, given the distinctive nature of these premises and their location. It is also possible that the vessels, which are moored at the site, could be relocated elsewhere and replaced by other commercial activities. It is not possible however to forecast this with accuracy so it is assumed for the purposes of this assessment that the businesses would continue to operate in the base case as they do under the existing baseline conditions.

Operational base case

10.4.71 The operational assessment year and area are as set out in para. 10.3.8. As described in para. 10.3.11, there are no developments relevant to the operational assessment within the assessment area that would alter the base case.

10.4.72 Therefore, the base case in Year 1 of operation would not change beyond that set out for the construction base case above.

10.5 Construction effects assessment

Displacement of business – Tattershall Castle (bar and restaurant)

10.5.1 The Tattershall Castle would be temporarily moved approximately 120m upstream to the Mainstream Leisure mooring at the start of the construction phase. At the end of the construction phase Tattershall Castle would then be permanently repositioned at a new mooring approximately 30m downstream of this temporary mooring position (ie, approximately 90m from its current mooring).

10.5.2 The magnitude of the impact is influenced by the following factors:

a. The close proximity of the two future mooring positions to the existing mooring would mean that whatever benefits that the business derives from being in its baseline riverside setting would effectively be the same in the interim and permanent relocation positions.

b. The number of people employed by the business is not known, but it is estimated that the business would mostly likely be classified as a small enterprise based on the number of employees on site (10 to 49 employees).

c. The effect on the business of relocating twice could be potentially significant as there would be costs and expenditure associated with the move including but not limited to removal expenses, legal and surveyor fees, taxes, costs of securing and adapting new premises, and diminution of goodwill following the move. If the business failed as a result of the relocations, its employees could potentially lose their jobs.

d. However, in accordance with the Thames Tideway Tunnel project compensation programme (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application), compensation would be available. Given that Thames Water would comply with the provisions of the programme, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred in association with the two moves would be met.

10.5.3 Taking account of the above, it is considered that the magnitude of the impact arising from the relocation of Tattershall Castle to a temporary position at the start of the construction phase and then a permanent new position at the end of the construction phase would be low.

10.5.4 Given the low magnitude of the impact and the medium sensitivity, it is assessed that there could be a **minor adverse** effect on the business and employment provided by the business.

Displacement of moorings – Mainstream Leisure

10.5.5 The permanent relocation of the Tattershall Castle would in turn require the permanent relocation of the existing service mooring used by Mainstream Leisure.

10.5.6 The magnitude of the impact is influenced by the following factors:

a. As the mooring is used as a service mooring, it is considered likely that Mainstream Leisure would be able to relocate the Golden Salamander to an alternative mooring position that is suitable for their requirements. The relocation of the mooring is unlikely to affect the business' ability to operate at its current capacity; the mooring does not perform a passenger function related to the business' operating route.

b. The effect on Mainstream Leisure as a result of the mooring being permanently relocated could be potentially significant as there would be costs and expenditure associated with the relocation of the mooring including but not limited to removal expenses, legal fees, taxes and costs of securing and adapting the new mooring.

c. However, in accordance with the Thames Tideway Tunnel project compensation programme (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application), compensation would be available. Given that Thames Water would comply with the provisions of the programme, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred in association with the relocation would be met.

10.5.7 Taking account of the above, it is considered that the magnitude of the impact arising from the permanent relocation of the mooring would be low.

10.5.8 Given the low magnitude of the impact and the low sensitivity, it is assessed that there would be a **negligible** effect on the Mainstream Leisure business.

Temporary relocation of moorings – City Cruises

10.5.9 The permanent relocation of the Tattershall Castle would in turn require the temporary relocation of the existing service mooring used by City Cruises. At the end of the construction phase the City Cruises mooring would be reinstated in its existing position.

10.5.10 The magnitude of the impact is influenced by the following factors:

a. The impact would be temporary and, based on the duration of the construction period, medium term.

b. The benefits the business derives from being able to access the moorings in their current location. As the mooring is used as a service mooring, it is considered likely that City Cruises would be able to relocate to an alternative mooring position that is suitable for their requirements. The relocation of the mooring would be unlikely to affect City Cruises' ability to operate at its current capacity; the mooring does not perform a passenger function related to the business' operating route.

c. The effect on City Cruises as a result of the mooring being temporarily relocated could be potentially significant as there would be costs and expenditure associated with the relocation of the mooring including but not limited to removal expenses, legal fees, taxes and costs of securing and adapting the new mooring.

d. However, in accordance with the Thames Tideway Tunnel project compensation programme (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application), compensation would be available. Given that Thames Water would comply with the provisions of the programme, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred in association with the relocation would be met.

10.5.11 Taking account of the above, it is considered that the magnitude of the impact arising from the temporary relocation of the City Cruises mooring would be low.

10.5.12 Given the low magnitude of the impact and the low sensitivity, it is assessed that there would be a **negligible** effect on the City Cruises business.

Temporary diversion of the Thames Path

10.5.13 The Thames Path would be diverted via the pavement on the opposite (western) side of Victoria Embankment during the construction period.

10.5.14 The magnitude of the impact is influenced by the following factors:

a. Usage surveys indicate that the diversion would affect high numbers of users, although many would be occasional recreational users, including tourists.

b. The diversion would occur over a medium term period.

c. The proposed diversion follows the pavement on the opposite side of Victoria Embankment carriageway and is only slightly longer than the section of the Thames Path that would require temporary closure. As a result, it is unlikely that users would become disorientated or experience significant delays and inconvenience.

d. The diversion and its duration would be more likely to inconvenience regular users, such as commuters, rather than occasional recreational users and tourists. However, regular users would be likely to identify and use alternative routes for some or part of their journey to avoid the diversion and delay, particularly given that most origins and destinations in this area require users to cross Victoria Embankment.

e. The two existing signalised pedestrian crossings would allow pedestrians to cross the road safely at either end of the diversion

10.5.15 On the basis of the above factors, it is assessed that the magnitude of impact is likely to be medium.

10.5.16 Given the medium magnitude of impact and the low sensitivity, it is assessed that the effect of the temporary diversion of a section of the Thames Path would be **minor adverse**.

10.5.17 There is potential for additional effects to occur on users of the Thames Path due to the diversion of the Thames Path at the Blackfriars Bridge Foreshore site (approximately 1,500m downstream of the site) during construction at that site, as users (of both sections of the Thames Path) would be diverted twice along a pathway that would ordinarily take approximately 20 to 25 minutes to walk from one end to the other. Both diversions involve crossing to the other side of the road (see Vol 18 Blackfriars Bridge Foreshore) meaning the diversions would increase walking time accordingly.

10.5.18 The degree to which this would increase the significance of the effect depends on the proportion of users that are likely to walk the length of the Thames Path between the two sites and thus be subject to both diversions. Based on observations made during the usage surveys, it is estimated that approximately half or less of all users of either section would be affected by both diversions. Nonetheless, given that both diversions allow path users to continue along the opposite side of the road and do not cause significant inconvenience to users, it is considered that there would be no additional effect on users.

Effect on the Tattershall Castle due to construction activity

10.5.19 If customers are sufficiently deterred from dining and drinking at Tattershall Castle by amenity impacts such as noise, dust or unpleasant views, then the business could in turn suffer deterioration in trade. For this reason the overall effect on amenity, as it would be experienced by people drinking and dining on-deck within the Tattershall Castle is relevant and is considered below.

10.5.20 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects of the project arising during construction. For further information refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual). The following points summarise the residual effect findings of those assessments on the Tattershall Castle:

a. Local air quality would be **major beneficial** (owing to the new location experiencing lower levels of background air pollution). Construction dust would be **minor adverse**.

b. Noise effects would be **significant** at the business. This finding is informed in part by the estimate that during the day ambient noise levels would be exceeded for a total of eight months over the entire duration of the works. The assessment also states that on the open deck area, the daytime construction noise levels would be well in excess of the daytime ambient noise levels and that it is likely that daytime construction noise would at times cause disturbance to users of the bar depending on construction activities in progress. The predicted evening and night time construction noise effects are below the existing ambient noise level for both evening and night-time periods. Noise effects as a result of river based construction traffic would be **not significant**. Vibration effects would be **not significant**.

c. The Tattershall Castle was not assessed as a receptor for the purposes of the visual impact assessment. However, a **major adverse** effect was identified at a nearby viewpoint which takes in views of the construction site along the Thames Path to the north (viewpoint 2.1). While this viewpoint is not a precise substitute for views from the restaurant boat, it is a useful reference and indicates that views towards the construction site from the restaurant boat deck would be likely to be adversely affected.

10.5.21 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are relevant to the way in which the businesses would be affected:

a. Given the four and a half year construction programme, the effects noted above would be likely to be experienced over a medium term period.

b. Although recorded for a recreational receptor on the Thames Path rather than from a viewpoint on the vessel itself, the above findings indicate that visual effects would be significant. This would be particularly so from the north-facing deck of the vessel which would overlook the construction site. It is considered that there would be a considerable risk that significant visual effects could deter people from choosing to drink and dine at the Tattershall Castle. This would occur even during those times when there is an absence of other significant effects such as noise (as well as adverse air quality, construction dust and vibration effects – all of which would be not significant), because perceptions of the potential decline in amenity may exceed the actual decline and deter customers. In such circumstances, this would be likely to lead to deterioration in trading conditions for the Tattershall Castle.

c. However, views from the south facing deck of the vessel would also be much less significantly affected than those from the north facing deck.

d. Notwithstanding the significant effects identified, the business is similar to a pub and the appeal of the boat as a unique drinking and dining establishment may also count in its favour, and help it to continue to attract customers in spite of the adverse visual effects.

10.5.22 On the basis of the above findings and factors, it is considered that under a worst case scenario the magnitude of impact on the business from a potential downturn in trade due to construction activities on the site would be medium.

10.5.23 Given a medium magnitude of impact and the medium sensitivity of the business, the effect on the Tattershall Castle due to construction activity would be **moderate adverse**.

Effect on the Hispaniola due to construction activity

10.5.24 If customers are sufficiently deterred from dining at the Hispaniola by amenity impacts such as noise, dust or unpleasant views, then the business could in turn suffer deterioration in trade. For this reason the overall effect on amenity, as it would be experienced by people dining below deck and on-deck, is relevant and is considered below.

10.5.25 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects of the project arising during construction. For further information refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual). The following points summarise the residual effect findings of those assessments on the Hispaniola:

a. Local air quality effects would be **negligible.** Construction dust effects would be **minor adverse**.

b. Noise effects would be **significant** at the Hispaniola during the daytime. This assessment result is partly based on the estimated exceedence of the ambient noise level for two months. However, the noise assessment also found that the Hispaniola's upper deck bar, which is not within the main restaurant, would experience construction noise levels during the day that would be well above the daytime ambient noise levels for certain periods of the work and that it is likely that construction noise during the day may at times cause some disturbance to users of the bar depending on the type of construction activities in progress. The guideline noise levels for conference facilities would also be exceeded. Noise effects would be **not significant** during the evening. Noise effects from river based construction traffic would be **not significant**. Vibration effects would be **not significant**.

c. The Hispaniola was not assessed as a receptor for the purposes of the visual impact assessment. However, a **major adverse** effect was identified at a nearby viewpoint which takes in views of the construction site along the Thames Path to the north (viewpoint 2.1). While this viewpoint is not a precise substitute for views from the restaurant boat, it is a useful reference and indicates that views towards the construction site from the restaurant boat deck would be likely to be adversely affected.

10.5.26 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are relevant to the way in which the businesses would be affected:

a. Given the four and a half year construction programme, the effects noted above would be likely to be experienced over a medium term period.

b. Although recorded for a recreational receptor on the Thames Path rather than from a viewpoint on the vessel itself, the above findings indicate that visual effects would be likely to significantly affect the business during construction. This would be particularly so from the south-facing deck of the vessel which would overlook the construction site.

c. The position of the vessel, whereby its northern portion is situated under the southern Jubilee footbridge means that the business would be less able to focus on-deck dining and activities away from the construction site facing side of the boat to the other side. However, the vessel includes a below deck restaurant and this is much less likely to be affected by adverse visual effects. Overall, it is considered that there is a considerable risk that significant visual effects would deter people from choosing to drink and dine at the Hispaniola. This could occur even in the absence of any other significant effects, because perceptions of the potential decline in amenity may exceed the actual decline. In such circumstances, this would be likely to lead to deterioration in trading conditions for the Hispaniola.

d. Notwithstanding the significant effects identified, the appeal of the boat as a dining establishment may also count in its favour, and help it to continue to attract customers in spite of the adverse visual effects. However, the Hispaniola may also have more limited appeal than the Tattershall Castle as a venue because many patrons may consider the position of the vessel during the works between the Jubilee footbridge position and the construction site to be off putting.

10.5.27 The Hispaniola could submit a claim for compensation for financial loss resulting from a drop in trade in accordance with statutory procedures provided for by the Thames Tideway Tunnel project compensation programme (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application). However, given the nature of such compensation, the outcome of any such claim cannot be guaranteed at this point. Hence, for the purposes of this assessment it is considered possible that the business could incur a financial loss during construction due to perceived and actual drop in the amenity conditions surrounding the vessel and the consequent fall in patronage.

10.5.28 On the basis of the above findings and factors, it is considered that under a worst case scenario the magnitude of impact on the business from a potential downturn in trade due to construction activities on the site would be high.

10.5.29 Given a high magnitude of impact and the medium sensitivity of the business, the effect on the Hispaniola due to construction activity would be **major adverse**.

Effect on the amenity of Thames Path users

10.5.30 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects of the project arising during construction. For further information, refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual). The following points summarise the residual effect findings of those assessments on the Thames Path:

a. Both local air quality and construction dust effects would be **minor adverse**.

b. No noise or vibration receptors were identified for assessment in relation to the Thames Path at this site.

c. There are likely to be **major adverse** visual effects at three of the five viewpoints identified (2.1, 2.2 and 2.3) and **minor adverse** visual effects at the other two viewpoints (2.5 and 2.19).

10.5.31 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with other factors that are relevant to the receptor's overall experience of amenity at this site:

a. Given the four and a half year construction programme, the effects noted above would be likely to be experienced over a medium term period. The exception is that local air quality effects may not be minor adverse over the whole construction period as the assessment is purely based on the peak construction year and these effects may be negligible in other years.

b. The high use of the Thames Path at this site means that any impacts would affect a high number of users although many would be likely to be occasional recreational users, including tourists.

c. Given that the Thames Path, in terms of its function as a recreational asset, is mostly used for walking, jogging and cycling, the time taken to pass by the site would be a relatively short period (eg, up to five minutes) for most users.

10.5.32 On the basis of the above findings and factors, it is considered that the magnitude of impact on overall amenity would be medium.

10.5.33 Given the medium magnitude of impact and the low sensitivity of Thames Path users, the effect on the amenity of Thames Path users would be **minor adverse**.

Effect on the amenity of open space (Whitehall Garden) users

10.5.34 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects of the project arising during construction. For further information, refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual). The following points summarise the residual effect findings of those assessments on Whitehall Garden:

a. Both local air quality and construction dust effects would be **negligible**.

b. Noise and vibration effects on users would be **not significant** at the relevant receptor identified.

c. Visual effects would be **minor adverse** from one viewpoint (2.22).

10.5.35 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are relevant to the receptor's overall experience of amenity at this site:

a. Given the four and a half year construction programme, the effects noted above would be likely to be experienced over a medium term period.

b. The moderate use of Whitehall Garden, mostly for passive recreation, means that any impacts would affect a moderate number of users.

c. It is considered that the minor adverse effect from viewpoint 2.22 is unlikely to significantly detract from users' amenity or deter their use of the garden. This is because the effect would be caused by the intermittent visibility of the construction site through intervening mature trees and most users of Whitehall Garden, particularly in summer, would be focused on sights within the garden and not looking at or towards the River Thames. This is particularly true during summer when the garden is most highly used, as foliage prevents views towards the River Thames from the garden.

10.5.36 On the basis of the above findings and factors, it is considered that the magnitude of overall amenity impact would be low.

10.5.37 Given the low magnitude of impact and the low sensitivity, it is considered that the effect on the amenity of open space (Whitehall Garden) users would be **negligible**.

Effect on the amenity of residents

10.5.38 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration and visual effects of the project arising during construction. For further information, refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual).

10.5.39 These air quality, construction dust, noise and vibration assessments found that the residual effect on nearby residential receptors that would arise as a result of construction activity at the site, including noise effects as a result of road and river based construction traffic, would be **negligible** / **not significant**. No viewpoints were identified for assessment in relation to residential receptors at this site.

10.5.40 On the basis of the above findings, it is considered that the magnitude of impact on the amenity of residents would be negligible.

10.5.41 Given the negligible magnitude of impact and the medium sensitivity of residents, the effect on the amenity of residents would be **negligible**.

Effect on the National Liberal Club due to construction activity

10.5.42 If club members are sufficiently deterred from frequenting the National Liberal Club or renewing their membership due to amenity impacts such as noise, dust or unpleasant views, then the club would in turn suffer deterioration due to lack of custom.

10.5.43 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects of the project arising during construction. For further information, refer to the respective construction effects sections within this volume (see

Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual).

10.5.44 These air quality, construction dust, noise and vibration assessments found that the residual effects on the National Liberal Club arising as a result of construction activity would be **negligible** / **not significant** on the club. No viewpoints were identified for assessment in relation to the National Liberal Club at this site.

10.5.45 Given these results, it is therefore assumed that club activities would be able to continue as they do in the base case. On this basis, it is considered that the magnitude of overall amenity impact would be negligible.

10.5.46 Given the negligible magnitude of impact and the low sensitivity, the effect on the National Liberal Club due to construction activity would be **negligible**.

Effect on the Royal Horseguards Hotel due to construction activity

10.5.47 Effects on environmental amenity such as noise, dust or unpleasant views have the potential to deter hotel guests from staying at the hotel (and therefore result in a deterioration in business), and would also affect staff.

10.5.48 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects arising during construction. For further information, refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual).

10.5.49 These air quality, construction dust, noise and vibration assessments found that the residual effects on the Royal Horseguards Hotel arising as a result of construction activity would be **negligible** / **not significant** on the hotel, or in the case of noise and vibration, on residential dwellings located within the same building. No viewpoints were identified for assessment in relation to the Royal Horseguards Hotel at this site.

10.5.50 Given these results, it is therefore assumed that hotel activities would be able to continue as they do in the base case. On this basis, it is considered that the magnitude of overall amenity impact would be negligible.

10.5.51 Given the negligible magnitude of impact and the medium sensitivity, the effect on the Royal Horseguards Hotel due to construction activity would be **negligible**.

Temporary effect on tourism

10.5.52 This area is frequented by tourists and there are several major tourist destinations near the site. The project could affect the tourism sector during the construction works.

10.5.53 The magnitude of the impact on tourism is influenced by the following factors:

a. The construction works would occur over a medium term period and the impact would therefore be temporary in nature.

b. Usage surveys observed a high number of tourists walking past and taking photographs, but also that the majority were in the area for under five minutes at a time. While the site is located within a popular part of London for tourists, it is likely that many tourists passing this construction site would be walking between major attractions or transit points (for example, London Underground stations).

c. While tourists are likely to be aware of the construction site when they arrive in the area, they are unlikely to have any prior knowledge of the works taking place. As such, the volume of tourists coming to the area would be unlikely to decline. In the same way, the project would be unlikely to affect this location's potential to act as a successful gathering point for major events such as the New Year fireworks. It is also very unlikely that the majority of tourist related businesses nearby the site would be adversely affected.

10.5.54 The Tattershall Castle and Hispaniola are located within the immediate vicinity of the site and tourists are an important potential source of custom; these receptors have been considered separately within this assessment.

10.5.55 On the basis of the above factors, it is assessed that the magnitude of impact is likely to be low.

10.5.56 Given the low magnitude of impact and the medium sensitivity of tourism to effects associated with the project, it is assessed that the effect of the temporary disruption would be **minor adverse**.

10.6 Operational effects assessment

Permanent gain of public amenity space

10.6.1 The extension of the river wall out in to the foreshore would result in the permanent provision of an increased area of pleasantly landscaped and functional public amenity space measuring up to approximately 0.1ha in size.

10.6.2 The magnitude of the impact is influenced by the following factors:

a. The new amenity space would offer an increased area of functional, pleasantly landscaped space ideally suited to passive recreation, along this section of the Thames Path.

b. The impact would be permanent and provide a point of interest overlooking the river, with seating positioned to maximise views.

c. The new space would be the equivalent of a small pocket park under the Mayor's Public Open Space Hierarchy. According to this hierarchy, such size spaces typically serve a catchment area of up to 400m for local residents and employees. However, given its position on the Thames Path in central London, it is likely to draw usage from a much wider catchment area.

d. Given the high numbers of people that use this section of the Thames Path at most times of day, the new space is likely to be well used and therefore benefit a large number of users, including local residents, local workers and both domestic and international tourists. The high proportion of local older residents would be likely to find such space particularly appealing (see para. 10.4.3c).

10.6.3 Taking account of the above findings and factors, in particular the space's size, the permanent nature of the impact and the high numbers of people likely to make use of the space, it is considered that the magnitude of impact would be medium.

10.6.4 Given the medium magnitude of impact and the low sensitivity of the Thames Path and the future public amenity space users, it is considered that the effect on users of the new public amenity space would be **minor beneficial**.

10.7 Cumulative effects assessment

Construction effects

10.7.1 As described in Section 10.3, there are no other developments which would be under construction at the same time as the Thames Tideway Tunnel project at this site and which have the same type of effects as those considered in Section 10.5 and potentially give rise to cumulative effects with the proposed development at Victoria Embankment Foreshore site.

10.7.2 Therefore, the effects on socio-economics would remain as described in Section 10.5.

Operational effects

10.7.3 As described in Section 10.3, no developments within the amenity effect assessment area would be under construction at the same time as the Thames Tideway Tunnel project at this site. Therefore, no cumulative effects are likely to arise.

10.7.4 Therefore, the effects on socio-economics would remain as described in Section 10.6.

10.8 Mitigation and compensation

Mitigation

Construction effects

10.8.1 The above assessment has concluded that there would be a major adverse effect on the Hispaniola and a moderate adverse effect on the Tattershall Castle as a result of the potential for amenity effects to result in a reduction in customer numbers and a subsequent financial loss to the businesses.

10.8.2 The above amenity assessment has drawn from the residual effects assessments undertaken in relation to air quality, construction dust, noise, vibration and visual effect assessments. Where practicable and applicable, embedded measures have been included and no further practicable measures or mitigation can be adopted above those methods identified in the *CoCP*.

10.8.3 The above assessment has concluded that there would be no other significant adverse socio-economic effects (that is major or moderate) at this site in the construction phase requiring mitigation.

Operational effects

10.8.4 The above assessment has concluded that operational effects would be beneficial and therefore mitigation is not needed.

Compensation

Construction effects

10.8.5 A compensation programme has been established (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application) relating to construction disturbance - for example, noise, dust, vibration, and / or light disturbance from worksites at night. The programme has been established to address claims of exceptional hardship or disturbance.

10.8.6 In relation to the effects on the vessel based restaurant / bar businesses due to construction activity (see Section 10.5); the businesses would be entitled to submit a claim for compensation in accordance with the Thames Tideway Tunnel compensation programme. The programme measures are considered to be mitigation. Therefore the residual effects reported in this *Environmental Statement* take the offsetting effects of these measures into account. Further information is contained in the Thames Tideway Tunnel Compensation Programme (see Schedule 2 of the *Statement of Reasons*, which accompanies the application).

10.9 Residual effects assessment

Construction effects

10.9.1 In relation to the Tattershall Castle, which may experience significant adverse effects, as compensation is considered to mitigate (ie, reduce) the significant adverse effect, it is considered that the effect due to construction activity would be reduced in severity and rated as **minor adverse**.

10.9.2 In relation to the Hispaniola, which may experience significant adverse effects, as compensation is considered to mitigate (ie, reduce) the significant adverse effect, it is considered that the effect due to construction activity would be reduced in severity. However, due to the vessel's position, it is considered likely that the effect on the business would still be significant and would be rated as **moderate adverse**.

10.9.3 All residual effects are presented in Section 10.10.

Operational effects

10.9.4 As no mitigation measures are proposed, the residual operational effects remain as described in Section 10.6.

10.9.5 All residual effects are presented in Section 10.10.

10.10 Assessment summary

Vol 17 Table 10.10.1 Socio-economics – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect	Compensation
Businesses – the Tattershall Castle bar / restaurant vessel	Displacement of business	Minor adverse	None	Minor adverse	
Business – Mainstream Leisure	Displacement of mooring	Negligible	None	Negligible	
Business – City Cruises	Temporary displacement of mooring	Negligible	None	Negligible	
Users of the Thames Path	Temporary diversion of a section of Thames Path	Minor adverse	None	Minor adverse	
Tourism	Temporary effects on tourism sector	Minor adverse	None	Minor adverse	
Businesses – Tattershall Castle bar / restaurant vessel	Effect on business due to construction activity	Moderate adverse	No further on site mitigation practicable.	Minor adverse	Compensation measures available for amenity related disturbance during the construction phase
Businesses – the Hispaniola vessel	Effect on business due to construction activity	Major adverse	No further on site mitigation practicable.	Moderate adverse	Compensation measures available for amenity related disturbance during the construction phase.

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect	Compensation
Users of the Thames Path	Effect on the amenity of Thames Path users	Minor adverse	None	Minor adverse	
Users of Whitehall Garden	Effect on the amenity of open space users	Negligible	None	Negligible	
Residents	Effect on the amenity of residents	Negligible	None	Negligible	
Private members facility – National Liberal Club	Effect on the National Liberal Club due to construction activity	Negligible	None	Negligible	
Business – Royal Horseguards Hotel	Effect on the Royal Horseguards Hotel due to construction activity	Negligible	None	Negligible	

Vol 17 Table 10.10.2 Socio-economics – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Users of the Thames Path	Permanent gain of public amenity space	Minor beneficial	None	Minor beneficial

References

[1] Department of Environment, Food and Rural Affairs. National Policy Statement for Waste Water (2012). Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf. Accessed November 2012

[2] People 1st. *State of the Nation Annual Report Executive Summary* (2011). Available at: http://www.goskills.org/webfiles/Research/State%20Of%20The%20Nation/2011/State_of_the_Nation_2011_Executive_Summary.pdf. Accessed August 2012.

[3] Thames River Boats. *'The Golden Salamander'.* Available at: http://www.thamesriverboats.net/page30.htm. Accessed September 2012.

[4] City Cruises. *Timetable information* (2012). Available at: http://www.citycruises.com/rrrinfo.php. Accessed February 2012.

[5] National Liberal Club. *Reciprocal Clubs list* (2012). Available at: http://www.nlc.org.uk/reciplist.pdf. Accessed August 2012.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 11: Townscape and visual

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 11: Townscape and visual

List of contents

Page number

11 Townscape and visual 1
11.1 Introduction 1
11.2 Proposed development relevant to townscape and visual 2
11.3 Assessment methodology 4
11.4 Baseline conditions 10
11.5 Construction effects assessment 65
11.6 Operational effects assessment 75
11.7 Cumulative effects assessment 89
11.8 Mitigation 89
11.9 Residual effects assessment 90
11.10 Assessment summary 91
References 104

List of plates

Page number

Vol 17 Plate 11.4.1 The character of the site 14
Vol 17 Plate 11.4.2 River Thames – Houses of Parliament Reach TCA 16
Vol 17 Plate 11.4.3 River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA 17
Vol 17 Plate 11.4.4 River Thames – Central London Reach TCA 18
Vol 17 Plate 11.4.5 Victoria Embankment Administrative TCA 19
Vol 17 Plate 11.4.6 Temples Conservation Area TCA 21
Vol 17 Plate 11.4.7 Whitefriars Conservation Area TCA 22
Vol 17 Plate 11.4.8 South Bank Conservation Area TCA 23

Vol 17 Plate 11.4.9 Westminster Abbey and Parliament Square TCA...................... 24
Vol 17 Plate 11.4.10 Linear View 9A.1: winter view.. 25
Vol 17 Plate 11.4.11 Viewpoint 2.1: winter view 26
Vol 17 Plate 11.4.12 Viewpoint 2.1: summer view.. 27
Vol 17 Plate 11.4.13 Viewpoint 2.2: winter view 28
Vol 17 Plate 11.4.14 Viewpoint 2.2: summer view.. 29
Vol 17 Plate 11.4.15 Viewpoint 2.3: winter view 30
Vol 17 Plate 11.4.16 Viewpoint 2.3: summer view.. 31
Vol 17 Plate 11.4.17 Viewpoint 2.4: winter view 32
Vol 17 Plate 11.4.18 Viewpoint 2.5: winter view 33
Vol 17 Plate 11.4.19 Viewpoint 2.5: summer view.. 34
Vol 17 Plate 11.4.20 Viewpoint 2.6: winter view 35
Vol 17 Plate 11.4.21 Viewpoint 2.7: winter view 36
Vol 17 Plate 11.4.22 Viewpoint 2.7: summer view.. 37
Vol 17 Plate 11.4.23 Viewpoint 2.8: winter view 38
Vol 17 Plate 11.4.24 Viewpoint 2.9: winter view 39
Vol 17 Plate 11.4.25 Viewpoint 2.9: summer view.. 40
Vol 17 Plate 11.4.26 Viewpoint 2.10: winter view towards Victoria Embankment Foreshore (southwest)... 41
Vol 17 Plate 11.4.27 Viewpoint 2.10: summer view towards Victoria Embankment Foreshore (southwest)... 42
Vol 17 Plate 11.4.28 Viewpoint 2.10: winter view towards Blackfriars Bridge Foreshore (east) 43
Vol 17 Plate 11.4.29 Viewpoint 2.10: summer view towards Blackfriars Bridge Foreshore (east) 44
Vol 17 Plate 11.4.30 Viewpoint 2.11: winter view 45
Vol 17 Plate 11.4.31 Viewpoint 2.11: summer view.. 45
Vol 17 Plate 11.4.32 Viewpoint 2.12: winter view 46
Vol 17 Plate 11.4.33 Viewpoint 2.12: summer view.. 47
Vol 17 Plate 11.4.34 Viewpoint 2.13: winter view 48
Vol 17 Plate 11.4.35 Viewpoint 2.14: winter view 49
Vol 17 Plate 11.4.36 Viewpoint 2.14: summer view.. 50
Vol 17 Plate 11.4.37 Viewpoint 2.15: winter view 51
Vol 17 Plate 11.4.38 Viewpoint 2.16: winter view 52
Vol 17 Plate 11.4.39 Viewpoint 2.16: summer view.. 53
Vol 17 Plate 11.4.40 Viewpoint 2.17: winter view 54

Vol 17 Plate 11.4.41 Viewpoint 2.17: summer view 55
Vol 17 Plate 11.4.42 Viewpoint 2.18: winter view 56
Vol 17 Plate 11.4.43 Viewpoint 2.18: summer view 57
Vol 17 Plate 11.4.44 Viewpoint 2.19: winter view 58
Vol 17 Plate 11.4.45 Viewpoint 2.19: summer view 59
Vol 17 Plate 11.4.46 Viewpoint 2.20: winter view 60
Vol 17 Plate 11.4.47 Viewpoint 2.21: winter view 61
Vol 17 Plate 11.4.48 Viewpoint 2.22: winter view 62
Vol 17 Plate 11.4.49 Viewpoint 2.22: summer view 62
Vol 17 Plate 11.4.50 Viewpoint 2.23: winter view 63
Vol 17 Plate 11.4.51 Viewpoint 2.24: winter view 64
Vol 17 Plate 11.6.1 Viewpoint 2.2 – illustrative operational phase photomontage.... 83
Vol 17 Plate 11.6.2 Viewpoint 2.2 – illustrative night time operational phase photomontage 83
Vol 17 Plate 11.6.3 Viewpoint 2.3 – illustrative operational phase photomontage.... 84
Vol 17 Plate 11.6.4 Viewpoint 2.14 – illustrative operational phase photomontage.. 86
Vol 17 Plate 11.6.5 Viewpoint 2.17 – illustrative operational phase photomontage.. 86
Vol 17 Plate 11.6.6 Viewpoint 2.14 – illustrative night time operational phase photomontage 87

List of tables

Page number

Vol 17 Table 11.3.1 Townscape and visual – stakeholder engagement..................... 5
Vol 17 Table 11.4.1 Townscape – open space type and distribution........................ 12
Vol 17 Table 11.4.2 Townscape – site components 14
Vol 17 Table 11.5.1 Townscape – impacts on existing site components during construction 65
Vol 17 Table 11.6.1 Townscape – impacts on baseline components in Year 1 of operation.. 76
Vol 17 Table 11.10.1 Townscape – summary of construction assessment 91
Vol 17 Table 11.10.2 Visual – summary of construction assessment....................... 93
Vol 17 Table 11.10.3 Townscape – summary of Year 1 and Year 15 operational assessment 97
Vol 17 Table 11.10.4 Visual – summary of Year 1 and Year 15 operational assessment 99

This page is intentionally blank

11 Townscape and visual

11.1 Introduction

11.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on townscape and visual amenity at Victoria Embankment Foreshore. The assessment describes the current conditions found within and around the site – the nature and pattern of buildings, streets, open space and vegetation and their interrelationships within the built environment – and the changes that would be introduced as a result of the proposed development during construction and operation.

11.1.2 The effects of these changes during construction and operation are assessed. The construction phase assessment includes effects on townscape character areas and visual effects during daytime. The Year 1 operational phase assessment includes effects on townscape character areas and visual effects during both daytime and night time. The Year 15 operational phase assessment includes effects on townscape character areas and visual effects during daytime. The assessment also identifies mitigation measures where appropriate.

11.1.3 An assessment of effects arising from lighting during the construction phase is not required because it is judged that there would not be any significant effects (this is further explained in para. 11.3.10).

11.1.4 Each section of the assessment is structured with townscape aspects described first, followed by visual.

11.1.5 The assessment of the likely significant townscape and visual effects of the project has considered the requirements of the National Policy Statement (NPS) for Waste Water (Defra, 2012)[1]. In line with these requirements, the townscape and visual assessment considers effects during construction and operation on townscape components, townscape character and visual receptors. The construction and design of the proposed development also takes account of townscape and visual considerations in line with the NPS recommendations. Vol 2 Section 11 provides further details on the methodology.

11.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

11.1.7 A separate but related assessment of effects on the setting of heritage assets is included in Section 7 Historic environment.

11.2 Proposed development relevant to townscape and visual

11.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to the townscape and visual assessment are set out below.

Construction

11.2.2 The specific construction works which may give rise to effects on townscape character and visual receptors are listed as follows, with the activities likely to give to the most substantial townscape and visual effects described first:

a. use of cranes during shaft sinking and secondary lining of the connection tunnel

b. construction of a temporary cofferdam using a piling rig

c. clearance of the site in advance of works, including removal of stretches of the river wall and trees along Victoria Embankment (refer to the Demolition and site clearance plan 1 of 2, separate volume of figures – Section 1)

d. provision of welfare facilities, assumed to be a maximum of three storeys in height

e. installation of 2.4m high hoardings around the boundary of the construction site, and 3.6m high hoardings along the western boundary.

Code of construction practice

11.2.3 The *Code of Construction Practice* (*CoCP*) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site-specific requirements for this site (Part B). Measures incorporated into the *CoCP Part A* to reduce townscape and visual impacts include:

a. protection of existing trees in accordance with *BS5837 'Trees in Relation to Construction – Recommendations (see CoCP Part A* Section 11*)'*

b. protection of listed structures, including the river wall (See *CoCP Part A* Section 12)

c. use of well-designed visually attractive hoardings (see *CoCP Part A* Section 4)

d. the use of appropriate capped and directional lighting when required (see *CoCP Part A* section 4).

11.2.4 Measures incorporated into the *CoCP Part B* to reduce townscape and visual impacts include:

a. provision for incorporating suitable art work and viewing windows in public facing sections of the hoarding

b. increasing the height of the hoardings to 3.6m along the western boundary.

Operation

11.2.5 The particular components of importance to this topic include the:

a. design and materials used for the river wall around the new foreshore structure

b. design, layout and materials used in the public realm including the treatment of level changes, seating, railings and lighting (including feature lighting of the ventilation columns)

c. design, siting and materials used for the ventilation column and control kiosks, and the zones within which these above ground structures may be located

d. size, layout and species used for tree planting along Victoria Embankment and on the foreshore structure.

Environmental design measures

11.2.6 Figures illustrating the proposed development during operation are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures). Where photomontages have been prepared to assist the assessment of effects, these are referenced in the appropriate viewpoint in Section 11.6.

11.2.7 Measures which have been incorporated into the design of the proposed development (described in the *Design Principles* report, see Vol 1 Appendix B) include the:

a. use of granite blocks for the river wall, in keeping with the existing Embankment wall

b. use of shadow gaps where appropriate along the elevation of the river wall to reduce the visual bulk of the foreshore structure

c. the orthogonal design and layout of the foreshore structure, which is sympathetic to the geometry and character of the surrounding townscape and would provide additional public open space along the river

d. use of natural stone appropriate to the townscape character to clad the control kiosks and the inclusion of a planted roof on the structures

e. the control kiosks would be located on the line of the existing river wall

f. the use of natural stone appropriate to the townscape character for the public realm

g. retention of the majority of the existing river wall visible above ground level and lamp columns along Victoria Embankment

h. use of visually unobtrusive hand railings along the river wall of the foreshore structure

i. use of low level lighting for the public realm which is capped and directional to minimise light spill (generic lighting principles)

j. commitment to a high quality design for the ventilation columns

k. reinstatement of semi mature London plane trees along Victoria Embankment

l. reinstatement of the festoon lighting, sturgeon lamp stands and Sphinx benches along Victoria Embankment as far as possible.

11.3 Assessment methodology

Engagement

11.3.1 Volume 2 Environment assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of townscape and visual effects are presented here.

11.3.2 Following the scoping process, Westminster City Council and neighbouring authorities (City of London Corporation, London Borough [LB] of Lambeth and LB of Southwark) and English Heritage have been consulted on the detailed approach to the townscape and visual assessment, including the number and location of viewpoints. All consultee comments relevant to this site are presented in Vol 17 Table 11.3.1 below. The City of London Corporation, LB of Lambeth and LB of Southwark have not commented on the proposed viewpoints.

11.3.3 In March 2011, English Heritage and the Environment Agency were consulted on the scope of the townscape and visual and ecology assessments through a site visit. English Heritage provided feedback on the proposed design, particularly with regard the shape of the proposed foreshore structure. English Heritage also indicated their agreement of the proposed visual assessment viewpoints prior to their formal acceptance (described in Vol 17 Table 11.3.1 below).

11.3.4 Following changes to the proposed development and also the findings of the preliminary assessment of effects, the number and location of viewpoints were adjusted by adding an additional location on Horse Guards Parade and reducing the number of viewpoints assessed during operation. Westminster City Council, the City of London Corporation, LB of Lambeth, LB of Southwark and English Heritage have been consulted on these changes. The City of Westminster confirmed acceptance of the proposed changes, but also requested additional viewpoints be included from three locations. On the basis that the visual receptors at these locations are considered to be assessed already with reference to existing viewpoints, these additional viewpoints have not been included in the assessment. The City of London Corporation provided comments on the proposed changes at the Blackfriars Bridge Foreshore site but made no comments on the Victoria Embankment Foreshore site. The LB of Lambeth confirmed acceptance of the proposed changes. The LB of Southwark and English Heritage have not commented changes.

11.3.5 A description of how the on-site alternatives to the proposed approach have been considered and the main reasons why these alternatives have not been adopted is included in Section 3.6 of this volume.

Vol 17 Table 11.3.1 Townscape and visual – stakeholder engagement

Organisation	Comment	Response
Westminster City Council (February 2012)	The setting of the heritage assets needs to be considered as part of the historic environment assessment, including details of impacts and mitigation for the: • listed Embankment wall • setting of the nearby listed buildings • Victoria Embankment Gardens • Whitehall conservation area • riverside views	Setting in relation to these features has been considered and is included in the assessment of historic environment (see Section 7) and cross-referred to here where relevant.
Westminster City Council (February 2012)	The site of the proposed foreshore development is in the foreground of view 17A.2 ('River prospect: Golden Jubilee/Hungerford Footbridges: upstream') of the new revised London View Management Framework (July 2010). This view is terminated by the Palace of Westminster, which forms part of the City's World Heritage Site. The impacts on this view should be considered in the ES.	The effects on this view have been considered in the assessment.
Westminster City Council (February 2012)	Details of how impacts on the listed embankment wall and the linear character of the wall will be managed and mitigated should be included in the ES.	An assessment of effects on the listed Embankment wall is covered in the Historic environment assessment. Effects on the wider townscape character of the site are covered within the townscape and visual assessment.
Westminster City Council (February 2012)	The proposed ventilation column has the potential to harmfully impact on the setting of nearby listed buildings and the river prospect views	An assessment of effects of the proposed permanent structures has been included within the

Organisation	Comment	Response
	towards the World Heritage Site. This should be taken into account in the ES.	townscape and visual and historic environment assessments.
Westminster City Council (February 2011)	Requested an additional viewpoint from Victoria Embankment and an additional verifiable photomontage from the Golden Jubilee footbridge.	These have been included in the visual assessment and are shown in Vol 17 Figure 11.4.7 (see separate volume of figures).
Westminster City Council (May 2012)	Requested an assessment of the effects of operational phase lighting at night time on visual receptors in the assessment area.	This has been undertaken and is reported in Section 11.6.
English Heritage (May 2011)	Confirmed acceptance of the proposed viewpoints.	-
English Heritage (May 2011)	Depending on the final design of the site, careful consideration of the effects of lighting on night time character will need to be considered in the ES, including with reference to the existing festoon lighting along Embankment	An assessment of the visual effects at night time arising from operational lighting has been undertaken and is reported in Section 11.6.

Baseline

11.3.6 The baseline methodology follows the methodology described in Vol 2. In summary the following surveys have been undertaken to establish baseline data for this assessment:

a. Preliminary site visit to check the zone of theoretical visibility (ZTV), establish the extents of townscape character areas and identify locations for visual assessment viewpoints (October 2010)

b. Photographic surveys of townscape character areas (August 2011, August 2011 and August 2011)

c. Winter photographic surveys of the view from each visual assessment viewpoint (November 2011, November 2011, February 2012 and February 2012)

d. Summer photographic surveys of the view from each visual assessment viewpoint considered in the operational assessment (August 2011, August 2011, May 2012 and June 2012)

e. Night time survey of the view from each visual assessment viewpoint considered in the operational assessment (June 2012)

f. Daytime verifiable photography (March 2011 and March 2011), night time verifiable photography (March 2012) and verifiable surveying (March 2011) for all viewpoints requiring a photomontage to be produced, as agreed with stakeholders (described in para. 11.3.2).

11.3.7 With specific reference to the Victoria Embankment Foreshore site, baseline information on open space distribution and type, conservation areas, townscape character and protected views has been gathered through a review of:

a. The London View Management Framework (Mayor of London, 2012)[2]

b. The Core Strategy for the City of Westminster[3] and the neighbouring City of London[4], LB of Lambeth[5] and LB of Southwark[6]

c. Savoy, Strand, Whitehall and Westminster Abbey and Parliament Square Conservation Area General Information Leaflets, produced by the City of Westminster[7]

d. Whitefriars[8] and Temples[9] Conservation Area Character Summaries, produced by the City of London Corporation

e. Temples Conservation Area: Management Strategy, produced by the City of London Corporation[10]

f. South Bank Conservation Area Statement[11], produced by the LB of Lambeth

g. Savoy, Strand, Whitehall and Westminster Abbey and Parliament Square Conservation Area General Information Leaflets, produced by the Westminster City Council[12]

h. The Palace of Westminster and Westminster Abbey including St Margaret's Church World Heritage Site Management Plan[13].

Construction

11.3.8 The assessment methodology for the construction phase follows that described in Vol 2. Site-specific variations are described below.

11.3.9 With reference to the Victoria Embankment Foreshore site, the peak construction phase relevant to this topic would be during Site Year 2 of construction, when the shaft would be under construction. Cranes would be present at the site and material would be taken away by barge. This has therefore been used as the assessment year for townscape and visual impacts. The intensity of construction activities would be similar during Site Year 3 of construction, during the secondary lining of the short connection tunnel, involving the import of materials by road.

11.3.10 No assessment of effects on night time character is made for this site during construction on the basis that:

a. the site would generally only be lit in the early evening during winter, except for short durations of 24 hour working during the construction of the Regent Street connection tunnel

b. all site lighting would have minimal spill into the wider area due to the measures set out in the *CoCP* (see CoCP Part A Section 4)

c. the surrounding area is lit in the early evening by street lighting and by light spill from surrounding buildings

d. visual receptors have limited sensitivity to additional lighting in the early evening.

11.3.11 The assessment area, defined using the methodology provided in Vol 2, is indicated in Vol 17 Figure 11.4.6 for townscape and Vol 17 Figure 11.4.7 for visual (see separate volume of figures). The scale of the townscape assessment area has been set by the maximum extents of all character areas located partially or entirely within the construction phase ZTV, except in those locations upstream of the site where visibility is in reality obscured by Blackfriars Bridge and Blackfriars railway bridge, and downstream of the site where the visibility is in reality obscured by Westminster Bridge. The scale of the visual assessment area has been set by the maximum extent of the construction phase ZTV, except in those locations upstream of the site where visibility is in reality obscured by Blackfriars Bridge and Blackfriars railway bridge, and downstream of the site where the visibility is in reality obscured by Westminster Bridge. All visual assessment viewpoints are located within the ZTV.

11.3.12 The construction assessment area for this site intersects with the assessment area for the proposed Thames Tideway Tunnel project site at Blackfriars Bridge Foreshore; therefore likely significant effects on receptors arising from construction at both sites are included in this assessment.

11.3.13 For the construction base case for the assessment of effects arising from the proposed development at the Victoria Embankment Foreshore site, it is assumed that the following developments (as detailed in Vol 17 Appendix N) within the assessment area would be complete and occupied by Site Year 2 of construction:

a. London Eye Pier extension, approximately 160m southeast of the site

b. Elizabeth House commercial, retail and residential development, comprising three buildings between 11 and 29 storeys high, approximately 570m southeast of the site

c. Mixed use development on land bounded by Upper Ground and Doon Street, including a 43 storey tower, approximately 600m east of the site.

11.3.14 As detailed in the site development schedule (Vol 17 Appendix N) no schemes, within 1km of the site, would be under construction at the same time as the Victoria Embankment Foreshore site and therefore do not meet the criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken for Victoria Embankment Foreshore in the construction phase.

11.3.15 The assessment of construction effects also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Operation

11.3.16 The assessment methodology for the operational phase follows that described in Vol 2. Any site specific variations are described below.

11.3.17 Four daytime verifiable photomontages have been prepared for this site to assist the assessment of operational visual effects during the day. These are shown in Vol 17 Figure 11.6.1, Vol 17 Figure 11.6.3, Vol 17 Figure 11.6.4 and Vol 17 Figure 11.6.6 (see separate volume of figures). Two night time verifiable photomontages have been prepared for this site to assist the assessment of operational visual effects during the night. These are shown in Vol 17 Figure 11.6.2 and Vol 17 Figure 11.6.5 (see separate volume of figures).

11.3.18 The operational phase assessment has been undertaken for Year 1 of operation and Year 15 of operation.

11.3.19 The assessment area, defined using the methodology provided in Vol 2, is indicated in Vol 17 Figure 11.4.6 for townscape and Vol 17 Figure 11.4.7 for visual (see separate volume of figures). The scale of the townscape assessment area has been set by the maximum extents of all character areas located partially or entirely within the operational phase ZTV, except in those locations downstream of the site where visibility is in reality obscured by Blackfriars Bridge and Blackfriars railway bridge, and upstream of the site where the visibility is in reality obscured by Westminster Bridge. The scale of the visual assessment area has been set by the maximum extent of the operational phase ZTV, except in those locations downstream of the site where visibility is in reality obscured by Blackfriars Bridge and Blackfriars Railway Bridge, and upstream of the site where the visibility is in reality obscured by Westminster Bridge. All visual assessment viewpoints are located within the ZTV.

11.3.20 The operational assessment area for this site intersects with the assessment area for the proposed Thames Tideway Tunnel project site at Blackfriars Bridge Foreshore; therefore likely significant effects on receptors arising from operation at both sites are assessed in this assessment.

11.3.21 For the purposes of the operational assessments, it is assumed there would be no further substantial changes in the townscape and visual baseline, beyond those described in para. 11.3.13, between 2012 and Year 1 and Year 15 of operation.

11.3.22 As detailed in the site development schedule (Vol 17 Appendix N) no schemes have been identified within 1km of the site which meet the criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken for Victoria Embankment Foreshore in the operational phase.

11.3.23 As with construction (para. 11.3.15), the assessment of operational effects also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assumptions and limitations

11.3.24 The assumptions and limitations associated with this assessment are presented in Vol 2. Site specific assumptions and limitations are detailed below.

Assumptions

11.3.25 For the purposes of the construction phase assessment, it is assumed that the construction activities and plant, site hoardings, welfare facilities and access points are in the location shown on the phase two construction plan (see separate volume of figures – Section 1)). The assessment of effects would be no worse if these elements of the proposed development were in different locations within the maximum extent of working area shown on the Construction phase plans (see separate volume of figures – Section 1), with the permanent structures under construction located within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1).

11.3.26 For the purposes of the operational phase assessment, it is assumed that the above ground structures are in the location shown on the Proposed landscape plan (see separate volume of figures – Section 1). The assessment of effects would be no worse if these elements of the proposed development were in different locations within the zones (shown on the Site works parameter plan, see separate volume of figures – Section 1).

Limitations

11.3.27 There are no limitations specific to the assessment of this site.

11.4 Baseline conditions

11.4.1 The following section sets out the baseline conditions for the townscape and visual assessment within and around the site as follows:

a. Information on the physical elements that make up the overall townscape character of the assessment area (topography, land use, development patterns, vegetation, open space and transport routes), which inform the identification of townscape character areas. These form the receptors for the townscape assessment.

b. Information on the townscape character (including setting), condition, tranquillity, value and sensitivity of the site and each townscape character area.

c. Information on the nature of the existing views towards the site from all visual assessment viewpoints, during winter and summer, and during both daytime and night time where relevant. This is ordered beginning with the most sensitive receptors through to the least sensitive.

d. Future baseline conditions (base case) are also described.

Current baseline

Townscape baseline

Physical elements

11.4.2 The physical elements of the townscape in the assessment area are described below. The assessment area includes a number of conservation areas, which are shown on Vol 17 Figure 11.4.1 (see separate volume of figures).

Topography

11.4.3 The assessment area is located on a relatively flat plateau along Victoria Embankment on the north bank of the River Thames. To the north and west the ground rises away from the river.

Land use

11.4.4 In the assessment area, the north bank of the river is predominantly characterised by commercial and administrative uses, with some leisure and retail further from the river. On the southern bank of the river, land use is dominated by a mix of cultural, leisure and tourism related uses, including the Tate Modern art gallery, Shakespeare's Globe theatre, the National Theatre and Royal Festival Hall. Some high rise office and residential units are located directly opposite the site, including the Oxo Tower, with smaller residential properties further away from the river.

Development patterns and scale

11.4.5 Vol 17 Figure 11.4.2 (see separate volume of figures) illustrates the pattern and scale of development and building heights within the assessment area.

11.4.6 Within the assessment area, the north bank of the river is characterised by dense blocks of buildings with large footprints and heights of up to approximately 40m. Buildings are typically orientated towards the river and streets are narrow and laid out in a grid formation parallel with the river. Upstream of Blackfriars Bridge, Victoria Embankment provides a wide vehicular and pedestrian route alongside the river. Upstream of Waterloo Bridge, buildings along the riverfront have been set back behind the Embankment Gardens.

11.4.7 On the southern bank of the river, opposite the site, buildings are arranged in a more informal layout. The river frontage is characterised by intermittent tall landmark buildings in excess of 50m high, including the Oxo Tower (1km east) and the Shell building (400m southeast). The majority of the southern bank is characterised by a wide pedestrian route along the river.

Vegetation patterns and extents

11.4.8 Vol 17 Figure 11.4.3 (see separate volume of figures) illustrates the pattern and extent of vegetation, including tree cover, within the assessment area.

11.4.9 North and south of the site, Victoria Embankment is characterised by mature London plane trees, with a grand avenue of trees running to Temple Garden, approximately 800m downstream of the site. Smaller trees are present along the southern bank, including within Jubilee Gardens.

11.4.10 Public open spaces within the assessment area, generally located along the river, are typically characterised by open grass and scattered trees. Most of the vegetation within the assessment area on both sides of the river is contained within private and semi-private spaces, particularly within housing estates, internal courtyards and private rear gardens to the south of the river.

11.4.11 The majority of mature trees within the City of Westminster are protected by Tree Preservation Orders (TPOs) by virtue of being located within conservation areas.

Open space distribution and type

11.4.12 Vol 17 Figure 11.4.4 (see separate volume of figures) illustrates the distribution of different open space types within the assessment area, indicating all relevant statutory, non-statutory and local plan designations.

11.4.13 Public open spaces are generally located along the riverfront within the assessment area, including the Embankment Gardens along the north bank and Jubilee Gardens on the southern bank. These are described in more detail in Vol 17 Table 11.4.1 below.

Vol 17 Table 11.4.1 Townscape – open space type and distribution

Open space	Distance from site	Character summary
Whitehall Gardens	10m west (north of river)	The gardens are characterised by their formal design, with well-maintained vegetation. The planting ranges from formal grass areas, trees, shrubs and seasonal flowers. The gardens include several notable statues and landmarks. Designated as a Grade II Registered Park and Garden.
Victoria Embankment Gardens	200m north (north of river)	Formally arranged gardens to the north of the railway line, characterised by large areas of lawns and mature tree planting. Designated as Metropolitan Open Land.
Temple Gardens	800m northeast (north of river)	Private gardens characterised by wide open lawns, informal trees and herbaceous borders. Designated as Soft Open Space in the City of London UDP.
South Bank	200m east (south of river)	Predominantly hard paved linear pedestrian corridor on the South Bank of the river, with double avenues of small

Open space	Distance from site	Character summary
		trees. Characterised by large numbers of visitors associated with leisure and retail uses along the river frontage. Partially designated as an 'Other public open space' in the LB of Lambeth UDP.
Jubilee Gardens	200m east (south of river)	Wide open grassed public space with sparsely scattered trees, dominated by the London Eye. Designated as Metropolitan Open Land and as a Park in the LB of Lambeth UDP.
Victoria Embankment Gardens – Lower	100m southwest (north of river)	These gardens form a continuation of the upper part of Victoria Embankment Gardens, and are similar in character apart from fewer mature trees being present within the space.

Transport routes

11.4.14 Vol 17 Figure 11.4.5 (see separate volume of figures) illustrates the transport network within the assessment area, including cycleways, footpaths and Public Rights of Way.

11.4.15 The site is located immediately adjacent to Victoria Embankment and Northumberland Avenue, both of which are characterised by high levels of vehicular traffic. Other strategic, heavily trafficked routes in the assessment area include the Strand and Waterloo Bridge to the north, the A3200 to the east and Westminster Bridge to the south. The majority of other streets are fairly narrow and characterised by varied levels of both vehicular and pedestrian traffic.

11.4.16 The Thames Path runs along both banks of the river, although the route is much wider and dedicated to pedestrians on the southern bank.

11.4.17 The townscape south of the river is heavily dissected by rail corridors connecting Blackfriars railway station with south London, and Charing Cross and Waterloo East railway stations with east London.

Site character assessment

11.4.18 The site is located within Whitehall Conservation Area in the City of Westminster, immediately south of the Hungerford Bridge and Golden Jubilee footbridges. The majority of the site is located on the foreshore of the River Thames, with the remainder on the riverside pavement of Victoria Embankment. Victoria Embankment, in this location, is characterised by the historic stone wall built when the Embankment was constructed by infilling part of the river. The length is further characterised by mature London plane trees and Grade II listed lamp standards. The Tattershall Castle and Hispaniola vessels are permanently moored within the site boundary. The foreshore is generally not exposed at low tide for most of the site boundary area.

11.4.19 The site is located within a London View Management Framework (LVMF) protected Linear View from King Henry VIII's Mound, Richmond (9A.1) to St Paul's Cathedral.

11.4.20 The character of the site is illustrated by Vol 17 Plate 11.4.1 and the components of the site are described in more detail in Vol 17 Table 11.4.2.

Vol 17 Plate 11.4.1 The character of the site

Date taken: 4 October 2010. 23mm lens.

Vol 17 Table 11.4.2 Townscape – site components

ID	Component	Description	Condition
01	Grade II listed river wall	Granite clad river wall constructed by Sir Joseph Bazalgette between 1865 and 1870. The wall has regularly spaced stanchions and sits at flood defence level, approximately 1m higher than the pavement level	Good condition
02	Grade II listed sturgeon lamp standards	Ornamental cast iron lamp standards positioned on the regularly spaced stanchions in the river wall.	Good condition
03	Mature trees	Mature London plane trees, protected by TPOs, lining Victoria Embankment.	Good condition
04	Thames Path	Concrete paved pavement alongside the river wall and	Good condition

ID	Component	Description	Condition
		Victoria Embankment road.	
05	Tattershall Castle vessel	Permanently moored former paddle steamer with restaurants and bars and used for parties and conferences. On the National Register of Historic Ships. Access to the boat is via a series of ramps with gates.	Fair condition
06	Grade II listed benches	Four ornamental benches at the rear of the pavement along Embankment, elevated on small plinths.	Good condition
07	Grade II listed catenary lamp standards	Ornamental cast iron lamp standards located along the pavement on Embankment	Good condition
08	Mooring in (north)	Boat mooring in the river	Good condition
09	Mooring (south)	Boat mooring in the river	Good condition

11.4.21 The condition of the townscape within the site is generally good. However, the approach ramps and associated gates and railings to the permanent moorings are detrimental to the character of the site.

11.4.22 The site's location close to the interchange of Victoria Embankment and Northumberland Avenue, which are dominated by heavy traffic, and adjacent to Hungerford Railway Bridge, means the site has a low level of tranquillity. The river is also heavily used, further reducing levels of tranquillity.

11.4.23 The site is located within an internationally significant historical and cultural stretch of the River Thames and is experienced by large numbers of people. It provides the setting to the Houses of Parliament World Heritage Site and the London Eye, and is also located within a protected viewing corridor towards St Paul's Cathedral. The site is therefore internationally valued.

11.4.24 Due to the good condition and international value of the site's character, the site has a high sensitivity to change.

Townscape character assessment

11.4.25 The townscape character areas surrounding the site are identified in Vol 17 Figure 11.4.6 (see separate volume of figures). Townscape character areas are ordered beginning with the river reaches, then to the north of the site and continuing around the site in a clockwise direction. Each area is described below.

River Thames – Houses of Parliament Reach TCA

11.4.26 This reach is an internationally valued stretch of the river characterised by the Palace of Westminster and Westminster Abbey including St Margaret's Church World Heritage Site, which forms a dominant component of the area's setting. This reach of the River Thames extends from Lambeth Bridge in the west, beyond the assessment area of this site, to Westminster Bridge in the east. The reach is dominated by the Houses of Parliament World Heritage Site fronting onto the river, set adjacent to dense tree planting within Victoria Tower Gardens, Lambeth Palace Gardens and along Albert Embankment. The character of this area is illustrated by Vol 17 Plate 11.4.2.

Vol 17 Plate 11.4.2 River Thames – Houses of Parliament Reach TCA

Date taken: 2 August 2011. 18mm lens.

11.4.27 The river itself is characterised by a straight sweep with relatively few incursions into the river beyond the historic stone river wall. The banks of the river have little or no foreshore. There are a number of moorings present along the river.

11.4.28 The river wall and bridges are generally very well maintained. The overall townscape condition is good.

11.4.29 Tranquillity within the area is limited by the density of activity on the nearby roads, and the river, which is used by commercial and industrial boats, river taxis and pleasure craft.

11.4.30 This reach is experienced by large numbers of people, including tourists.

11.4.31 Due to the good condition and international value of the townscape, this character area has a high sensitivity to change.

River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

11.4.32 This reach of the River Thames extends from Westminster Bridge in the west to Waterloo Bridge in the east, both of which lie to the west of the site. The reach is characterised by dense commercial, administrative and tourism related development along both banks, reflecting the strong heritage of central London. The area features the large open spaces of Victoria Embankment Gardens and Jubilee Gardens. The avenue of London plane trees on Victoria Embankment forms a substantial element of the setting along the northern bank. The setting along the southern bank is dominated by the London Eye, in addition to the County Hall. The Houses of Parliament (a World Heritage Site) forms part of the wider setting of this area. This stretch of the river is crossed by Westminster Bridge (road and pedestrian), Hungerford Bridge (rail) and the attached Golden Jubilee footbridges, and Waterloo Bridge (road and pedestrian). The character of this area is illustrated by Vol 17 Plate 11.4.3.

Vol 17 Plate 11.4.3 River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

Date taken: 12 August 2011. 18mm lens.

11.4.33 The river is characterised by numerous jetties and permanent moorings which extend from the historic stone river wall. The north bank of the river has little or no foreshore, while the southern bank has a relatively narrow stretch of foreshore exposed at low tide. The overall character is urban. Formal tree planting along Victoria Embankment, and also within Victoria Embankment Gardens and Jubilee Gardens form prominent elements on the edges of the character area.

11.4.34 The jetties, river wall and bridges are well maintained. The overall townscape condition is good.

11.4.35 Tranquillity within the area is limited by the daily density of activity on the river, which is used by commercial and industrial boats, river taxis and pleasure craft.

11.4.36 This reach is an internationally valued stretch of the river, experienced by large numbers of people, with a high percentage of tourists visiting attractions such as the London Eye and the Houses of Parliament (in the neighbouring character reach of the river), which form key components of the setting.

11.4.37 Because of the international value of the townscape and its good condition, this character area has a high sensitivity to change.

River Thames – Central London Reach TCA

11.4.38 This reach of the River Thames extends from Waterloo Bridge in the west towards to Southwark Bridge in the east. The reach is characterised by dense commercial and tourist related development along both banks, much of which reflects the strong heritage of central London. This stretch of the river is crossed by Waterloo Bridge (road and pedestrian), Blackfriars Bridge (road and pedestrian), Blackfriars Bridge (rail), the Millennium Bridge (pedestrian) and Southwark Bridge (road and pedestrian). The character of this area is illustrated by Vol 17 Plate 11.4.4.

Vol 17 Plate 11.4.4 River Thames – Central London Reach TCA

Date taken: 09 August 2011. 28mm lens.

11.4.39 The river is characterised by numerous jetties and permanent moorings beyond the historic stone river wall. The north bank has little or no foreshore, while in contrast the southern bank has a relatively wide area of foreshore exposed at low tide. The overall character is urban, with little planting along the banks of the river. The exception is the avenue of

London plane trees along part of Victoria Embankment, east of the site, illustrated by Vol 17 Plate 11.4.4 above.

11.4.40 The jetties, river wall and bridges are well maintained. The overall townscape condition is good.

11.4.41 Tranquillity within the area is limited by the intensity of activity on the river, which is used by commercial and industrial boats, river taxis and pleasure craft, and further reduced by heavy traffic along Victoria Embankment.

11.4.42 This reach is an internationally valued stretch of the river, experienced by large numbers of people, including a high percentage of tourists. The main attractions are (from west to east) Somerset House, the National Theatre, The Oxo Tower, St Paul's Cathedral and the Tate Modern art gallery which form the key components of the setting.

11.4.43 Because of the international value of the townscape and its good condition, this character area has a high sensitivity to change.

Victoria Embankment Administrative TCA

11.4.44 This area is dominated by administrative and institutional uses present along Victoria Embankment. This character area comprises Whitehall, Savoy and Strand Conservation Areas. The buildings in the area are characterised by a mix of building styles and periods, including buildings dating from the early 19th century, late Victorian, Edwardian and early 20th century periods. Along Kingsway and Aldwych buildings are typically around seven storeys high. Buildings fronting onto the Strand are lower and typically between four and six storeys high. The river forms an important element of the setting of this area. The character of this area is illustrated by Vol 17 Plate 11.4.5.

Vol 17 Plate 11.4.5 Victoria Embankment Administrative TCA

Date taken: 12 August 2011. 18mm lens.

11.4.45 A baseline description of Whitehall and Savoy Conservation Areas, and the Grade II* Registered Victoria Embankment Gardens as heritage assets is provided in Section 7.4 of this volume.

11.4.46 The area is further characterised by the level change from the Strand to the river, created by the construction of Victoria Embankment and the original topography of the area. The area lies between two transport corridors; The Strand and Victoria Embankment are both heavily trafficked routes. These main vehicular and pedestrian routes through the area are characterised by mature tree planting, most notably the avenue of plane trees along Victoria Embankment. Somerset House (Grade I listed) and the Royal Courts of Justice (Grade I listed) are key components of the area's character.

11.4.47 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.48 Tranquillity within the area is limited by the high levels of pedestrian and vehicular activity and the level of activity on the river.

11.4.49 The character area is located within a nationally important historical and cultural stretch of the River Thames, experienced by large numbers of people including a high percentage of tourists.

11.4.50 Because of the national value of the townscape and its good condition, the area has a high sensitivity to change.

Temples Conservation Area TCA

11.4.51 This area comprises Temples Conservation Area (designated by City of London Corporation) and is dominated by administrative and commercial uses. The area is characterised by the Inner and Middle Temple gardens (Grade II listed), which are enclosed to the north, east and west by large Victorian buildings, and bordered by Victoria Embankment and the River Thames to the south. Temple Gardens are the largest private green space in the City and provide a rich setting to the surrounding buildings. Victoria Embankment in this location is characterised by the avenue of mature London plane trees, which continue further to the west of the character area. The majority of the public realm is characterised by high quality paving. The river forms a key part of the setting of this character area. The character of this area is illustrated by Vol 17 Plate 11.4.6.

Vol 17 Plate 11.4.6 Temples Conservation Area TCA

Date taken: 9 August 2011. 18mm lens.

11.4.52 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.53 Although Temple Gardens are relatively tranquil, the overall tranquillity of the area is limited by the high levels of pedestrian and vehicular activity and the level of activity on the river.

11.4.54 The character area is located within a nationally important historical and cultural stretch of the River Thames, experienced by large numbers of people. The area is nationally valued as part of the wider character of the River Thames and London.

11.4.55 Because of the national value of the townscape and its good condition, the area has a high sensitivity to change.

Whitefriars Conservation Area TCA

11.4.56 This area comprises Whitefriars Conservation Area (designated by the City of London Corporation) and an area, north of the conservation area, which is not designated, but is of similar character. The area features large scale Victorian and Edwardian commercial and administrative premises set out on a formal grid pattern. The majority of buildings are four to five storeys in height, and the river frontage is framed by a strong frontage of five to six storey buildings. The character area is bordered to the east and south by busy roads. The river forms a key part of the setting of this area, although existing structures along the Thames Path and on the approach to Blackfriars Bridge detract from the immediate riverside setting. The character of this area is illustrated by Vol 17 Plate 11.4.7.

Vol 17 Plate 11.4.7 Whitefriars Conservation Area TCA

Date taken: 12 August 2011. 18mm lens.

11.4.57 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.58 Tranquillity within the area is limited by the commercial land use, presence of high levels of vehicular traffic and lack of street trees or other vegetation.

11.4.59 The character area is located within a nationally important historical and cultural stretch of the River Thames, which is experienced by large numbers of people. In addition a protected viewing corridor (towards St Paul’s Cathedral) traverses this character area.

11.4.60 This character area is of national value and the townscape is in good condition which gives it a high sensitivity to change.

South Bank Conservation Area TCA

11.4.61 This area predominantly comprises the South Bank Conservation Area. The area is characterised by large public realm areas along the river front, including Jubilee Gardens, which is designated as MOL. The area is dominated by cultural, leisure and tourism related land uses, including County Hall (Grade II* listed), Royal Festival Hall (Grade I listed) and the National Theatre (Grade II* listed). Building footprints are typically large, and there are a number of tall buildings, including the Shell Building, (regarded as an important element of London’s skyline), set behind the London Eye. The townscape is dissected by several transport corridors; Waterloo Bridge, Stamford Street, York Road, and the railway line connecting Waterloo East with Charing Cross on the opposite side of the river via the Hungerford Bridge. Further from the river, there are some residential blocks within the character area. Developments are typically orientated towards the river, and heavily influenced by its character on the northern bank. The character of this area is illustrated by Vol 17 Plate 11.4.8.

Vol 17 Plate 11.4.8 South Bank Conservation Area TCA

Date taken: 9 August 2011. 18mm lens.

11.4.62 A baseline description of South Bank Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.63 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.64 Tranquillity within the area is limited by the high levels of pedestrian and vehicular activity, the level of activity on the river and the frequency of trains passing through the area.

11.4.65 The character of this area which is dominated by landmark London buildings is internationally valued, experienced by large numbers of people including a high percentage of tourists.

11.4.66 The area has a high sensitivity to change due to the international value of the townscape and its good condition.

Westminster Abbey and Parliament Square TCA

11.4.67 This area is characterised by its highly valued and sensitive townscape, and comprises Westminster Abbey and Parliament Square Conservation Area. The area is characterised by the Palace of Westminster and Westminster Abbey including St Margaret’s Church, all designated as World Heritage Sites. Within the assessment area for this site, this area comprises the distinctive Grade I listed Palace of Westminster, also known as the Houses of Parliament, and the Clock Tower which houses “Big

Ben" – its main bell. The character of this area is illustrated by Vol 17 Plate 11.4.9.

Vol 17 Plate 11.4.9 Westminster Abbey and Parliament Square TCA

Date taken: 12 August 2011. 18mm lens.

11.4.68 A baseline description of Westminster Abbey and Church of St Margaret World Heritage Site as a heritage asset is provided in Section 7.4 of this volume.

11.4.69 The buildings and public realm within the area are very well maintained. The overall townscape condition is good.

11.4.70 Tranquillity within the area is low due to the high levels of pedestrian and vehicular activity, particularly along the adjacent Westminster Bridge, and the level of activity on the river.

11.4.71 The character of this area, designated as a World Heritage Site and dominated by the Grade I listed Palace of Westminster, which forms an important part of London's skyline, is internationally valued and experienced by large numbers of people.

11.4.72 Due to the good condition and international value of the townscape, the area has a high sensitivity to change.

Visual baseline

11.4.73 Vol 17 Figure 11.4.7 (see separate volume of figures) indicates the location of viewpoints referenced below, including the LVMF Linear Views that fall within the assessment area. All LVMF viewing corridors, residential and recreational receptors have a high sensitivity to change, and employment receptors have a low sensitivity to change. For each viewpoint, the first part of the baseline description relates to the view during winter, the second part relates to the summer view for viewpoints included in the operational assessment and the final part relates to the view at night time, again for viewpoints included in the operational assessment.

London View Management Framework Linear Views

Linear View 9A.1 – King Henry VIII's Mound, Richmond to St Paul's Cathedral

11.4.74 This LVMF Linear View passes through the site and has a high sensitivity to change.

Vol 17 Plate 11.4.10 Linear View 9A.1: winter view

Date taken: 21 February 2012. 35mm lens.

11.4.75 The far distant view (illustrated in Vol 17 Plate 11.4.10) towards St Paul's Cathedral is framed by an avenue of trees in Richmond Park. The site is located below the frame of view, screened by intervening low height buildings and structures.

Recreational

11.4.76 Recreational receptors (apart from those engaged in active sports) generally have a high sensitivity to change, as attention is focused on enjoyment of the townscape. Tourists engaged in activities whereby attention is focused on the surrounding townscape also have a high sensitivity to change. The visual baseline in respect of recreational receptors, including tourists, is discussed below.

Viewpoint 2.1: View south from the Thames Path along Victoria Embankment, at the junction with Northumberland Avenue

11.4.77 This viewpoint is representative of the view for recreational users of the Thames Path along Victoria Embankment, close to the junction with Northumberland Avenue, immediately north of the site.

Vol 17 Plate 11.4.11 Viewpoint 2.1: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.78 The linear view (illustrated in Vol 17 Plate 11.4.11) down Victoria Embankment is focused on the avenue of mature London plane trees along the north bank and the London Eye and County Hall on the opposite side of the river. The foreground of the view is dominated by the permanent moorings and associated access ramps within the site. Views of the site are unobstructed from this location.

Vol 17 Plate 11.4.12 Viewpoint 2.1: summer view

Date taken: 12 August 2011. 18mm lens.

11.4.79 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.12) is largely unchanged, although the avenue of London plane trees in the periphery of the foreground view is more distinct.

11.4.80 At night, the most visible elements of the view comprise festoon lighting along Victoria Embankment, decorative lighting on the Hispaniola vessel and the distinctive lighting on the London Eye. The foreground of the view is also heavily affected by light spill from vehicles along Victoria Embankment.

Viewpoint 2.2: View south from the western end of the southern Golden Jubilee footbridge (LVMF River Prospect)

11.4.81 This viewpoint is representative of the view for pedestrians crossing the southern Golden Jubilee footbridge, towards the western end of the bridge. The viewpoint is recorded as a River Prospect in the LVMF (Golden Jubilee/Hungerford Footbridges: upstream, Viewing Location 17A.2), and is representative of the most westerly of a sequence of designated views along the bridge.

Vol 17 Plate 11.4.13 Viewpoint 2.2: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.82 The linear view (illustrated in Vol 17 Plate 11.4.13) up the River Thames is focused on The Palace of Westminster and Westminster Bridge in the background. The view is framed by the avenue of mature London plane trees along Victoria Embankment. The approach ramps to the Hispaniola and Tattershall Castle vessels form the foreground of the view. The RAF Memorial forms a distinctive component in the middle ground. Views of the Victoria Embankment Foreshore site are unobstructed from this location.

Vol 17 Plate 11.4.14 Viewpoint 2.2: summer view

Date taken: 12 August 2011. 35mm lens.

11.4.83 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.14) is largely unchanged, although the avenue of London plane trees is more distinct.

11.4.84 At night, the facade lighting of the Palace of Westminster forms the most distinctive component of the background of the view. The foreground of the view is characterised by festoon lighting along Victoria Embankment and decorative lighting on the Tattershall Castle vessel. Decorative lighting of the RAF Memorial is visible in the middle ground.

11.4.85 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.3: View southwest from the centre of the southern Golden Jubilee footbridge (LVMF River Prospect)

11.4.86 This viewpoint is representative of the view for pedestrians crossing the southern Golden Jubilee footbridge, towards the centre of the bridge. The viewpoint is recorded as a River Prospect in the LVMF (Golden Jubilee/Hungerford Footbridges: upstream; located between Viewing Locations 17A.1 and 17A.2), and is representative of part of a sequence of designated views along the bridge.

Vol 17 Plate 11.4.15 Viewpoint 2.3: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.87 The foreground of the view towards the site (illustrated in Vol 17 Plate 11.4.15) is characterised by the Hispaniola and Tattershall Castle vessels adjacent to the avenue of mature London plane trees along Victoria Embankment. Whitehall Court forms the key skyline element in the background of the view. Views of the Victoria Embankment Foreshore site are unobstructed from this location.

Vol 17 Plate 11.4.16 Viewpoint 2.3: summer view

Date taken: 12 August 2011. 35mm lens.

11.4.88 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.16) is largely unchanged, although the avenue of London plane trees is more distinct.

11.4.89 At night, the view is characterised by street and festoon lighting along Victoria Embankment, decorative lighting on the two moored vessels and facade lighting on Whitehall Court in the background of the view. Light spill from vehicles along Victoria Embankment is also apparent.

11.4.90 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.4: View south from outside the eastern entrance to Embankment Underground station

11.4.91 This viewpoint is representative of the view for pedestrians walking along the footpath outside Embankment Underground station on Victoria Embankment.

Vol 17 Plate 11.4.17 Viewpoint 2.4: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.92 The view (illustrated in Vol 17 Plate 11.4.17) is focused along Victoria Embankment, framed by Hungerford Bridge in the middle ground of the view. The foreground of the view is dominated by heavy traffic along Victoria Embankment. Views of the site are largely obscured by Hungerford Bridge.

11.4.93 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.5: View south from the Thames Path opposite Victoria Embankment Gardens

11.4.94 This viewpoint is representative of the view for recreational users of the Thames Path, opposite Victoria Embankment Gardens – Main Gardens.

Vol 17 Plate 11.4.18 Viewpoint 2.5: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.95 The view (illustrated in Vol 17 Plate 11.4.18) is an open panorama across the River Thames, focused on Hungerford Bridge in the middle ground of the view. The foreground of the view encompasses the floating pontoons of Embankment Pier alongside the avenue of mature London plane trees along Victoria Embankment. The London Eye forms the key component on the skyline in the background of the view. Views towards the site are largely obscured by Embankment Pier and the arches of Hungerford Bridge.

Vol 17 Plate 11.4.19 Viewpoint 2.5: summer view

Date taken: 12 August 2011. 18mm lens.

11.4.96 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.19) is largely unchanged, although the avenue of London plane trees is more distinct in the periphery of the foreground view.

11.4.97 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.6: View south from the centre of Victoria Embankment Gardens

11.4.98 This viewpoint is representative of the view for recreational users of Victoria Embankment Gardens – Main Gardens, towards the centre of the open space.

Vol 17 Plate 11.4.20 Viewpoint 2.6: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.99 The view (illustrated in Vol 17 Plate 11.4.20) is characterised by the paving, seating, pedestrian paths and mature trees and shrubs within the gardens, which largely obscure views of the river and the site.

Viewpoint 2.7: View southwest from the Thames Path adjacent to Savoy Pier

11.4.100 This viewpoint is representative of the view for recreational users of the Thames Path, adjacent to Savoy Pier.

Vol 17 Plate 11.4.21 Viewpoint 2.7: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.101 The view (illustrated in Vol 17 Plate 11.4.21) is an open panorama up the River Thames focused on Hungerford Bridge and the London Eye in the background of the view. The foreground of the view encompasses Cleopatra's Needle, which projects into the river, and moorings along Victoria Embankment. Views towards the site are largely obscured by these moorings and the arches of Hungerford Bridge.

Vol 17 Plate 11.4.22 Viewpoint 2.7: summer view

Date taken: 12 August 2011. 18mm lens.

11.4.102 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.22) is largely unchanged, although the avenue of London plane trees along Victoria Embankment forms a stronger component of the periphery of the view.

11.4.103 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.8: View south from the northern end of Victoria Embankment Gardens

11.4.104 This viewpoint is representative of the view for recreational users of Victoria Embankment Gardens – Main Gardens, towards the centre of the open space.

Vol 17 Plate 11.4.23 Viewpoint 2.8: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.105 The view (illustrated in Vol 17 Plate 11.4.23) is characterised by the surrounding mature trees and shrubs within the gardens, which largely obscure views of the river or in the direction of the site.

Viewpoint 2.9: View southwest from the northern end of Waterloo Bridge (LVMF River Prospect)

11.4.106 This viewpoint is representative of the view for pedestrians crossing Waterloo Bridge, towards the northern end of the bridge. The viewpoint is recorded as a River Prospect in the LVMF (Waterloo Bridge: upstream, Viewing Location 15A.2).

Vol 17 Plate 11.4.24 Viewpoint 2.9: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.107 The view (illustrated in Vol 17 Plate 11.4.24) is an open panorama up the River Thames focused on Hungerford Bridge and the London Eye in the middle ground, and the Palace of Westminster in the background of the view. The foreground of the view encompasses Cleopatra's Needle, which projects into the river, and jetties along Victoria Embankment. The view is framed by the avenue of mature London plane trees and distinctive buildings along the northern bank. Views towards the site are partially obscured by the jetties and moorings along Victoria Embankment and the arches of Hungerford Bridge.

Vol 17 Plate 11.4.25 Viewpoint 2.9: summer view

Date taken: 12 August 2011. 18mm lens.

11.4.108 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.25) is largely unchanged, although the avenue of London plane trees along Victoria Embankment forms a stronger component of the view.

11.4.109 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.10: View southwest and east from the Thames Path opposite Somerset House

11.4.110 This viewpoint is representative of the typical view for recreational users of the Thames Path, in front of Somerset House.

Vol 17 Plate 11.4.26 Viewpoint 2.10: winter view towards Victoria Embankment Foreshore (southwest)

Date taken: 21 November 2011. 18mm lens.

11.4.111 The view southwest (illustrated in Vol 17 Plate 11.4.26) towards Victoria Embankment Foreshore is an open panorama across the River Thames towards Waterloo Bridge, which partially limits views further upstream. The foreground of the view across the river is dominated by Waterloo Bridge and adjacent moorings along Victoria Embankment. Views along the river are framed by the avenue of mature London plane trees along Victoria Embankment. The Golden Jubilee footbridges (adjacent to the Victoria Embankment Foreshore site, and the London Eye are visible in the background of the view. Views towards Victoria Embankment Foreshore are largely obscured by intervening permanent moorings and piers, Waterloo Bridge and the Golden Jubilee footbridges.

Vol 17 Plate 11.4.27 Viewpoint 2.10: summer view towards Victoria Embankment Foreshore (southwest)

Date taken: 12 August 2011. 18mm lens.

11.4.112 In summer (illustrated in Vol 17 Plate 11.4.27), deciduous trees in the foreground provide some intermittent screening of the Victoria Embankment Foreshore site.

11.4.113 At night, the view is characterised by street and festoon lighting along Victoria Embankment and distinctive lighting on the London Eye and Palace of Westminster in the middle and background of the view. Light spill from vehicles along Victoria Embankment is also apparent in the foreground.

11.4.114 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Blackfriars Bridge Foreshore (refer to para. 11.3.12).

Vol 17 Plate 11.4.28 Viewpoint 2.10: winter view towards Blackfriars Bridge Foreshore (east)

Date taken: 15 February 2012. 35mm lens.

11.4.115 The view east (illustrated in Vol 17 Plate 11.4.28) is dominated by the avenue of mature London plane trees along Victoria Embankment, which partially screen views towards the Blackfriars Bridge Foreshore main site. Beyond the trees, moorings along Victoria Embankment are visible. Blackfriars Bridge and the Tate Modern art gallery are visible in the background of the view. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 17 Plate 11.4.29 Viewpoint 2.10: summer view towards Blackfriars Bridge Foreshore (east)

Date taken: 9 August 2011. 18mm lens.

11.4.116 In summer (illustrated in Vol 17 Plate 11.4.29), deciduous trees along Victoria Embankment provide further intermittent screening of the Blackfriars Bridge Foreshore main site.

11.4.117 At night, the foreground of the view is characterised by street lighting, festoon lighting and light spill from buildings and vehicles along Victoria Embankment.

Viewpoint 2.11: View southwest from the southern end of Waterloo Bridge (LVMF River Prospect)

11.4.118 This viewpoint is representative of the typical view for pedestrians crossing Waterloo Bridge, towards the southern end of the bridge. The viewpoint is recorded as a River Prospect in the LVMF (Waterloo Bridge: upstream, Viewing Location 15A.1).

Vol 17 Plate 11.4.30 Viewpoint 2.11: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.119 The view (illustrated in Vol 17 Plate 11.4.30) is an open panorama across the River Thames focused on Hungerford Bridge in the foreground and Whitehall Court beyond. The avenue of mature London plane trees along Victoria Embankment forms a key component of the view. Views of the site are partially obscured by the arches of Hungerford Bridge.

Vol 17 Plate 11.4.31 Viewpoint 2.11: summer view

Date taken: 12 August 2011. 35mm lens.

11.4.120 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.31) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.121 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Blackfriars Bridge Foreshore. However, in reality Waterloo Bridge obscures visibility of the Blackfriars Bridge Foreshore site from this viewpoint. Therefore the Blackfriars Bridge Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.12: View west from the southern bank outside the Royal Festival Hall

11.4.122 This viewpoint is representative of the view for recreational users of the Thames Path on the southern bank, outside the Royal Festival Hall.

Vol 17 Plate 11.4.32 Viewpoint 2.12: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.123 The view (illustrated in Vol 17 Plate 11.4.32) is an open panorama across the River Thames, characterised by Hungerford Bridge in the foreground of the view. The view of the opposite river bank is characterised by the avenue of mature London plane trees and distinctive buildings along Victoria Embankment, including Charing Cross station and Whitehall Court. Views of the site are largely obstructed by the arches of Hungerford Bridge.

Vol 17 Plate 11.4.33 Viewpoint 2.12: summer view

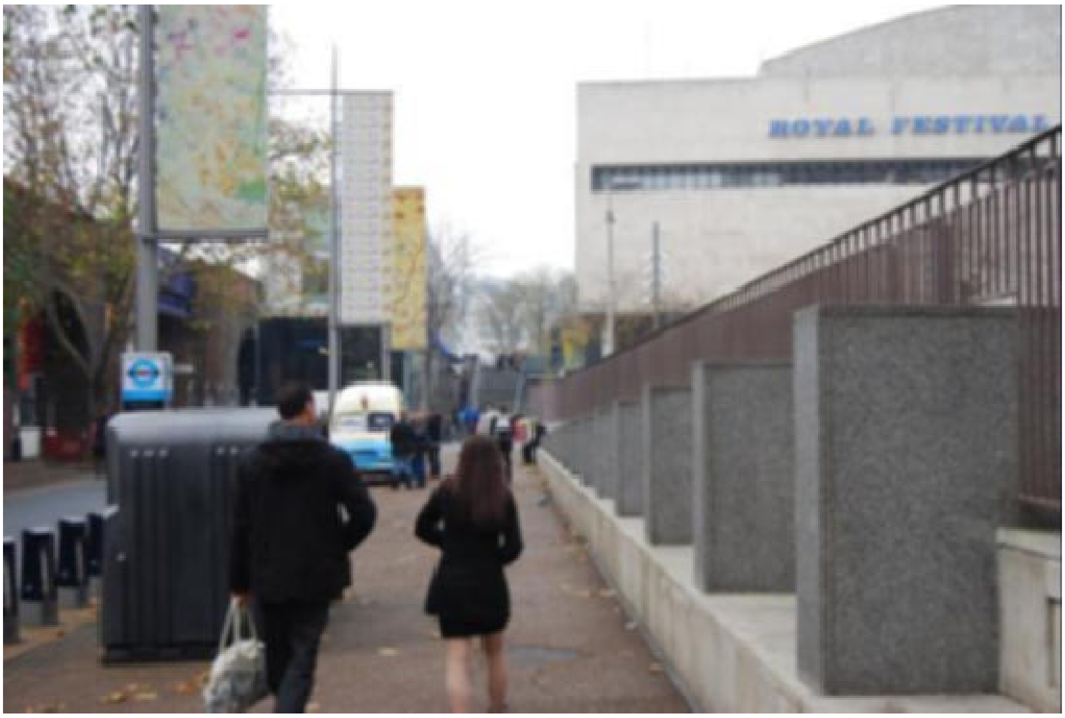
Date taken: 12 August 2011. 18mm lens.

11.4.124 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.33) is largely unchanged.

Viewpoint 2.13: View west from the Concert Hall Approach

11.4.125 This viewpoint is representative of the view for pedestrians walking along Concert Hall Approach towards the Golden Jubilee footbridges and River Thames.

Vol 17 Plate 11.4.34 Viewpoint 2.13: winter view



Date taken: 29 November 2011. 18mm lens.

11.4.126 The linear view (illustrated in Vol 17 Plate 11.4.34) towards the river is framed by the elevated railway line to the south (left) and the Royal Festival Hall to the north (right). Views towards the site are obscured by the level change from this viewpoint to the southern bank of the river.

Viewpoint 2.14: View northwest from the Thames Path alongside Jubilee Gardens (LVMF River Prospect)

11.4.127 This viewpoint is representative of the view for recreational users of the Thames Path on the southern bank, alongside Jubilee Gardens and adjacent to the London Eye. The viewpoint is recorded as a River Prospect in the LVMF (Jubilee Gardens, Viewing Location 21B.1).

Vol 17 Plate 11.4.35 Viewpoint 2.14: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.128 The view (illustrated in Vol 17 Plate 11.4.35) is an open panorama across the River Thames, focused on Whitehall Court and Charing Cross station, which form skyline elements in the background of the view. The Hispaniola and Tattershall Castle permanent moorings and the avenue of mature London plane trees along Victoria Embankment form key components of the view. Views of the site are unobstructed from this location.

Vol 17 Plate 11.4.36 Viewpoint 2.14: summer view

Date taken: 12 August 2011. 35mm lens.

11.4.129 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.36) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.130 At night, the foreground of the view is dominated by the unlit expanse of the river. Street lighting, festoon lighting and light spill from buildings and vehicles along Victoria Embankment are visible in the cross-river view. Facade lighting on Whitehall Court forms a key component of the background view.

Viewpoint 2.15: View northwest from the Jubilee Gardens

11.4.131 This viewpoint is representative of the view for recreational users of Jubilee Gardens, close to the London Eye.

Vol 17 Plate 11.4.37 Viewpoint 2.15: winter view

Date taken: 20 November 2012. 18mm lens.

11.4.132 The view (illustrated in Vol 17 Plate 11.4.37) is focused on the extensive open space of Jubilee Gardens and the London Eye. The foreground of the view is characterised by mature trees along the river frontage, limiting views to the river and opposite bank beyond. Whitehall Court forms a skyline element in the background of the view.

Viewpoint 2.16: View northwest from the Thames Path outside County Hall (LVMF River Prospect)

11.4.133 This viewpoint is representative of the view for recreational users of the Thames Path on the southern bank, alongside County Hall. The viewpoint is located in the same position as a River Prospect in the LVMF (Thames side in front of County Hall, Viewing Location 21A.1), although the focus of the designated view is towards the Palace of Westminster, to the southwest of the viewpoint.

Vol 17 Plate 11.4.38 Viewpoint 2.16: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.134 The view (illustrated in Vol 17 Plate 11.4.38) is an open panorama across the River Thames, focused on Whitehall Court and Charing Cross station, which form skyline elements in the background of the view. The Hispaniola and Tattershall Castle permanent moorings and the avenue of mature London plane trees along Victoria Embankment form key components of the view. Views of the site are unobstructed from this location.

Vol 17 Plate 11.4.39 Viewpoint 2.16: summer view

Date taken: 12 August 2011. 35mm lens.

11.4.135 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.39) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.136 At night, the foreground of the view is dominated by the unlit expanse of the river. Street lighting, festoon lighting and light spill from buildings and vehicles along Victoria Embankment are visible in the cross-river view. Facade lighting on Whitehall Court forms a key component of the background view. Feature lighting of the RAF Memorial is also visible.

Viewpoint 2.17: View north from the eastern end of Westminster Bridge (LVMF River Prospect)

11.4.137 This viewpoint is representative of the view for pedestrians crossing Westminster Bridge, towards the eastern end of the bridge. The viewpoint is recorded as a River Prospect in the LVMF (Westminster Bridge: downstream, Viewing Location 18B.2).

Vol 17 Plate 11.4.40 Viewpoint 2.17: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.138 The view (illustrated in Vol 17 Plate 11.4.40) is an open panorama across the River Thames, focused on the Ministry of Defence, Whitehall Court and Charing Cross station, which form skyline elements in the background of the view. The avenue of mature London plane trees along Victoria Embankment frame the view along the river, with the RAF Memorial forming a key component in the middle ground. The Hispaniola and Tattershall Castle permanent moorings, located at the site, are visible in the background of the view. Views of the site are unobstructed from this location.

Vol 17 Plate 11.4.41 Viewpoint 2.17: summer view

Date taken: 12 August 2011. 18mm lens.

11.4.139 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.41) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.140 At night, the foreground of the view is dominated by the unlit expanse of the river. Street lighting, festoon lighting and light spill from buildings and vehicles along Victoria Embankment are visible in the cross-river view. Facade lighting on Whitehall Court forms a key component of the background view. Feature lighting of the RAF Memorial is also visible.

Viewpoint 2.18: View north from Westminster Bridge opposite the Palace of Westminster (LVMF River Prospect)

11.4.141 This viewpoint is representative of the view for pedestrians crossing Westminster Bridge, opposite the Palace of Westminster on the north bank of the river. The viewpoint is recorded as a River Prospect in the LVMF (Westminster Bridge: downstream, Viewing Location 18B.1).

Vol 17 Plate 11.4.42 Viewpoint 2.18: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.142 The linear view (illustrated in Vol 17 Plate 11.4.42) down the river is characterised by the avenue of mature London plane trees along Victoria Embankment. The foreground of the view is dominated by the floating pontoons of Westminster Millennium Pier. The RAF Memorial, permanently moored Tattershall Castle and Hispaniola vessels and the Hungerford Bridge are visible in the background of the view. Views of the site are partially obscured by intervening moorings.

Vol 17 Plate 11.4.43 Viewpoint 2.18: summer view

Date taken: 23 May 2012. 18mm lens.

11.4.143 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.43) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.144 At night, the foreground of the view is characterised by fairly bright levels of light from street lighting, festoon lighting and light spill from buildings and vehicles along Victoria Embankment. Feature lighting of the RAF Memorial is also visible.

Viewpoint 2.19: View north from the Thames Path adjacent to Westminster Millennium Pier

11.4.145 This viewpoint is representative of the view for recreational users of the Thames Path on Victoria Embankment, adjacent to Westminster Millennium Pier.

Vol 17 Plate 11.4.44 Viewpoint 2.19: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.146 The linear view (illustrated in Vol 17 Plate 11.4.44) down the river is characterised by the Thames Path, sturgeon lamp standards and avenue of mature London plane trees along Victoria Embankment. The RAF Memorial is visible in the foreground of the view. The permanently moored Tattershall Castle and Hispaniola vessels and the Hungerford Bridge are visible in the background of the view. Views of the site are partially obscured by intervening moorings.

Vol 17 Plate 11.4.45 Viewpoint 2.19: summer view

Date taken: 12 August 2011. 35mm lens.

11.4.147 In summer, the view towards the site (illustrated in Vol 17 Plate 11.4.45) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.148 At night, the foreground of the view is characterised by fairly bright levels of light from street lighting, festoon lighting and light spill from buildings and vehicles along Victoria Embankment. Feature lighting of the RAF Memorial is also highly visible.

Viewpoint 2.20: View north from Victoria Embankment Gardens - Lower

11.4.149 This viewpoint is representative of the view for recreational users of Victoria Embankment Gardens – Lower, towards the centre of the open space.

Vol 17 Plate 11.4.46 Viewpoint 2.20: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.150 The view (illustrated in Vol 17 Plate 11.4.46) is characterised by the avenues of mature trees surrounding the open space, which largely obscure views to the river and site. Traffic along Victoria Embankment is intermittently visible in the middle ground of the view.

Viewpoint 2.21: View east from the eastern end of Horse Guards Parade

11.4.151 This viewpoint is representative of the view for pedestrians walking east along Horse Guards Parade, towards the eastern end of the road.

Vol 17 Plate 11.4.47 Viewpoint 2.21: winter view

Date taken: 20 November 2012. 35mm lens.

11.4.152 The linear view (illustrated in Vol 17 Plate 11.4.47) along Horse Guards Parade is frame by avenues of mature trees along both sides of the road and is terminated by the avenue of mature London plane trees along Victoria Embankment, filtering views of the river beyond. The foreground of the view is characterised by traffic along both Horse Guards parade and Victoria Embankment. The Shell Building (on the southern bank) is intermittently visible in the background of the view. Views of the site are partially obscured by mature trees.

11.4.153 At night, the foreground of the view is brightly lit by street lighting and light spill from buildings and vehicular traffic.

Viewpoint 2.22: View east from Whitehall Gardens

11.4.154 This viewpoint is representative of the view for recreational users of Victoria Embankment Gardens – Upper, located on the central axis of the open space.

Vol 17 Plate 11.4.48 Viewpoint 2.22: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.155 The view (illustrated in Vol 17 Plate 11.4.48) is framed by the mature trees surrounding the open space and also the avenue of mature London plane trees along Victoria Embankment, which heavily filter views towards the river and site. Traffic and coach parking along Victoria Embankment is intermittently visible beyond the line of trees.

Vol 17 Plate 11.4.49 Viewpoint 2.22: summer view

Date taken: 12 August 2011. 18mm lens.

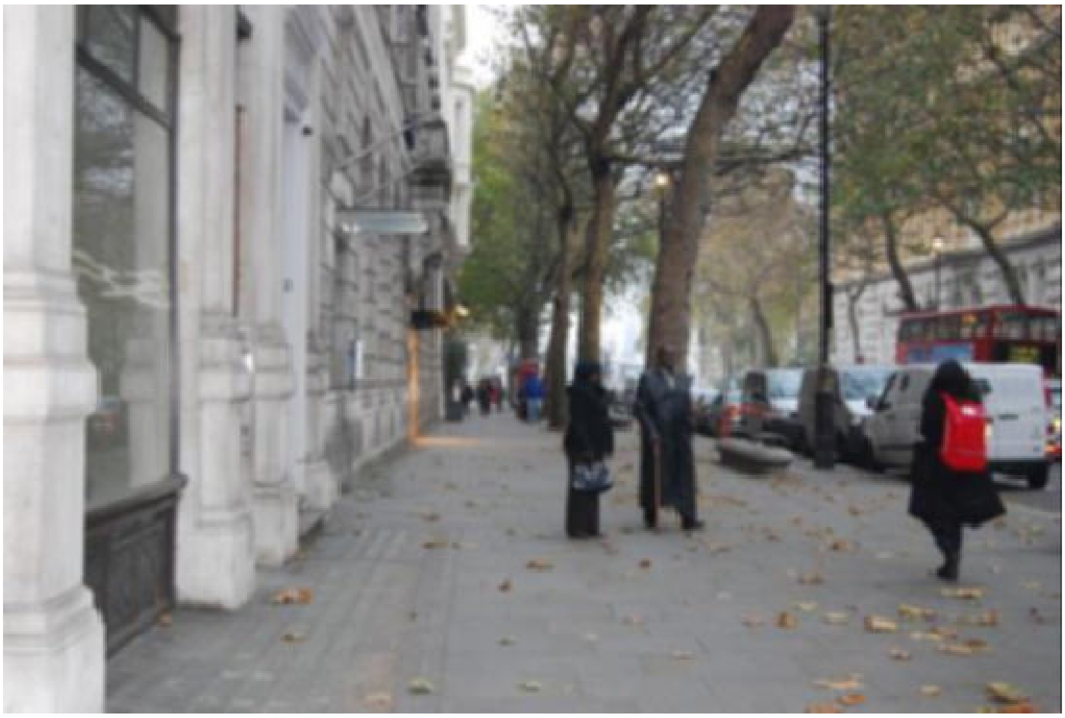
11.4.156 In summer, mature trees along the edge of the gardens largely obscure views towards the site (illustrated in Vol 17 Plate 11.4.49).

11.4.157 At night, the foreground of the view is largely unlit, although affected by light spill from street lighting and vehicles along Victoria Embankment, and from buildings to the west of the open space.

Viewpoint 2.23: View east from Northumberland Avenue

11.4.158 This viewpoint is representative of the view for pedestrians walking down Northumberland Avenue towards the Golden Jubilee footbridges and Victoria Embankment, close to the junction with Northumberland Street.

Vol 17 Plate 11.4.50 Viewpoint 2.23: winter view



Date taken: 21 November 2011. 35mm lens.

11.4.159 The linear view (illustrated in Vol 17 Plate 11.4.50) along Northumberland Avenue is framed by buildings and avenues of mature trees along both sides of the road. Views of the river and Hungerford Bridge are glimpsed in the background of the view. Views of the northern part of the site are obscured by the mature trees along Victoria Embankment and in the foreground of the view. Views of the remainder of the site are obscured by buildings along Northumberland Avenue and Whitehall Place.

Viewpoint 2.24: View southeast from Craven Street at the junction with Strand

11.4.160 This viewpoint is representative of the view for pedestrians walking down Craven Street towards the Golden Jubilee footbridges and Victoria Embankment, close to the junction with the Strand.

Vol 17 Plate 11.4.51 Viewpoint 2.24: winter view

Date taken: 21 November 2011. 35mm lens.

11.4.161 The narrow view (illustrated in Vol 17 Plate 11.4.51) down Craven Street is tightly framed by buildings on either side. The background of the view is characterised by mature trees along Northumberland Avenue, within Victoria Embankment Gardens and along the north bank of the river. These trees largely obscure views of the river and towards the site.

Construction base case

11.4.162 The base case in Site Year 2 of construction taking into account the schemes described in para. 11.3.13 would change the character of South Bank Conservation Area TCA to a limited extent. However, despite these changes across the character area, the sensitivity of this character area would remain high, as described in para. 11.4.66.

11.4.163 All other receptors would remain as detailed in the baseline.

Operational base case

11.4.164 The operational phase assessment has been undertaken for Year 1 of operation and Year 15 of operation. For the purposes of the operational assessments, it is assumed there would be no further substantial changes in the townscape and visual baseline, beyond those described in para. 11.4.162 to para. 11.4.163, between 2012 and Year 1 and Year 15 of operation.

11.5 Construction effects assessment

11.5.1 The following section describes the likely significant effects arising from construction at Victoria Embankment Foreshore taking account of Blackfriars Bridge Foreshore (as detailed in Section 11.3).

11.5.2 Due to the scale of the construction activities proposed across what are, in many cases, prominent locations in London, construction works would be highly visible. In policy terms, the NPS for Waste Water[14] recognises that nationally significant infrastructure projects are likely to take place in mature urban environments, with adverse construction effects on townscape and visual receptors likely to arise. In addition, construction works are a commonplace feature across London, and therefore the following assessment should be viewed in this context. It should also be noted that construction year defined in Section 11.3. Effects during other phases of works are likely to be less due to fewer construction plant being required at the time and a reduced intensity of construction activity.

11.5.3 Illustrative plans of the possible layout of the site during construction are contained in a separate volume (the Construction phase plans, see separate volume of figures – Section 1).

Site character assessment

11.5.4 Effects on the character of the site would arise from partial removal of the river wall, removal of lamp standards, relocation of the Tattershall Castle vessel, installation of site hoardings and welfare facilities, and construction activity associated with the construction of the cofferdam, shaft and ventilation equipment, and secondary lining of the tunnel. The impacts on specific components of the site are described in Vol 17 Table 11.5.1.

Vol 17 Table 11.5.1 Townscape – impacts on existing site components during construction

ID	Component	Impacts
01	Historic river wall	To facilitate access onto the site from Victoria Embankment, the section of the river wall above pavement level would require removal. In addition, the temporary cofferdam forming the site would be joined to the existing structure to ensure the resilience of the defences is retained during the works.
02	Grade II listed lamp standards	For the majority of the site boundary, the Grade II listed lamp standards would require removal and careful storage during construction (for reinstatement of all lamps, except one which would be re-used at the Blackfriars Bridge Foreshore site, following the works).
03	Mature trees	Seven trees would be removed to facilitate access onto the foreshore site and also interception works to the low level sewer.

ID	Component	Impacts
04	Thames Path	During construction, the Thames Path would be diverted to the opposite side of Victoria Embankment. The existing paving would be removed for the duration of construction.
05	Tattershall Castle vessel	This vessel would be temporarily relocated further upstream from the site. All associated access ramps and fencing would also be removed for the duration of construction. New access ramps would be provided to the relocated position.
06	Grade II listed benches	Two benches would be removed (for later reinstatement) during construction to facilitate access to the site. The other two benches would be retained and protected during construction.
07	Grade II listed catenary lamp standards	Three catenary lamp standards within the site boundary would be removed and stored for later reinstatement following the works.
08	Boat mooring (north)	Removed for later reinstatement
09	Boat mooring (south)	Removed for later reinstatement

11.5.5 The low level of tranquillity at the main site would be further reduced by the introduction of construction vehicles, plant equipment and high levels of activity in the river corridor.

11.5.6 Due to the high level of change to character and further reduction in levels of tranquillity, the overall magnitude of change to the site during construction is considered to be high.

11.5.7 The high magnitude of change, assessed alongside the high sensitivity of the site, would result in **major adverse** effects.

Townscape character areas assessment

River Thames – Houses of Parliament Reach TCA

11.5.8 The proposed site is approximately 400m north of this reach of the river, separated by Westminster Bridge. Construction activity would take place within the wider setting of this internationally valued stretch of the river, and would be partially screened by the presence of Westminster Bridge. The setting would be affected by the site cofferdam, presence of construction plant and construction activity. However, the relocation of the Tattershall Castle immediately upstream of the temporary cofferdam would partially obscure construction activity at the site.

11.5.9 The low levels of tranquillity in the area would be largely unaffected by construction activity at the site.

11.5.10 Due to the limited changes to the wider setting of the area, the magnitude of change is considered to be low.

11.5.11 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

11.5.12 The Victoria Embankment Foreshore site is located adjacent to this reach of the river. High levels of construction activity would be introduced across the green frontage of Victoria Embankment and Upper Victoria Embankment Gardens, adversely affecting the strong linear stretch of river defined by Victoria Embankment. The London Eye section of this reach (between Westminster Bridge and Hungerford Bridge) would be heavily affected by the site cofferdam, construction activity and construction plant. The wider setting of the remainder of the area would also be affected by the presence of tall construction plant and cranes.

11.5.13 The proposed Blackfriars Bridge Foreshore site is approximately 200m east of this reach of the river, separated by Waterloo Bridge. The character of the northern section of this character area (between Hungerford Bridge and Waterloo Bridge) would be affected by the wider presence of the site cofferdam, construction activity and construction plant at the Blackfriars Bridge Foreshore site.

11.5.14 The low levels of tranquillity in the area would be affected to a limited extent by construction activity at both sites, principally ongoing activities at the Victoria Embankment Foreshore site.

11.5.15 Due to the level of construction activity at both the proposed sites, the magnitude of change is considered to be high.

11.5.16 The high magnitude of change, assessed alongside the high sensitivity of this character area, would result in **major adverse** effects.

River Thames – Central London Reach TCA

11.5.17 The Victoria Embankment Foreshore site is located approximately 400m south of this reach of the river, separated by Hungerford Bridge and Waterloo Bridge. Construction activity would take place within the wider setting of this character area, but would be largely screened by the presence of the two bridges. The setting would be affected to a limited extent by the site cofferdam and presence of tall construction plant and cranes.

11.5.18 High levels of construction activity at the Blackfriars Bridge Foreshore site would be introduced within a part of the river currently only affected by the Blackfriars Millennium Pier. This activity would be set in front of the existing façades of Victorian and Edwardian buildings, adversely affecting the strong linear stretch of the river defined by Victoria Embankment along the northern bank. Between Waterloo Bridge and Blackfriars Bridge, the reach would be heavily affected by construction activity associated with the site.

11.5.19 The low levels of tranquillity in the area would be affected to a limited extent by construction activity at both sites, principally piling and ongoing activities at the Blackfriars Bridge Foreshore site.

11.5.20 Due to the level of construction activity at both the proposed sites, the magnitude of change is considered to be high.

11.5.21 The high magnitude of change, assessed alongside the high sensitivity of this character area, would result in **major adverse** effects.

Victoria Embankment Administrative TCA

11.5.22 The Victoria Embankment Foreshore site is set directly east of this highly valued character area. The setting of the southern section of the character area, comprising Victoria Embankment Gardens, the National Liberal Club and Whitehall, would be affected by the presence of the site cofferdam, construction activity, construction plant and road traffic along the busy Victoria Embankment. The open setting of the character area would also be locally affected by site hoardings and welfare facilities. The setting of the Central section, located between Hungerford Bridge and Waterloo Bridge, would be largely unaffected, apart from by the wider presence of tall construction plant and cranes.

11.5.23 The proposed Blackfriars Bridge Foreshore site forms part of the wider riverside setting of the northern section of this character area. The riverside setting of this part of the character area would be affected to a limited extent by the wider presence of the site cofferdam, piled deck, construction activity and construction plant.

11.5.24 The low levels of tranquillity in the areas would be affected to a limited extent by construction activities at both sites.

11.5.25 Due to changes in part of the riverside setting caused by both sites, and limited changes to tranquillity, the magnitude of change is considered to be medium.

11.5.26 The medium magnitude of change, assessed alongside the high sensitivity of this character area, would result in **moderate adverse** effects.

11.5.27 The assessment of specific effects on Whitehall and Savoy Conservation Areas, and the Grade II* Registered Victoria Embankment Gardens as heritage assets is set out in Section 7 of this volume. The historic environment assessment identifies minor adverse effects on the setting of Savoy Conservation Area and the Grade II* Registered Victoria Embankment Gardens as the setting of these assets would be less affected than other parts of the TCA.

Temples Conservation Area TCA

11.5.28 The Victoria Embankment Foreshore site forms part of the wider riverside setting of this character area. The presence of tall construction plant and cranes would affect the riverside setting of the character area to a limited extent, although the site cofferdam and low level construction activity would be largely obscured by Waterloo Bridge and Hungerford Bridge.

11.5.29 The proposed Blackfriars Bridge Foreshore site is set directly south of this character area, segregating the area from the River Thames. The open setting of the character area across the river would be substantially altered by site hoardings, welfare facilities, construction plant and intermittent construction traffic along the busy Victoria Embankment.

11.5.30 The low levels of tranquillity in the area would be affected to a limited extent by construction activities at the Blackfriars Bridge Foreshore site.

11.5.31 Due to the changes in the immediate riverside setting introduced by construction at Blackfriars Bridge Foreshore and also the limited changes in the wider setting at Victoria Embankment Foreshore, the magnitude of change is considered to be high.

11.5.32 The high magnitude of change, assessed alongside the high sensitivity of this character area would result in **major adverse** effects.

Whitefriars Conservation Area TCA

11.5.33 The Victoria Embankment Foreshore site forms part of the wider riverside setting of this character area. However, construction activities at this site would be barely perceptible beyond the construction activity at the Blackfriars Bridge Foreshore site. Therefore, effects on this site would only arise as a result of construction at the Blackfriars Bridge Foreshore site and are described in Volume 18.

South Bank Conservation Area TCA

11.5.34 The Victoria Embankment Foreshore site forms a distinct part of the riverside setting of the London Eye section of this character area. The presence of the site cofferdam, construction activity and construction plant would substantially affect the riverside setting of the promenade and public spaces and buildings along the southern bank including Jubilee Gardens, County Hall and the Royal Festival Hall.

11.5.35 The proposed Blackfriars Bridge Foreshore site forms part of the riverside setting of the northern section of this character area. The riverside setting of this part of the character area would be affected by the presence of the site cofferdam, piled deck, construction activity and construction plant on the opposite side of the river.

11.5.36 Tall construction plant and cranes at both sites would affect the riverside setting of the wider character area.

11.5.37 The low levels of tranquillity in the character area at present would be largely unaffected by construction activities at the two Thames Tideway Tunnel project sites.

11.5.38 Due to the substantial changes in the riverside setting arising from construction at the Blackfriars Bridge Foreshore site (for the northern section of the character area) and the Victoria Embankment Foreshore site (for the London Eye section of the character area), the magnitude of change is considered to be high.

11.5.39 The high magnitude of change, assessed with the high sensitivity of this character area, would result in **major adverse** effects.

11.5.40 The assessment of specific effects on South Bank Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset as much of the historic setting of the area would be largely unaffected.

Westminster Abbey and Parliament Square TCA

11.5.41 The proposed site forms part of the wider riverside setting of this internationally valued character area. The presence of the site cofferdam, construction plant and construction activity would affect the wider riverside setting of the character area to a limited extent, partially obscured by Westminster Bridge. The immediate riverside and landward setting of the area would remain largely unchanged. The relocation of the Tattershall Castle and other moorings along the northern bank, further protect the setting of this area.

11.5.42 The low levels of tranquillity in the area would be largely unaffected by construction activity at the site.

11.5.43 Due to the limited changes to the wider setting of the area, the magnitude of change is considered to be low.

11.5.44 The low magnitude of change, assessed alongside the high sensitivity of this character area, in particular the character of the World Heritage Site, would result in **minor adverse** effects.

11.5.45 The assessment of specific effects on Westminster Abbey and Church of St Margaret World Heritage Site as a heritage asset is set out in Section 7 of this volume.

Townscape – sensitivity test for programme delay

11.5.46 For the assessment of townscape effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.5.4 to 11.5.45). This is on the basis that there are no known schemes that would change the sensitivity to change of the townscape character areas already presented (paras. 11.4.2 to 11.4.72).

Visual assessment

11.5.47 The visual assessment for the construction phase has been undertaken during winter, in line with best practice guidance, to ensure a robust assessment. However, in some cases, visibility of construction activities may be reduced during summer when vegetation, if present in a view, would be in leaf.

London View Management Framework Linear Views

Linear View 9A.1 – King Henry VIII's Mound, Richmond to St Paul's Cathedral

11.5.48 During construction, cranes at the site would be intermittently visible in the distant background of the view, set partially in front of St Paul's Cathedral. However, without the use of a telephoto lens, the cranes would be barely perceptible to recreational receptors at this location. Other construction activity at the site would be obscured by the intervening low height buildings and structures. Therefore, the magnitude of change on this long range Linear View is considered to be negligible.

11.5.49 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

Recreational

Viewpoint 2.1: View south from the Thames Path along Victoria Embankment, at the junction with Northumberland Avenue

11.5.50 The view from this location along Victoria Embankment would be characterised by the foreground presence of site hoardings, welfare facilities, construction plant, construction activity and road transport. Construction at the site would partially obscure views across the river to the London Eye and County Hall. Therefore, the magnitude of change is considered to be high.

11.5.51 The high magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **major adverse** effects.

Viewpoint 2.2: View south from the western end of the southern Golden Jubilee footbridge (LVMF River Prospect)

11.5.52 Construction activity would be highly visible in the foreground of the view up the river from this location. Construction plant and activity on the temporary cofferdam would be highly visible due to the elevated nature of the viewpoint. Construction at the site would partially obscure views towards the Palace of Westminster and along Victoria Embankment. Therefore, the magnitude of change is considered to be high.

11.5.53 The high magnitude of change, assessed alongside the high sensitivity of the receptor would result in **major adverse** effects.

Viewpoint 2.3: View southwest from the centre of the southern Golden Jubilee footbridge (LVMF River Prospect)

11.5.54 Construction activity would be highly visible in the foreground of the view up the river from this location. Construction plant and activity on the temporary cofferdam would be highly visible due to the elevated nature of the viewpoint. Construction at the site would partially obscure views towards Victoria Embankment and Whitehall Court. Therefore, the magnitude of change is considered to be high.

11.5.55 The high magnitude of change, assessed alongside the high sensitivity of the receptor would result in **major adverse** effects.

Viewpoint 2.4: View south from outside the entrance to Embankment Underground station; and Viewpoint 2.5: View south from the Thames Path opposite Victoria Embankment Gardens – Main Gardens

11.5.56 Views from these locations would be affected to a limited extent during construction. The majority of the site would be obscured by Hungerford Bridge in the foreground of the views, although the presence of tall construction plant and cranes at the site would be visible above the line of the bridge set behind the structure of the Golden Jubilee footbridges, and road traffic along Victoria Embankment would be apparent. Therefore, the magnitude of change is considered to be low.

11.5.57 The low magnitude of change, assessed alongside the high sensitivity of these receptors would result in **minor adverse** effects.

Viewpoint 2.6: View south from the centre of Victoria Embankment Gardens – Main Gardens; and Viewpoint 2.8: View south from the northern end of Victoria Embankment Gardens – Main Gardens

11.5.58 Views from these locations would be affected to a limited extent during construction by intermittent visibility of tall construction plant and cranes above intervening dense vegetation within the gardens. The construction plant and cranes would form indistinct components of the views alongside the structure of the Golden Jubilee footbridges. Therefore, the magnitude of change is considered to be negligible.

11.5.59 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would result in a **negligible** effect.

Viewpoint 2.7: View southwest from the Thames Path adjacent to Savoy Pier; and Viewpoint 2.9: View southwest from the northern end of Waterloo Bridge (LVMF River Prospect)

11.5.60 The views of the site from these locations would be partially obscured by permanent moorings along Victoria Embankment, Hungerford Bridge and Embankment Pier in the middle ground of the views. The temporary cofferdam, construction plant and construction activity towards the east of the site would be intermittently visible through the arches of Hungerford Bridge. Tall construction plant and cranes would be intermittently visible alongside the structure of the Golden Jubilee footbridges. Therefore, the magnitude of change is considered to be low.

11.5.61 The low magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **minor adverse** effects.

Viewpoint 2.10: View southwest and east from the Thames Path opposite Somerset House

11.5.62 The view towards the Victoria Embankment Foreshore site would be affected to a limited extent during construction. The site would be largely obscured by Hungerford Bridge in the background of the view and Waterloo Bridge in the foreground, although the site cofferdam, construction activity and construction plant towards the east of the site would be partially visible underneath the arches of Hungerford Bridge. The presence of tall construction plant and cranes at the site would be visible in the background of the view, above the line of Hungerford Bridge set behind the structure of the Golden Jubilee footbridges.

11.5.63 Construction activity and the site cofferdam projecting into the river at the Blackfriars Bridge Foreshore site would be visible as noticeable elements in the middle ground of this view, set in front of Blackfriars Bridge. However, views of this site would be partially screened by the avenue of London plane trees and permanent moorings along Victoria Embankment, including the relocated ship ‘President’. Wider views over the river would be largely unaltered.

11.5.64 Due to the limited visibility of construction activity at both the Victoria Embankment Foreshore and Blackfriars Bridge Foreshore sites, the magnitude of change is considered to be low.

11.5.65 The low magnitude of change, assessed alongside the high sensitivity of the receptor would result in **minor adverse** effects.

Viewpoint 2.11: View southwest from towards the southern end of Waterloo Bridge (LVMF River Prospect); and Viewpoint 2.12: View west from the southern bank outside Royal Festival Hall

11.5.66 Views from these locations would be affected during construction. The site would be partially obscured by Hungerford Bridge in the middle ground of the views, although the temporary cofferdam, construction plant and construction activity towards the east of the site would be visible underneath the arches of the bridge. The presence of tall construction plant and cranes at the site would be visible above the line of the bridge set behind the structure of the Golden Jubilee footbridges. Therefore, the magnitude of change is considered to be medium.

11.5.67 The medium magnitude of change assessed alongside the high sensitivity of these receptors would result in **moderate adverse** effects.

Viewpoint 2.13: View west from the Concert Hall Approach

11.5.68 The majority of construction activities at the site would not be visible from this location, apart from intermittent visibility of cranes in the background of the view. Therefore, the magnitude of change is considered to be negligible.

11.5.69 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

Viewpoint 2.14: View northwest from the Thames Path alongside Jubilee Gardens (LVMF River Prospect); Viewpoint 2.16: View northwest from the Thames Path outside County Hall (LVMF River Prospect); and Viewpoint 2.17: View north from the eastern end of Westminster Bridge (LVMF River Prospect)

11.5.70 Views from these locations would encompass the temporary cofferdam, construction plant, construction activity and welfare facilities in the foreground of the view across the river. During construction, views of Victoria Embankment, the Embankment gardens and Whitehall Court would be partially obscured. Therefore, the magnitude of change is considered to be high.

11.5.71 The high magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **major adverse** effects.

Viewpoint 2.15: View northwest from Jubilee Gardens

11.5.72 The background of the view across the river from this location would be affected to a limited extent by the presence of the temporary cofferdam, construction plant, construction activity and welfare facilities. However, views would be heavily filtered by mature trees along the southern bank of the river. Therefore, the magnitude of change is considered to be low.

11.5.73 The low magnitude of change, assessed alongside the high sensitivity of the receptor would result in **minor adverse** effects.

Viewpoint 2.18: View north from Westminster Bridge opposite the Palace of Westminster; and Viewpoint 2.19: View north from the Thames Path adjacent to Westminster Millennium Pier

11.5.74 The background of views from these locations would encompass the temporary cofferdam, construction plant, construction activity and welfare facilities within the river corridor. However, construction at the site would be partially obscured by intervening piers and jetties along the northern bank, and further obscured by the relocation of the Tattershall Castle vessel immediately to the south of the temporary cofferdam. Therefore, the magnitude of change is considered to be low.

11.5.75 The low magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **minor adverse** effects.

Viewpoint 2.20: View north from Victoria Embankment Gardens - Lower

11.5.76 Views from this location would be affected to a limited extent during construction by intermittent visibility of tall construction plant and cranes through intervening mature trees along the boundary of the gardens. The construction plant and cranes would form indistinct components of the view alongside the structure of the Golden Jubilee footbridges. Therefore, the magnitude of change is considered to be negligible.

11.5.77 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would result in a **negligible** effect.

Viewpoint 2.21: View east from the eastern end of Horse Guards Parade

11.5.78 Views from this location would be affected to a limited extent during construction by visibility of the relocated Tattershall Castle vessel at the end of the view. The majority of the vessel would be obscured by the river wall and further screened by intervening mature trees along Victoria Embankment. Other construction activity would be obscured by intervening trees, buildings and structures. Therefore, the magnitude of change is considered to be negligible.

11.5.79 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would result in a **negligible** effect.

Viewpoint 2.22: View east from Victoria Embankment Gardens - Upper

11.5.80 Views from this location would be affected to a limited extent during construction by intermittent visibility of construction plant, construction activity, welfare facilities and site hoardings through intervening mature trees along the boundary of the gardens. The construction plant and cranes would form indistinct components of the view alongside the structure of the Golden Jubilee footbridges. Therefore, the magnitude of change is considered to be low.

11.5.81 The low magnitude of change, assessed alongside the high sensitivity of the receptor would result in **minor adverse** effects.

Viewpoint 2.23: View east from Northumberland Avenue; and Viewpoint 2.24: View southwest from Craven Street at the junction with Strand

11.5.82 The view from these locations would be affected to a limited extent by the background visibility of tall construction plant and cranes at the northern edge of the site, partially obscured by intervening mature trees. Views of the majority of the site would be obscured by intervening buildings along Northumberland Avenue and Craven Street. Therefore, the magnitude of change is considered to be negligible.

11.5.83 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors, would result in a **negligible** effect.

Visual effects – sensitivity test for programme delay

11.5.84 For the assessment of visual effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.5.48 to 11.5.83). This is on the basis that there are no known schemes within the assessment area that would introduce new visual receptors, or alter visibility of the proposed development from the viewpoints described in paras. 11.4.74 to 11.4.161.

11.6 Operational effects assessment

11.6.1 The following section describes the likely significant effects arising during the operational phase at Victoria Embankment Foreshore taking account of the Blackfriars Bridge Foreshore site (as detailed in Section 11.3).

11.6.2 Effect on tranquillity is one factor which informs the overall assessment of effects on townscape character. Since the operation of the proposed development would have little above ground activity associated with it, apart from infrequent maintenance visits, it is considered that the proposed development would have a **negligible** effect on tranquillity for all townscape character areas. This conclusion is not repeated for each character area discussed below.

11.6.3 For the site, all surrounding townscape character areas and all viewpoints, adverse effects would be minimised by the commitment to a high quality design as detailed in the design principles summarised in para. 11.2.6. Where specific measures are of particular relevance to the effect on a receptor, these are described under each townscape character area and viewpoint.

11.6.4 Illustrative plans of the proposed development during operation are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures) and design principles describing environmental design measures are set out in Vol 1 Appendix B. Where photomontages have been prepared to assist the assessment of effects, these are referenced in the appropriate viewpoint below.

Operational effects Year 1

Site character assessment

11.6.5 The proposed development would have a permanent effect on the character of the site. The permanent layout would result in a new area of public realm along Victoria Embankment that would project into the river by approximately 25m. The projection would introduce a new structure into the river beyond the line of the river wall in a stretch of river characterised predominantly by small scale projections such as the RAF Memorial and Cleopatra's Needle, albeit much larger in scale. However, the orthogonal design, geometry and symmetry of the foreshore structure would be sympathetic to the historic character of the river in this location. The bulk of the structure would be reduced through the incorporation of a lower publicly accessible floodable terrace along the front of the foreshore structure. The structure would be further integrated into the surrounding townscape character through use of natural stone on the river wall and a design that responds to the existing Grade II listed wall. The front face of the river wall would incorporate horizontal bands in the stone to mark river levels. The design intent for the river wall is illustrated on the River wall design intent figures - sheets 1 and 2 (see separate volume of figures – Section 1).

11.6.6 A 4-8m high, well designed ventilation column would be located on the new foreshore structure (excluding the floodable terrace), and the 6m high electrical and control kiosks would be located along the landward edge of the foreshore structure. The design intent for the ventilation column (which would be project signature design) is illustrated on the Ventilation columns design intent figure – type B (see separate volume of figures – Section 1). An indicative drawing of the design intent for the electrical and control kiosks, which would incorporate natural stone cladding and a planted pergola structure along the roofs, is shown on the Kiosk design intent figure (see separate volume of figures – Section 1). A further narrow 6m high ventilation column serving the interception chamber would be located on the existing Victoria Embankment pavement and would be viewed as an element of street furniture similar in character to existing lighting columns.

11.6.7 The land based area of the construction site would be returned to its original condition at completion, including the replacement of mature London plane trees removed during construction. While the works provide an area of high quality public realm alongside Victoria Embankment, they also introduce a new element into a highly sensitive stretch of the River Thames. The impacts on specific components of the site are described in Vol 17 Table 11.6.1 below.

Vol 17 Table 11.6.1 Townscape – impacts on baseline components in Year 1 of operation

ID	Component	Impacts
01	Historic river wall	The majority of the river wall above pavement level would be reinstated after construction, apart from stretches to allow for pedestrian access, and

ID	Component	Impacts
		occasional vehicular access for maintenance, onto the foreshore structure.
02	Grade II listed Sturgeon lamp standards	All, except two, would be reinstated following the works. The festoon lighting would also be reinstated. One of the remaining lamp standards would be reinstated in its original location on Victoria Embankment and the other would be used at the Blackfriars Bridge Foreshore site if possible.
03	Mature trees	Seven mature trees would be removed during construction; replaced by seven semi-mature London plane trees.
04	Thames Path	The Thames Path would be reinstated to the riverside location and resurfaced as part of the wider enhancement to the public realm.
05	Tattershall Castle vessel	This vessel would be permanently relocated immediately upstream of the permanent foreshore structure, close to her original position. New access ramps and fencing would be provided over the river wall.
06	Grade II listed benches	These would be reinstated in their original locations.
07	Grade II listed catenary lamp standards	These would be reinstated in their original locations.
08	Boat mooring (north)	This would be reinstated.
09	Boat mooring (south)	This would be reinstated.

11.6.8 Although a high quality design is proposed for the foreshore structure, public realm and above ground structures, the overall change caused by the projection into the river in a highly sensitive townscape is considered to be adverse. However, the magnitude of change is considered to be low due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6) in addition to the reinstatement of key components including the ‘Tattershall Castle’ back to close to her original position.

11.6.9 The low magnitude of change, assessed alongside the high sensitivity of the site, would result in **minor adverse** effects.

Townscape character areas assessment

11.6.10 This section describes effects arising from the proposed development in operation on townscape character areas surrounding the site. No assessment of townscape effects has been made for the following character areas, as the components of the operational scheme would not substantially alter their setting:

a. Temples Conservation Area TCA

b. Whitefriars Conservation Area TCA.

River Thames – Houses of Parliament Reach TCA; and Westminster Abbey and Parliament Square TCA

11.6.11 The proposed development would alter the wider setting of these character areas to a limited extent due to the introduction of new elements in front of the existing river wall, including the foreshore structure itself, control kiosks and ventilation columns. However, due to the design of the structures which would be in keeping with the surrounding townscape character, these elements would not comprise a noticeable change to the existing setting. Therefore, the magnitude of change is considered to be negligible.

11.6.12 The negligible magnitude of change, assessed alongside the high sensitivity of these character areas, would result in a **negligible** effect.

River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

11.6.13 The proposed development at Victoria Embankment Foreshore would result in the addition of a new large scale foreshore structure projecting into this reach of the river by approximately 25m. The projection would introduce a new structure into the river beyond the line of the river wall in a stretch of river characterised predominantly by relatively small scale projections such as the RAF Memorial and Cleopatra's Needle. However, the orthogonal and symmetrical design and geometry of the foreshore structure, and the high quality materials and design proposed for the river wall would be sympathetic to the character of the surrounding townscape. The above ground structures, including the signature design ventilation columns and electrical and control kiosks, would introduce new built elements into the area, but their design, facade materials and locations would suit the character of the sensitive townscape. Therefore, the magnitude of change is considered to be low.

11.6.14 The low magnitude of change, assessed alongside the high sensitivity of the character area, would result in **minor adverse** effects.

River Thames – Central London Reach TCA

11.6.15 The Victoria Embankment Foreshore site would result in changes to the wider setting of this character area, due to the introduction of new built elements in front of the existing river wall, including the foreshore structure (projecting into the river by approximately 25m), electrical and control kiosks and signature design ventilation columns.

11.6.16 The proposed development at Blackfriars Bridge Foreshore would result in the alteration of the strong link between the river and Victoria Embankment due to the introduction of a large scale new foreshore structure that would project into the river by approximately 35m. The projection would introduce a new structure into the river beyond the line of the river wall in a stretch of river characterised predominantly by small scale projections and other incursions that are temporary in nature, including moored vessels. However, the orthogonal design and geometry of the foreshore structure, and the high quality materials and design proposed for the river wall would be sympathetic to the character of the surrounding townscape. The above ground structures, including the signature design ventilation columns and electrical and control kiosks, would introduce new built elements into the area, but their design, facade materials and locations would suit the character of the sensitive townscape.

11.6.17 The overall change caused by the projection of the Blackfriars Bridge Foreshore site into the river in a highly sensitive townscape, in addition to the projection of the Victoria Embankment Foreshore site in the adjacent river reach, forming part of the wider setting, is considered to be adverse. However, the magnitude of change is considered to be low due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6).

11.6.18 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

Victoria Embankment Administrative TCA

11.6.19 The proposed development at Victoria Embankment Foreshore would result in changes to the immediate riverside setting of the southern section of this character area, due to the introduction of new built elements in front of the existing river wall. The projection into the river would be set against other projections which are smaller in scale, including the RAF Memorial and Cleopatra's Needle, albeit much larger in scale. The orthogonal and symmetrical design and geometry of the foreshore structure, and the high quality materials and design proposed for the river wall would be sympathetic to the character of the surrounding townscape. The above ground structures, including the signature design ventilation columns and electrical and control kiosks, would introduce new built elements into the area, but their design, facade materials and locations would suit the character of the sensitive townscape. Furthermore, the wider riverside setting of the area would only be affected to a limited extent by the presence of the foreshore structure. Therefore, the magnitude of change is considered to be low.

11.6.20 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

11.6.21 The assessment of specific effects on Whitehall Conservation Area and the Grade II* Registered Victoria Embankment Gardens as heritage assets is set out in Section 7 of this volume.

South Bank Conservation Area TCA

11.6.22 The proposed development at the Victoria Embankment Foreshore site, comprising a foreshore structure (projecting into the river by approximately 25m) and above ground structures would affect the riverside setting of the London Eye section of this character area. The setting would be affected through the introduction of a relatively large structure into the river, not entirely in keeping with the character of other projections (which comprise small scale monumental projections such as the RAF Memorial in addition to a number of permanent moorings). However, the retention of the Hispaniola vessel downstream of the site and repositioning of the Tattershall Castle vessel slightly upstream of the site, in conjunction with the commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6), would minimise the magnitude of change arising from the Victoria Embankment Foreshore site.

11.6.23 The foreshore structure at the Blackfriars Bridge Foreshore site (projecting into the river by approximately 35m) would affect the riverside setting of the northern section of this character area, locally altering the character of the river to the west of Blackfriars Bridge. The setting would be affected through the introduction of the foreshore structure and additional above ground structures (ventilation columns and control kiosks) into a section of the river currently only characterised by the presence of the Millennium Pier. However, the magnitude of change would be minimised through the reinstatement of the 'President' vessel upstream of the foreshore structure, and the commitment to a high quality design (described in full in Volume 18 Blackfriars Bridge Foreshore), including use of natural stone for the river wall, visually unobtrusive railings and materials appropriate to the character of the surrounding townscape for the above ground structures.

11.6.24 Due to the changes in riverside setting caused by both the Blackfriars Bridge site (northern section of the character area) and the Victoria Embankment Foreshore site (London Eye section of the character area), set against the high quality design principles described in para. 11.2.6 and the positioning of vessels alongside the foreshore structures, the magnitude of change is considered to be low.

11.6.25 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

11.6.26 The assessment of specific effects on South Bank Conservation Area as a heritage asset is set out in Section 7 of this volume.

Townscape – sensitivity test for programme delay

11.6.27 For the assessment of townscape effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.6.5 to 11.6.26). This is on the basis that there are no known schemes that would change the sensitivity to change of the townscape character areas already presented (paras. 11.4.2 to 11.4.72).

Visual assessment

11.6.28 For each viewpoint, an assessment of the visual effects during Year 1 of operation has been made. In each instance, the first part of the assessment relates to visual effects during winter at daytime, the second part relates to visual effects during summer at daytime and the final part relates to visual effects at night time arising from operational lighting.

11.6.29 No assessment of visual effects has been made for the following viewpoints, as the components of the operational scheme would either not be visible, or would be barely perceptible in the background of the view:

a. Linear View 9A.1 – King Henry VIII's Mound, Richmond to St Paul's Cathedral

b. Viewpoint 2.4: View south from outside the eastern entrance to Embankment Underground station

c. Viewpoint 2.6: View south from the centre of Victoria Embankment Gardens – Main Gardens

d. Viewpoint 2.8: View south from the northern end of Victoria Embankment Gardens – Main Gardens

e. Viewpoint 2.10: View southwest and east from the Thames Path opposite Somerset House

f. Viewpoint 2.13: View west from the Concert Hall Approach

g. Viewpoint 2.15: View northwest from the Jubilee Gardens

h. Viewpoint 2.20: View north from Victoria Embankment Gardens – Lower

i. Viewpoint 2.21: View east from the eastern end of Horse Guards Parade

j. Viewpoint 2.23: View east from Northumberland Avenue

k. Viewpoint 2.24: View southeast from Craven Street at the junction with Strand

11.6.30 The night time assessment considers effects arising from feature lighting of the ventilation columns. Other public realm and operational lighting requirements have not been assessed on the basis that they would be low level, capped and direction, providing lighting for the immediate area only. Therefore, no assessment of visual effects at night time has been made for the following viewpoints, as the feature lighting of the ventilation columns would be obscured or barely perceptible:

a. Viewpoint 2.5: View south from the Thames Path opposite Victoria Embankment Gardens – Main Gardens

b. Viewpoint 2.7: View southwest from the Thames Path adjacent to Savoy Pier

c. Viewpoint 2.9: View southwest from the northern end of Waterloo Bridge (LVMF River Prospect)

d. Viewpoint 2.11: View southwest from the southern end of Waterloo Bridge (LVMF River Prospect)

e. Viewpoint 2.12: View west from the southern bank outside the Royal Festival Hall

Recreational

Viewpoint 2.1: View south from the Thames Path along Victoria Embankment, at the junction with Northumberland Avenue

11.6.31 Views from this location would be affected by the design of the above ground structures and public realm, and the removal of mature trees along Victoria Embankment. The new structures would form highly visible components in the view, set in front of Victoria Embankment. The proposed works would introduce new built elements in front of the existing river wall, including the permanent foreshore structure, control kiosks and ventilation columns. Although the new structure would be highly prominent in the foreground of this view, the orthogonal and symmetrical design, and commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would minimise the level of change perceived by visual receptors. Furthermore, the approach ramps to the Hispaniola vessel in the foreground of the view would remain unchanged. Therefore, the magnitude of change is considered to be low.

11.6.32 The low magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to **minor adverse** effects.

11.6.33 There would be no change to the assessment during summer.

11.6.34 At night, the feature lighting of the ventilation columns would be visible in the middle ground of the view. Although the lit columns would not represent a skyline feature, they would introduce a new element in the panoramic view across the river, in the context of features such as the London Eye. However, due to the brightly lit context of the wider view, the magnitude of change is considered to be negligible.

11.6.35 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 2.2: View south from the western end of the southern Golden Jubilee footbridge (LVMF River Prospect)

11.6.36 Views from this location would be affected by the design of the river wall, above ground structures and public realm, and the removal of mature trees along Victoria Embankment. The new structures would form key components in the view towards the Houses of Parliament, set in front of Victoria Embankment. The proposed works would introduce new built elements in front of the existing river wall, including the foreshore structure itself, control kiosks and ventilation columns. The view of the proposed development from this viewpoint is illustrated in Vol 17 Plate 11.6.1 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 17 Figure 11.6.1 (see separate volume of figures). The layout of the proposed development illustrated in this photomontage may change within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1), however the assessment of effects would be no worse than that described here.

Vol 17 Plate 11.6.1 Viewpoint 2.2 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

11.6.37 Although the new structure would be highly prominent in the foreground of this view, the orthogonal and symmetrical design, and commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would minimise the level of change perceived by visual receptors. Furthermore, the approach ramps to the Hispaniola vessel in the foreground of the view would remain unchanged. Therefore, the magnitude of change is considered to be low.

11.6.38 The low magnitude of change, assessed alongside the high sensitivity of these receptors would result in a **minor adverse** effect.

11.6.39 There would be no change to the assessment during summer.

11.6.40 At night, the feature lighting of the ventilation columns would be visible in the foreground of the view. Although the lit columns would not represent a skyline feature, they would introduce a new element in the view set in front of the brightly lit Victoria Embankment, in the context of features such as the RAF Memorial. The reinstatement of sturgeon lamp standards and festoon lighting along Victoria Embankment would reduce changes to the view at night. The view of the proposed development at night from this viewpoint is illustrated in Vol 17 Plate 11.6.2 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 17 Figure 11.6.2 (see separate volume of figures). The layout of the proposed development illustrated in this photomontage may change within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1), however the assessment of effects would be no worse than that described here.

Vol 17 Plate 11.6.2 Viewpoint 2.2 – illustrative night time operational phase photomontage

Date taken: 1 March 2012. 50mm lens.

11.6.41 Due to the brightly lit context of the wider view, the magnitude of change is considered to be negligible.

11.6.42 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 2.3: View southwest from the centre of the southern Golden Jubilee footbridge (LVMF River Prospect)

11.6.43 Views from this location would be affected by the design of the river wall, above ground structures and public realm, and the removal of mature trees along Victoria Embankment. The new structures would form key components in the view towards Whitehall Court, set in front of Victoria Embankment. The view of the proposed development from this viewpoint is illustrated in Vol 17 Plate 11.6.3 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 17 Figure 11.6.3 (see separate volume of figures). The layout of the proposed development illustrated in this photomontage may change within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1), however the assessment of effects would be no worse than that described here.

Vol 17 Plate 11.6.3 Viewpoint 2.3 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

11.6.44 Although the new structure would be highly prominent in the foreground of this view, the orthogonal and symmetrical design, and commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would minimise the level of change perceived by visual receptors. Furthermore, the permanently moored Hispaniola vessel would remain unchanged in the foreground of the view. Therefore, the magnitude of change is considered to be low.

11.6.45 The low magnitude of change, assessed alongside the high sensitivity of these receptors would result in a **minor adverse** effect.

11.6.46 There would be no change to the assessment during summer.

11.6.47 At night, the feature lighting of the ventilation columns would be visible in the foreground of the view. Although the lit columns would not represent a skyline feature, they would introduce a new element in the view set in front of the brightly lit Victoria Embankment, in the context of features such as the RAF Memorial. The reinstatement of sturgeon lamp standards and festoon lighting along Victoria Embankment would reduce changes to the view at night. Furthermore, due to the brightly lit context of the wider view, the magnitude of change is considered to be negligible.

11.6.48 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 2.5: View south from the Thames Path opposite Victoria Embankment Gardens – Main Gardens; Viewpoint 2.7: View southwest from the Thames Path adjacent to Savoy Pier; and Viewpoint 2.9: View southwest from the northern end of Waterloo Bridge (LVMF River Prospect)

11.6.49 Views from these locations would be affected to a limited extent by the design of the new river wall and ventilation columns, which would be intermittently visible in the background of the view. Views of these elements would be largely obscured by Embankment Pier and the arches of Hungerford Bridge. The design of the proposed development, in keeping with the surrounding townscape character, would mean it would represent a barely perceptible change from this location. Therefore, the magnitude of change is considered to be negligible.

11.6.50 The negligible magnitude of change assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect.

11.6.51 There would be no change to the assessment during summer.

Viewpoint 2.11: View southwest from towards the southern end of Waterloo Bridge (LVMF River Prospect)

11.6.52 The view from this location would be affected by the design of the river wall, control kiosks and ventilation columns. The introduction of the new foreshore structure projecting into the river would form a component of the background of the view, intermittently visible through the piers of Hungerford Bridge. However, the orthogonal and symmetrical design, and commitment to a high quality design in keeping with the townscape character of the area, including the use of natural stone for the new river wall and the reinstatement of semi-mature London plane trees along Victoria Embankment would help to integrate the proposed development into the surrounding townscape. Therefore, the magnitude of change is considered to be low.

11.6.53 The low magnitude of change, assessed alongside the high sensitivity of the receptor would result in a **minor adverse** effect.

11.6.54 There would be no change to the assessment during summer.

Viewpoint 2.12: View west from the southern bank outside the Royal Festival Hall

11.6.55 Views of the proposed development from this location would be almost entirely obscured by the arches and structure of the Hungerford Bridge and adjoining Golden Jubilee footbridges. Furthermore, the commitment to a high quality design in keeping with the local townscape character would mean that the proposed development would be barely perceptible. Therefore, the magnitude of change is considered to be negligible.

11.6.56 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to **negligible** effects.

11.6.57 There would be no change to the assessment during summer.

Viewpoint 2.14: View northwest from the Thames Path alongside Jubilee Gardens (LVMF River Prospect); Viewpoint 2.16: View northwest from the Thames Path outside County Hall (LVMF River Prospect); and Viewpoint 2.17: View north from the eastern end of Westminster Bridge (LVMF River Prospect)

11.6.58 Views from these locations would be affected by the design of the river wall, above ground structures and public realm, and the removal of mature trees along Victoria Embankment. The new structures would form key components in the cross-river views, set in front of Victoria Embankment. The proposed works would introduce new built elements in front of the existing river wall, including the foreshore structure itself, control kiosks and ventilation columns. The view of the proposed development from viewpoints 2.14 and 2.17 are illustrated in Vol 17 Plate 11.6.4 and Vol 17 Plate 11.6.5 below. A larger scale print of the photomontages, including the wider context and annotations, is provided in Vol 17 Figure 11.6.4 and Vol 17 Figure 11.6.5 (see separate volume of figures). The layout of the proposed development illustrated in these photomontages may change with the zones shown on the Site works parameter plan (see separate volume of figures - Section 1), however the assessment of effects would be no worse than that described here.

Vol 17 Plate 11.6.4 Viewpoint 2.14 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

Vol 17 Plate 11.6.5 Viewpoint 2.17 – illustrative operational phase photomontage

Date taken: 6 December 2011. 50mm lens.

11.6.59 Although the new structure would be prominent in these views, the orthogonal and symmetrical design, and commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would minimise the level of change perceived by visual receptors. Furthermore, the Tattershall Castle would be moored slightly upstream of the structure, reducing its visibility and locating this vessel back close to the original position. Therefore, the magnitude of change is considered to be low.

11.6.60 The low magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to **minor adverse** effects.

11.6.61 There would be no change to the assessment during summer.

11.6.62 The view of the proposed development at night from viewpoint 2.14 is illustrated in Vol 17 Plate 11.6.6 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 17 Figure 11.6.6 (see separate volume of figures). The layout of the proposed development illustrated in this photomontage may change with the zones shown on the Site works parameter plan (see separate volume of figures - Section 1), however the assessment of effects would be no worse than that described here.

Vol 17 Plate 11.6.6 Viewpoint 2.14 – illustrative night time operational phase photomontage

Date taken: 8 March 2011. 50mm lens.

11.6.63 At night, the feature lighting of the ventilation columns would be visible across the river, set alongside lighting on the two permanently moored vessels and in front of the brightly lit Victoria Embankment. Although the lit columns would not represent a skyline feature, they would introduce a new element in the view set in front of the brightly lit Victoria Embankment, in the context of features such as the RAF Memorial. The reinstatement of sturgeon lamp standards and festoon lighting along Victoria Embankment would reduce changes to the view at night. Furthermore, due to the brightly lit context of the wider view, the magnitude of change is considered to be negligible.

11.6.64 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect at night.

Viewpoint 2.18: View north from Westminster Bridge opposite the Palace of Westminster; and Viewpoint 2.19: View north from the Thames Path adjacent to Westminster Millennium Pier

11.6.65 Views from these locations would be affected by the design of the river wall, above ground structures and public realm, and the removal of mature trees along Victoria Embankment. The new structures would be form components in the background of the views, set in front of Victoria Embankment and Hungerford Bridge. The proposed works would introduce new built elements in front of the existing river wall, including the foreshore structure itself, control kiosks and ventilation columns.

11.6.66 Although the new structure would be visible from these locations, the orthogonal and symmetrical design, and commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would minimise the level of change perceived by visual receptors. Furthermore, the Tattershall Castle would be moored alongside the structure, largely screening it and reinstating this vessel back to the original position. Therefore, the magnitude of change is considered to be negligible.

11.6.67 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect.

11.6.68 There would be no change to the assessment during summer.

11.6.69 At night, the feature lighting of the ventilation columns would be visible along the river, set beyond lighting on the Tattershall Castle vessel and in front of the brightly lit Victoria Embankment. Although the lit columns would not represent a skyline feature, they would introduce a new element in the view, in the context of features such as the RAF Memorial. The reinstatement of sturgeon lamp standards and festoon lighting along Victoria Embankment would reduce changes to the view at night. Furthermore, due to the brightly lit context of the wider view, the magnitude of change is considered to be negligible.

11.6.70 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect at night.

Viewpoint 2.22: View east from Victoria Embankment Gardens – Upper

11.6.71 Views of the proposed development from this location would be partially obscured by foreground planting along Victoria Embankment, although the removal of five mature trees adjacent to the site would be apparent, with intermittent views of the electrical and control kiosks and signature design ventilation columns beyond. However, due to the commitment to a high quality design in keeping with the character of the surrounding townscape, in addition to the intervening presence of heavy traffic along Victoria Embankment, partially obscuring views towards the site, the magnitude of change is considered to be low.

11.6.72 The low magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to **minor adverse** effects.

11.6.73 During summer, the avenue of mature London plane trees along Victoria Embankment and along the edge of the gardens would largely obscure views towards the site. Therefore, the magnitude of change is considered to be negligible, giving rise to a **negligible** effect during summer.

11.6.74 At night, lighting of the ventilation column would be barely perceptible beyond the high levels of light along Victoria Embankment. Therefore the magnitude of change is considered to be negligible.

11.6.75 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect at night.

Visual effects – sensitivity test for programme delay

11.6.76 For the assessment of visual effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.6.29 to 11.6.75). This is on the basis that there are no known schemes within the assessment area that would introduce new visual receptors, or alter visibility of the proposed development from the viewpoints described in paras. 11.4.74 to 11.4.161.

Operational effects Year 15

11.6.77 Operational effects for all townscape and visual receptors identified would remain unchanged in Year 15 compared to Year 1, due to the limited effect any maturing vegetation (including the newly planted London plane trees) would have on the visibility of the site and the limited changes anticipated in the surrounding area in the Year 15 base case. This would also apply in the event of a programme delay to the Thames Tideway Tunnel project of approximately one year.

11.7 Cumulative effects assessment

11.7.1 As detailed in the site development schedule (Vol 17 Appendix N) no schemes have been identified within 1km of the site which meet the criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken. This would also apply in the event of a programme delay to the Thames Tideway Tunnel project of approximately one year.

11.8 Mitigation

11.8.1 All measures embedded in the proposed development and *CoCP* of relevance to the townscape and visual assessment are summarised in Section 11.2. No further mitigation during construction is possible due to the highly visible nature of the construction activities.

11.8.2 A process of iterative design and assessment has been employed to reduce adverse effects during operation. No further mitigation is possible due to the highly sensitive nature of the townscape and highly visible nature of the proposed development.

11.9 Residual effects assessment

Construction effects

11.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 11.5. All residual effects for construction are presented in Section 11.10.

Operational effects

11.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 11.6. All residual effects for operation are presented in Section 11.10.

11.10 Assessment summary

Vol 17 Table 11.10.1 Townscape – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
The site	Change to character due to site clearance, construction of the site cofferdam and intensity of construction activity.	Major adverse	No mitigation possible	Major adverse
River Thames – Houses of Parliament Reach TCA	Change to wider setting due to the presence of the site cofferdam, construction plant and construction activity, partially obscured by the relocated Tattershall Castle	Minor adverse	None	Minor adverse
River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA	Change to setting of the southern section of the character area due to high levels of construction activity at the Victoria Embankment Foreshore site. Marginal change to setting of the northern section of the character area due to construction activity at the Blackfriars Bridge Foreshore site, partially screened by Waterloo Bridge.	Major adverse	No mitigation possible	Major adverse
River Thames – Central London Reach TCA	Change to setting due to high levels of construction activity in this reach of the river at the Blackfriars Bridge Foreshore site, in addition to a marginal change to the wider setting resulting from the presence of wider construction activity at Victoria Embankment Foreshore.	Major adverse	No mitigation possible	Major adverse
Victoria Embankment Administrative TCA	Change to immediate riverside setting of the southern section of the area due to construction at the Victoria Embankment Foreshore site. Change to wider riverside setting of the northern section of the character area due to construction activity at	Moderate adverse	No mitigation possible	Moderate adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	Blackfriars Bridge Foreshore.			
Temples Conservation Area TCA	Change to immediate riverside setting due to site hoardings, welfare facilities, construction activity and construction plant at the Blackfriars Bridge Foreshore site. Limited change to wider setting due to the presence of tall construction plant and cranes at the Victoria Embankment Foreshore site.	Major adverse	No mitigation possible	Major adverse
South Bank Conservation Area TCA	Change to riverside setting of the northern section of the character area due to construction activity at the Blackfriars Bridge Foreshore site and to the London Eye section of the area due to construction at the Victoria Embankment Foreshore site.	Major adverse	No mitigation possible	Major adverse
Westminster Abbey and Parliament Square TCA	Change to wider setting due to the presence of the site cofferdam, construction plant and construction activity, partially obscured by the relocated Tattershall Castle	Minor adverse	None	Minor adverse

Vol 17 Table 11.10.2 Visual – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Designated Views				
London View Management – Linear View 9A.1	Background visibility of cranes.	Negligible	None	Negligible
Recreational				
Viewpoint 2.1: View south from the Thames Path along Victoria Embankment, at the junction with Northumberland Avenue	Foreground visibility of site hoardings, welfare facilities, construction plant, construction activity and road transport.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.2: View south from the western end of the southern Golden Jubilee footbridge (LVMF River Prospect)	Foreground visibility of site hoardings, welfare facilities, construction plant, construction activity and road transport.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.3: View southwest from the centre of the southern Golden Jubilee footbridge (LVMF River Prospect)	Foreground visibility of site hoardings, welfare facilities, construction plant, construction activity and road transport.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.4: View south from outside the eastern entrance to Embankment Underground station	Visibility of tall construction plant and cranes, partially obscured by Hungerford Bridge. Visibility of road transport.	Minor adverse	None	Minor adverse
Viewpoint 2.5: View south from the Thames Path opposite Victoria Embankment Gardens – Main Gardens	Visibility of tall construction plant and cranes, partially obscured by Hungerford Bridge. Visibility of road transport.	Minor adverse	None	Minor adverse
Viewpoint 2.6: View south from the	Intermittent visibility of tall construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
centre of Victoria Embankment Gardens – Main Gardens	plant and cranes, largely obscured by intervening vegetation.			
Viewpoint 2.7: View southwest from the Thames Path adjacent to Savoy Pier	Visibility of the temporary cofferdam, construction plant and construction activity partially obscured by Hungerford Bridge.	Minor adverse	None	Minor adverse
Viewpoint 2.8: View south from the northern end of Victoria Embankment Gardens – Main Gardens	Intermittent visibility of tall construction plant and cranes, largely obscured by intervening vegetation.	Negligible	None	Negligible
Viewpoint 2.9: View southwest from the northern end of Waterloo Bridge (LVMF River Prospect)	Visibility of the temporary cofferdam, construction plant and construction activity partially obscured by Hungerford Bridge.	Minor adverse	None	Minor adverse
Viewpoint 2.10: View southwest and east from the Thames Path opposite Somerset House	Intermittent visibility of tall construction plant and cranes at Victoria Embankment Foreshore. Middle ground visibility of the temporary cofferdam at the Blackfriars Bridge Foreshore site, partially screened by mature trees and permanent river moorings.	Minor adverse	None	Minor adverse
Viewpoint 2.11: View southwest from towards the southern end of Waterloo Bridge (LVMF River Prospect)	Intermittent visibility of the temporary cofferdam, construction plant and construction activity through the arches of Hungerford Bridge.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 2.12: View west from the southern bank outside Royal Festival Hall	Intermittent visibility of the temporary cofferdam, construction plant and construction activity through the arches of Hungerford Bridge.	Moderate adverse	No mitigation possible	Moderate adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Viewpoint 2.13: View west from Concert Hall Approach	Intermittent background visibility of cranes.	Negligible	None	Negligible
Viewpoint 2.14: View northwest from the Thames Path alongside Jubilee Gardens (LVMF River Prospect)	Foreground visibility of the temporary cofferdam, construction plant, construction activity and welfare facilities.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.15: View northwest from Jubilee Gardens	Background visibility of the site cofferdam, construction plant and construction activity, heavily filtered by mature trees.	Minor adverse	None	Minor adverse
Viewpoint 2.16: View northwest from the Thames Path outside County Hall (LVMF River Prospect)	Foreground visibility of the temporary cofferdam, construction plant, construction activity and welfare facilities.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.17: View north from the eastern end of Westminster Bridge (LVMF River Prospect)	Foreground visibility of the temporary cofferdam, construction plant, construction activity and welfare facilities.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.18: View north from Westminster Bridge opposite the Palace of Westminster	Background visibility of the site cofferdam, construction plant and construction activity, partially obscured by intervening jetties and the Tattershall Castle.	Minor adverse	None	Minor adverse
Viewpoint 2.19: View north from the Thames Path adjacent to Westminster Millennium Pier	Background visibility of the site cofferdam, construction plant and construction activity, partially obscured by intervening jetties and the Tattershall Castle.	Minor adverse	None	Minor adverse
Viewpoint 2.20: View north from Victoria Embankment Gardens – Lower	Intermittent visibility of tall construction plant and cranes, largely obscured by intervening mature trees.	Negligible	None	Negligible
Viewpoint 2.21: View east from the	Visibility of the relocated Tattershall Castle	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
eastern end of Horse Guards Parade	at the end of the view.			
Viewpoint 2.22: View east from Victoria Embankment Gardens – Upper	Intermittent visibility of construction plant, construction activity, welfare facilities and site hoardings through intervening mature trees.	Minor adverse	None	Minor adverse
Viewpoint 2.23: View east from Northumberland Avenue	Background visibility of tall construction plant and cranes.	Negligible	None	Negligible
Viewpoint 2.24: View southeast from Craven Street at the junction with Strand	Background visibility of tall construction plant and cranes.	Negligible	None	Negligible

Vol 17 Table 11.10.3 Townscape – summary of Year 1 and Year 15 operational assessment[i]

Receptor[ii]	Effect	Significance of effect	Mitigation	Significance of residual effect
The site	Change in character through the introduction of a new area of public realm projecting into the river although sympathetic to the wider townscape character.	Minor adverse	None	Minor adverse
River Thames – Houses of Parliament Reach TCA	Marginal change to wider setting due to the presence of the foreshore structure and above ground structures in the river corridor, reduced through a design in keeping with the character of the townscape, meaning the change to setting is barely perceptible.	Negligible	None	Negligible
River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA	Change to the setting of the southern section due to the introduction of the foreshore structuring projecting into the river corridor, and the introduction of above ground structures, reduced through a design in keeping with the character of the townscape.	Minor adverse	None	Minor adverse
River Thames – Central London Reach TCA	Change to setting through the introduction of a new area of public realm projecting into the river at Blackfriars Bridge Foreshore and, in the wider setting, Victoria Embankment Foreshore. However, the design of both sites would be sympathetic to the wider townscape character.	Minor adverse	None	Minor adverse
Victoria Embankment Administrative TCA	Change to the riverside setting of the southern section due to the introduction of the foreshore structuring projecting into the river corridor, and the introduction of above ground	Minor adverse	None	Minor adverse

[i] Operational effects have been assessed to be the same in both Year 1 and Year 15 of operation

[ii] Townscape character areas not assessed during operation (refer to para. 11.6.10) are not included in the summary table

Receptor[ii]	Effect	Significance of effect	Mitigation	Significance of residual effect
	structures, reduced through a design in keeping with the character of the townscape.			
South Bank Conservation Area TCA	Change to wider riverside setting of the northern section of this character area through the introduction of a new area of public realm projecting into the river at the Blackfriars Bridge Foreshore site. Change to immediate riverside setting of the London Eye section of the area due to the foreshore structure at the Victoria Embankment Foreshore site.	Minor adverse	None	Minor adverse

Vol 17 Table 11.10.4 Visual – summary of Year 1 and Year 15 operational assessment[iii]

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Recreational				
Viewpoint 2.1: View south from the Thames Path along Victoria Embankment, at the junction with Northumberland Avenue	Visibility of the above ground structures and public realm, and the removal of mature trees along Victoria Embankment.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.2: View south from the western end of the southern Golden Jubilee footbridge (LVMF River Prospect)	Foreground visibility of the river wall, above ground structures and removal of mature trees along Victoria Embankment.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.3: View southwest from the centre of the southern Golden	Foreground visibility of the river wall, above ground structures and removal	Winter – Minor adverse	Winter – None	Winter – Minor adverse

[iii] Operational effects have been assessed to be the same in both Year 1 and Year 15 of operation

[iv] Viewpoints not assessed during operation (refer to para. 11.6.31) are not included in the summary table

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Jubilee footbridge (LVMF River Prospect)	of mature trees along Victoria Embankment.	Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.5: View south from the Thames Path opposite Victoria Embankment Gardens – Main Gardens	Background visibility of the river wall and above ground structures, largely obscured by Embankment Pier and Hungerford Bridge.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.7: View southwest from the Thames Path adjacent to Savoy Pier	Background visibility of the river wall and above ground structures, largely obscured by Embankment Pier and Hungerford Bridge.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.9: View southwest from the northern end of Waterloo Bridge (LVMF River Prospect)	Background visibility of the river wall and above ground structures, largely obscured by Embankment Pier and Hungerford Bridge.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.11: View southwest from towards the southern end of Waterloo Bridge (LVMF River Prospect)	Background visibility of the river wall and above ground structures through the arches of Hungerford Bridge. Effect reduced through a high quality design in keeping with the townscape character.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Viewpoint 2.12: View west from the southern bank outside the Royal Festival Hall	The components of the proposed development would be largely obscured by Hungerford Bridge from this location.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.14: View northwest from the Thames Path alongside Jubilee Gardens (LVMF River Prospect)	Visibility of the river wall, above ground structures and removal of mature trees in the cross-river view. Effect reduced through a high quality design in keeping with the townscape character.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.16: View northwest from the Thames Path outside County Hall (LVMF River Prospect)	Visibility of the river wall, above ground structures and removal of mature trees in the cross-river view. Effect reduced through a high quality design in keeping with the townscape character.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.17: View north from the eastern end of Westminster Bridge (LVMF River Prospect)	Visibility of the river wall, above ground structures and removal of mature trees in the cross-river view. Effect reduced through a high quality	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer –	Summer –	Summer –

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
	design in keeping with the townscape character.	Minor adverse	None	Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.18: View north from Westminster Bridge opposite the Palace of Westminster	Background visibility of the river wall, above ground structures and removal of mature trees. Effect reduced through a high quality design in keeping with the townscape character.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.20: View north from the Thames Path adjacent to Westminster Millennium Pier	Background visibility of the river wall, above ground structures and removal of mature trees. Effect reduced through a high quality design in keeping with the townscape character and the presence of the relocated Tattershall Castle vessel.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.22: View east from Victoria Embankment Gardens –	Visibility of the above ground structures and removal of mature	Winter – Minor adverse	Winter – None	Winter – Minor adverse

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Upper	trees partially obscured by mature trees on the boundary of the gardens.	Summer – Negligible	Summer – None	Summer – Negligible
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible

References

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

[2] Mayor of London. *Revised Supplementary Planning Guidance – London View Management Framework* (July 2012).

[3] Westminster City Council. *LDF Core Strategy* (January 2011).

[4] City of London Corporation. *LDF Core Strategy* (September 2010).

[5] LB of Lambeth. *LDF Core Strategy* (January 2011).

[6] LB of Southwark. *LDF Core Strategy* (April 2011).

[7] Westminster City Council. *Conservation Area Information Leaflets* (May 2004).

[8] City of London Corporation. *Whitefriars Conservation Area character summary* (no date).

[9] City of London Corporation. *Temples Conservation Area character summary* (2007).

[10] City of London Corporation. *Temples Conservation Area: Management Strategy* (no date).

[11] LB of Lambeth. *South Bank Conservation Area profile* (September 2007).

[12] Westminster City Council. *Conservation Area Information Leaflets* (May 2004).

[13] Westminster World Heritage Site Management Plan Steering Group. *The Palace of Westminster and Westminster Abbey including St. Margaret's Church World Heritage Site Management Plan* (May 2007).

[14] Defra (2012). See citation above.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 12: Transport

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 12: Transport

List of contents

Page number

12 Transport ... 1

12.1 Introduction ... 1

12.2 Proposed development relevant to transport ... 2

12.3 Assessment methodology ... 6

12.4 Baseline conditions ... 17

12.5 Construction effects assessment ... 33

12.6 Operational effects assessment ... 50

12.7 Cumulative effects assessment ... 52

12.8 Mitigation ... 52

12.9 Residual effects assessment ... 53

12.10 Assessment summary ... 54

References ... 58

List of plates

Page number

Vol 17 Plate 12.3.1 Transport – estimated construction lorry profile ... 14

Vol 17 Plate 12.3.2 Transport – estimated construction barge profile ... 15

List of tables

Page number

Vol 17 Table 12.2.1 Transport - construction details 2
Vol 17 Table 12.2.2 Transport – maximum estimated construction worker numbers 4
Vol 17 Table 12.3.1 Transport – stakeholder engagement.. 7
Vol 17 Table 12.4.1 Transport – baseline TRANSYT model outputs........................ 27
Vol 17 Table 12.4.2 Transport – receptors and sensitivity....................................... 29
Vol 17 Table 12.4.3 Transport – construction base case additional receptors......... 33
Vol 17 Table 12.5.1 Transport – mode split.. 34
Vol 17 Table 12.5.2 Transport – peak construction works vehicle movements 40
Vol 17 Table 12.5.3 Transport – construction TRANSYT model outputs (AM peak hour) 42
Vol 17 Table 12.5.4 Transport – construction TRANSYT model outputs (PM peak hour) 43
Vol 17 Table 12.5.5 Transport – significance of effects during construction............ 45
Vol 17 Table 12.10.1 Transport – summary of construction assessment 54
Vol 17 Table 12.10.2 Transport – summary of operational assessment.................. 57

12 Transport

12.1 Introduction

12.1.1 This section presents the findings of the assessment of the likely significant transport effects of the proposed development at the Victoria Embankment Foreshore site. The project-wide transport effects are described in Volume 3 Project-wide effects assessment.

12.1.2 Construction of the proposed development at the site has the potential to affect the following transport elements:

a. pedestrian routes
b. cycle routes
c. bus routes and patronage
d. London Underground and National Rail services
e. river passenger services and river navigation
f. car, coach and motorcycle parking
g. highway layout, operation and capacity.

12.1.3 Effects on each of these elements is considered within this assessment for the construction phases of the project at the Victoria Embankment Foreshore site as well as effects on specific receptors (eg, nearby residents and users of the National Liberal Club, Hispaniola and Tattershall Castle vessels and Victoria Embankment Gardens/Whitehall Gardens.

12.1.4 The operation of the Victoria Embankment Foreshore site has the potential to affect coach parking and highway layout and operation and therefore effects on these are considered within the operational assessment.

12.1.5 The assessment of transport presented in this section has considered the requirements of the National Policy Statement for Waste Water (Defra, 2012)[1] section 4.13. Further details of these requirements can be found in Vol 2 Section 12.3.

12.1.6 Additionally, a separate *Transport Assessment* has been produced which provides an assessment of the effects on the transport network as a result of the construction and operational phases at the Victoria Embankment Foreshore site. The *Transport Assessment* accompanies the application for development content (the application).

12.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

12.1.8 The separate but related assessments of effects of transport on air quality and noise and vibration are contained in Sections 4 and 9 respectively.

12.2 Proposed development relevant to transport

12.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to transport are set out below.

Construction

12.2.2 The construction site would be located on the foreshore of the River Thames. In order to provide working areas, the site would also occupy part of the Victoria Embankment (A3211) carriageway and the riverside footway. Vehicle access to and from the site would take place from the nearside lane of the southbound carriageway of Victoria Embankment (A3211), which would need to be closed for periods of time during the works.

12.2.3 During construction it is anticipated that the elements listed under para 12.1.2 above may be affected as a result of the additional construction traffic associated with the Victoria Embankment Foreshore site and other Thames Tideway Tunnel project construction sites with routes along Victoria Embankment, pedestrian diversions along Victoria Embankment and the temporary restriction of coach and motorcycle parking bays in the vicinity of the site.

12.2.4 Details of the peak year of construction, anticipated lorry and barge movements and the activities which would generate these movements are provided in Vol 17 Table 12.2.1.

Vol 17 Table 12.2.1 Transport - construction details

Description	Assumption
Assumed peak period of construction lorry movements	Site Year 1 of construction
Assumed average peak daily construction lorry vehicle movements (in peak month of Site Year 1 of construction)	28 movements per day (14 vehicle trips)
Assumed peak period of construction barge movements	Site Year 1 of construction
Assumed average peak daily construction barge movements (in peak month of Site Year 1 of construction)	4 movements per day (2 barge trips)
Typical types of lorry requiring access (comprising rigid-bodied, flatbed and articulated vehicles)	Excavated material on lorries Plant and equipment deliveries Imported fill lorries

Description	Assumption
	Ready mix concrete lorries Office/general delivery lorries Steel reinforcement lorries Temporary construction material lorries including formwork and falsework Shaft precast concrete lining segments lorries

Note: a movement is a construction vehicle/barge moving either to or from the site. A Site Year is a 12 month period, one in a series of Site Years; Site Year 1 commences at the start of construction.

12.2.5 During construction cofferdam fill (import and export), shaft excavated and 'other' material (export) would be transported by barge. For the transport assessment it has been assumed that 90% of these materials are taken by river. This allows for periods that the river is unavailable and material unsuitable for river transport. All other material would be transported by road.

12.2.6 Vehicle movements would take place during the standard day shift of ten hours on weekdays (08:00 to 18:00) and five hours on Saturdays (08:00 to 13:00). It would only be in exceptional circumstances that heavy goods vehicles (HGVs) and abnormal load movements could occur up to 22:00 on weekdays for large concrete pours and later at night by agreement with Westminster City Council.

Construction traffic routing

12.2.7 The Victoria Embankment Foreshore site is located on the Transport for London Road Network (TLRN) on Victoria Embankment (A3211) approximately 40m south of the junction with Northumberland Avenue (A400).

12.2.8 The construction routing for all phases of construction at Victoria Embankment Foreshore would use the TLRN. Construction vehicles would access the site directly via the southbound carriageway of Victoria Embankment (A3211) and the access would be arranged on a 'left-turn in / left-turn out' basis. Vehicle access to and from the site would take place from the nearside lane of the southbound carriageway, which would need to be closed for periods of time during the works. The access plan and highway layout during construction plan (see separate volume of figures – Section 1) present the highway layout during construction.

12.2.9 Vehicles leaving the site would travel along the southbound carriageway of Victoria Embankment (A3211) towards Westminster Bridge (A302). Vehicles travelling east would need to cross the bridge and continue journey westbound along the A3036 towards Lambeth or eastbound along the A3200. Vehicles travelling west would turn right at the junction of Victoria Embankment (A3211) and Bridge Street (A302) and would take the A3212 northbound and southbound routes.

12.2.10 This construction vehicle routing may overlap for a period with the closure of the Blackfriars Bridge exit slip road required for part of the works at the Blackfriars Bridge Foreshore site. This is taken into account as part of this assessment.

12.2.11 The project-wide assessment in Vol 3 further discusses the combined effects of works at both the Victoria Embankment Foreshore and Blackfriars Bridge Foreshore sites.

12.2.12 Vol 17 Figure 12.2.1 (see separate volume of figures) shows the construction traffic routes for access to/from Victoria Embankment Foreshore. Construction routes have been discussed with both Transport for London (TfL) and Westminster City Council for the purposes of the assessment.

Construction workers

12.2.13 The construction site is expected to require a maximum workforce of approximately 65 workers at any one time. The number and type of workers is shown in Vol 17 Table 12.2.2.

Vol 17 Table 12.2.2 Transport – maximum estimated construction worker numbers

Contractor		Client
Staff*	**Labour****	**Staff*****
08:00-18:00	**08:00-18:00**	**08:00-18:00**
30	25	10

**Staff Contractor – engineering and support staff to direct and project manage the engineering work and site.*
***Labour – those working on site doing engineering, construction and manual work.*
****Staff Client – engineering and support staff managing the project and supervising the Contractor.*

12.2.14 At the Victoria Embankment Foreshore site there would be no parking provided within the site boundary for workers. As parking on surrounding streets is also restricted, and measures to reduce car use would be incorporated into site-specific *Travel Plan* requirements (in accordance with the overall aims and objectives of the *Draft Project Framework Travel Plan*), it is highly unlikely that workers would travel by car. It is therefore assumed that construction workers would access the site by other modes of transport, further details of which are provided in Vol 17 Table 12.5.1.

Code of Construction Practice

12.2.15 Measures incorporated into the *Code of Construction Practice (CoCP)*[i] *Part A* (Section 5) to reduce transport issues include:

a. site specific *Traffic Management Plans (TMP)*: to set out how vehicular access to the site would be managed so as to minimise impact on the local area and communicate this with the local borough and other

[i] The *Code of Construction Practice (CoCP)* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

stakeholders. This includes any works on the highway, diversion or temporary closure of the highway or public right of way

b. HGV management and control: to ensure construction vehicles use appropriate routes to the sites and the vehicle fleet and/or drivers meet current safety and environmental standards

c. site specific *River Transport Management Plans (RTMP)* are to be produced for each relevant worksite. As with the *TMP*'s this would set out how river access to site would be managed so as to minimise impact on the river and communicate this with the PLA, local borough and other stakeholders

12.2.16 In addition to the general transport measures within the *CoCP Part A*, the following transport measures have been incorporated into the *CoCP Part B* (Section 5) relating to the Victoria Embankment Foreshore site:

a. access to the site would be from Victoria Embankment with left turn into the site. Egress from the site would be left turn out travelling south

b. the site areas would be designed to maintain two-way flow for traffic along Victoria Embankment

c. construction works would maintain two lanes on both carriageways except for short durations during utility diversions where only one lane on the southbound carriageway would be maintained

d. coach parking would be temporarily restricted to enable full use of traffic lanes on southbound carriageway. Coach parking spaces would be relocated to Albert Embankment (A3036) between Tinworth Street and Black Prince Road, Millbank (A3212) between Thorney Street and Atterbury Street, or Lambeth Palace Road (A3036) to the north of Lambeth Road (A3203) / Lambeth Bridge (A3203) / Albert Embankment (A3036) / Lambeth Palace Road (A3036) roundabout. Coach parking would be removed only after alternate provision is in place

e. minimum width of traffic lanes along Victoria Embankment to be retained would be one outer lane of 3m and one inner lane of 3.25m in each direction A suitable central safety barrier would be installed between alternate direction lanes

f. site areas impact into traffic lanes extent and duration to be minimised. Traffic barriers to be moved in and out as construction progresses as TfL require minimum land take within highway

g. access to existing Embankment Pier would be maintained for both pedestrians and services. Liaison with the London River Services (Transport for London) is required

h. the diversion of the Thames Path would be clearly signed.

12.2.17 The effective implementation of the *CoCP Part A* and *Part B* measures is assumed within the assessment.

12.2.18 Based on current travel planning guidance including TfL's 'Travel planning for new development in London (TfL, 2011)[2]; this development falls within the threshold for producing a *Strategic Framework Travel Plan*. A *Draft Project Framework Travel Plan* has been prepared based on the TfL ATTrBuTE guidance (TfL, 2011)[3]; this accompanies the application. The *Draft Project Framework Travel Plan* addresses project-wide travel planning measures, including the need for a project-wide Travel Plan Manager, initial travel surveys during construction and a monitoring framework. It also contains requirements and guidelines for the site-specific *Travel Plans* to be prepared by the site contractors. The site-specific travel planning requirements of relevance to the *Draft Project Framework Travel Plan* are as follows:

a. information on existing transport networks and travel initiatives for the Victoria Embankment Foreshore site

b. a mode split established for the Victoria Embankment Foreshore site construction workers to establish and monitor travel patterns

c. site-specific targets and interim targets based on the mode share which would link to objectives based on local, regional and national policy

d. a nominated person with responsibility for managing the *Travel Plan* monitoring and action plans specifically for this site.

Operation

12.2.19 During operation, maintenance vehicles would enter and leave the site from Victoria Embankment (A3211) westbound, as set out in the Victoria Embankment Foreshore design principles (see *Design Principles* report Section 4.14 in Vol 1 Appendix B). Access would be required for a light commercial vehicle on a three to six monthly maintenance schedule. Additionally there would be more substantive maintenance visits at approximately ten year intervals which would require access to enable two mobile cranes and associated support vehicles to be brought to the site and which may require temporary restriction of on-street coach parking in the vicinity of the site. This may also require a temporary diversion of the Thames Path.

12.3 Assessment methodology

Engagement

12.3.1 Vol 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of traffic and transport are presented in Vol 17 Table 12.3.1.

12.3.2 It was reported in the *Scoping Report* that operational traffic effects for the project as a whole were scoped out of the environmental impact assessment (EIA). However, while the environmental effects associated with transport for the operational phase are not expected to be significant or adverse, the assessment of transport effects in the *Environmental Statement* examines relevant aspects of the operational phase in order to satisfy the relevant stakeholders that technical issues have been addressed.

Vol 17 Table 12.3.1 Transport – stakeholder engagement

Organisation	Comment	Response
Transport for London, Transport Assessment workshop, November 2012	Information on construction traffic associated with other Thames Tideway Tunnel project sites should be provided.	The OmniTrans outputs used in the assessment identify lorry traffic which would be associated with the Victoria Embankment Foreshore site, or with other Thames Tideway Tunnel project sites, that would use routes in the vicinity of the Victoria Embankment Foreshore site.
Westminster City Council, Section 48 consultation, October 2012	Westminster City Council are also concerned that, at the time of Section 48 publicity, there were and remain significant gaps in project-wide and site specific environmental impacts assessments, and the ongoing need for further consultation on the Code of Construction Practice (Part B), Cumulative Impacts and *Transport Assessments*.	Draft versions of the site-specific and project-wide *Transport Assessment* were provided in October/November 2012 and comments were received from TfL.
PLA, Section 48 consultation, October 2012	The PLA has not seen the evidence to suggest that the impact of the works, both temporary and permanent, on river passenger services would be negligible and furthermore what assessment has been undertaken as to the impacts on commercial river users.	The impact of the Thames Tideway Tunnel project on the river passenger services have been assessed as described in Section 12.5.
Westminster City Council, Coach parking meeting, September and October 2012 Phase two consultation, February 2012 Consultation	Victoria Embankment is almost fully utilised for coach parking – alternative locations will be needed.	Coach parking bays would be relocated temporarily to Albert Embankment (A3036) between Tinworth Street and Black Prince Road, to Millbank (A3212) between Thorney Street and Atterbury Street, or to Lambeth Palace Road (A3036) to the north of Lambeth Road (A3203) / Lambeth Bridge (A3203) / Albert

Organisation	Comment	Response
workshop, September 2011		Embankment (A3036) / Lambeth Palace Road (A3036) roundabout and would be reinstated to the baseline situation following the construction works. The temporary relocation of these coach parking bays has been discussed with TfL and Westminster City Council.
Transport for London, TfL meeting, September 2012 Consultation workshop, October 2011	Discussions required with TfL in relation to coach relocation – both in temporary and permanent situation. Alternatives such as temporary suspension for planned works to be considered.	Coach parking bays would be relocated temporarily to Albert Embankment (A3036) between Tinworth Street and Black Prince Road, to Millbank (A3212) between Thorney Street and Atterbury Street, or to Lambeth Palace Road (A3036) to the north of Lambeth Road (A3203) / Lambeth Bridge (A3203) / Albert Embankment (A3036) / Lambeth Palace Road (A3036) roundabout and would be reinstated to the baseline situation following the construction works. The relocation of these coach parking bays has been discussed with TfL and Westminster City Council. .
Westminster City Council, Phase two consultation, January 2012 Consultation workshop, October 2011	Details for the proposed transport routes, route options, lorry holding areas and the power being sought by Thames Water to manage possible proposed changes to transport plans by contractors in the future will be required.	The proposed transport routes that have been assessed are set out in Vol 17 Figure 12.2.1 (see separate volume of figures).
Westminster City Council, Phase two consultation, February 2012 Consultation workshop, September 2011	The construction impact of the connecting tunnel should be considered as part of the assessment.	The assessment considers transport effects in the construction period with regard to construction traffic. This includes the construction of the Regent Street connection tunnel which would involve construction traffic movements.
Westminster City Council, phase	An assessment of the use of river transport for access,	As set out in the *Transport Strategy*, the assessment

Organisation	Comment	Response
two consultation, February 2012	construction and post construction works and activities compared to alternative modes of transport should be included in the *Environmental Statement*.	considers the use of river transport for cofferdam fill (import and export), shaft and other excavated material (export) at the Victoria Embankment Foreshore site. For assessment purposes, it has been assumed that 90% of these materials are taken by river.
Westminster City Council, phase two consultation, February 2012	Westminster City Council need to understand the extent of works at Northumberland Avenue and likely utility diversions.	Utility diversions have been discussed with Westminster City Council and the effects of the utility diversions have been included within the assessment.
Westminster City Council, phase two consultation, February 2012	Advanced signing is important and to be set up a suitable distance away to inform drivers of alternative routes.	No traffic diversions are proposed at this site.
Westminster City Council, phase two consultation, January 2012	Further information on the type and number of vehicles which will require access to the site in the operational phase will be required. The frequency of access will need to be considered in terms of how the pipe subway will be crossed and likely long term impacts of the crossings.	This has been taken into consideration in the operational section of the *Transport Assessment*. The impacts of loading / crossing the pipe subway are being assessed. The river wall and pipe subway may require strengthening in order to allow access to the site.
Westminster City Council, phase two consultation, January 2012	Further information on proposed transport of materials to and from the worksite is required. The City council would wish to see the maximum possible use of river transport, and details for any residual transport requirements for movement of materials by land.	The transport assessment work both informs the *Transport Strategy* and assesses the *Transport Strategy* for the purposes of the application.
Westminster City Council, phase two consultation, January 2012	There is a concern at the number of lorry visits to construction sites. It is difficult to understand how such a significant number of lorry movements can work	The transport assessment covers both the project-wide and site-specific issues. The transport assessment work for the Victoria Embankment Foreshore site includes measures to minimise

Organisation	Comment	Response
	in practice. Thames Water needs to do much more work with boroughs on minimising local disruption and agreeing site access routes.	local disruption and the site access routes have been agreed with Westminster City Council.
Greater London Authority, phase two consultation, February 2012	There is a concern on the overall impact of Chelsea Embankment Foreshore, Victoria Embankment Foreshore and Blackfriars Bridge Foreshore along Embankment with the potential to cause significant disruption to road users, pedestrians, cyclists and riverboat passengers.	This has been assessed in the site-specific transport assessments (Vols 4-27) and has been assessed in the project-wide volume (Vol 3).
Greater London Authority, phase two consultation, February 2012	Works at a number of proposed sites including Victoria Embankment will significantly impact on journey times and reliability for road users of the network, including bus services.	This has been considered within the assessment.
Westminster City Council, consultation workshop, October 2011	The impact of utility and traffic diversions should be considered as part of the construction activities and their effects assessed in relation to traffic flow, air quality, odour and dust, noise and vibration.	Utility and traffic diversions have been taken into account in the transport assessment where appropriate.
Westminster City Council, consultation workshop, October 2011	Westminster City Council is undertaking a public realm scheme which is likely to coincide with works.	Westminster City Council confirmed that no formal schemes were committed in the vicinity of the site at the time of writing.
Westminster City Council, consultation workshop, October 2011	Bus service 388 is currently only in place as part of Blackfriars diversion work. Currently proposed to be withdrawn on completion of station upgrade. Westminster City Council may want to retain.	Bus route 388 has been withdrawn from this area and the assessment has been undertaken on this basis.

Organisation	Comment	Response
Transport for London, consultation workshop, October 2011	Pedestrian crossing diversions will need to be tested for capacity, including diverted pedestrians from the southern footway.	This has been taken into consideration within the assessment.
Transport for London, consultation workshop, October 2011	During the operational phase, can the proposed crossing work in conjunction with adjacent junctions.	The crossing proposed at an earlier stage in the project no longer forms part of the design of the Victoria Embankment Foreshore site.
Transport for London, consultation workshop, October 2011	The width of the temporary lanes needs to be considered.	Two lanes in each direction would be maintained throughout the construction period with a minimum width of 3.25m for the inner lane, and 3.0m for the outer lane where applicable.
Transport for London, consultation workshop, October 2011	Central reservation – check for suitability of removing and using as temporary running lane.	There are no buried utilities that would appear to preclude the use of the central reservation as a temporary running lane, however the pavement structure and running course may need to be strengthened to take appropriate vehicle loads.
Transport for London, consultation workshop, October 2011	Request to test HGV routing from the west.	This has been undertaken as part of identifying likely construction routes for the Thames Tideway Tunnel project.
Transport for London, consultation workshop, October 2011	Utilities diversion requires additional details/ plan for consideration.	Design principles used follow TfL guidance in regards to providing a minimum highway width for HGVs and cyclists to use the highway safely. Further information is provided in the utilities phase highway layout plans (Section 1).
Transport for London, consultation workshop, October 2011	Question whether strengthening will be required for permanent access point.	All permanent access points would be designed to withstand HGV loading.
Transport for London, consultation workshop,	Ensure that the construction impact does not impede the operation of the SRN/TLRN including Victoria	Highway network operation has been considered at both strategic and local levels within the assessment (see Section 12.5).

Organisation	Comment	Response
September 2011	Embankment.	
Transport for London, consultation workshop, September 2011	During construction, could lane closures be carried out without the use of hoarded lanes as they are a temporary condition.	Temporary lane closures would be needed for lorry entry / exit during site construction. Permanent hoarding would only be required during utilities diversion works. During site construction cones/water-filled barriers would be used.

Baseline

12.3.3 The baseline methodology follows the methodology described in Vol 2. There are no site specific variations for identifying the baseline conditions for this site.

Construction

12.3.4 The assessment methodology for the construction phase follows that described in Vol 2. There are no site-specific variations for undertaking the construction assessment of this site.

12.3.5 The effect of all other Thames Tideway Tunnel project sites on the area surrounding Victoria Embankment Foreshore has been taken into account within the assessment of the peak year of construction at this site.

12.3.6 As indicated in the site development schedule (see Vol 17 Appendix N), all of the other developments identified within 1km of the Victoria Embankment Foreshore site would be complete and operational by the peak construction year forming part of the base case, with the exception of St James's Market which would still be under construction. This means that there are cumulative effects to assess, however, it is noted that the TfL Highway Assignment Models (HAM) have been developed using GLA employment and population forecasts, which are based on the employment and housing projections set out in the *London Plan 2011* (GLA, 2011)[4]. As a result the assessment inherently takes into account a level of future growth and development across London.

Construction assessment area

12.3.7 The assessment area for the Victoria Embankment Foreshore site includes the site access directly from Victoria Embankment (A3211) which is a part of the TLRN. The junctions of Victoria Embankment (A3211) with Northumberland Avenue (A400) and Horse Guards Avenue have also been assessed.

12.3.8 These roads and junctions have been assessed for highway, cycle and pedestrian impacts. The Thames Path has been included within the assessment due to its proximity to the development site. Effects on local bus services within 640m of the site and rail services within 960m of the site have also been assessed[ii].

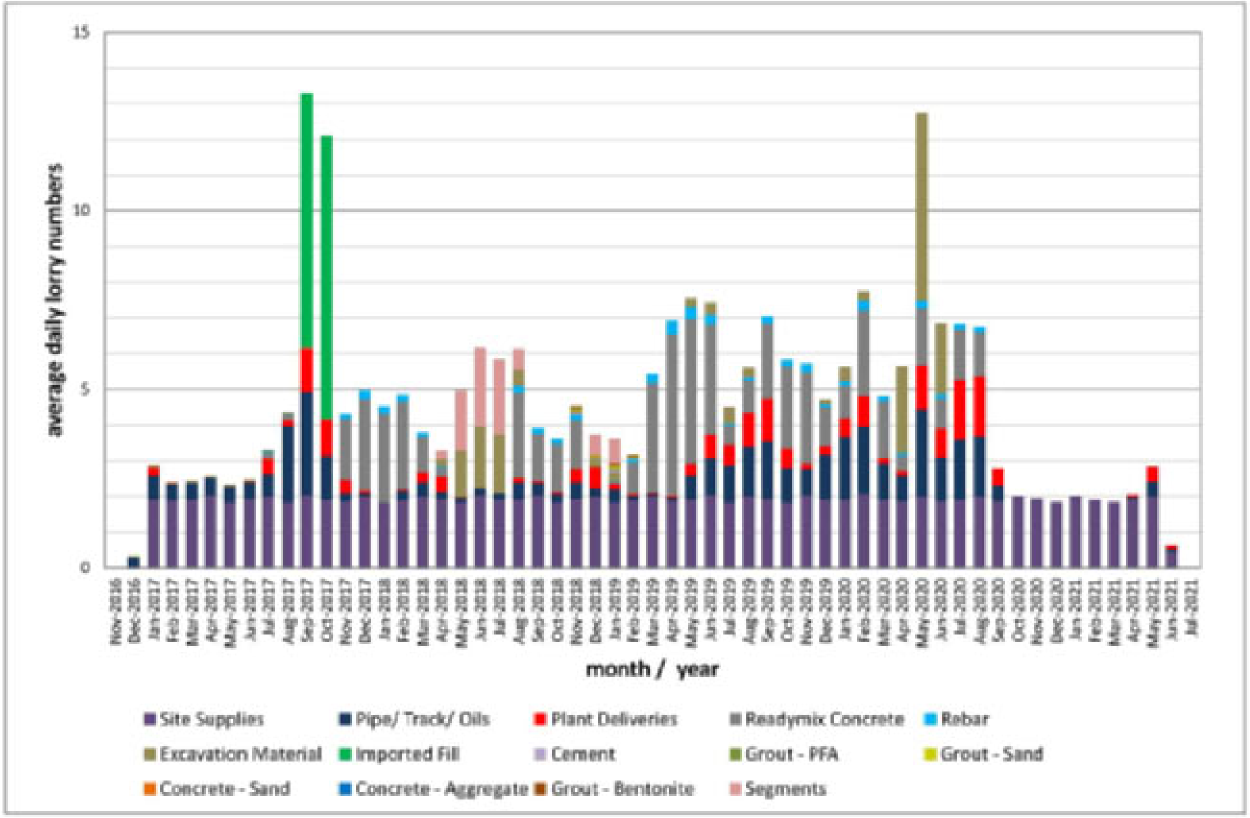
Construction assessment year

12.3.9 A site-specific peak construction assessment year has been identified for this site. The histograms in Vol 17 Plate 12.3.1 and Vol 17 Plate 12.3.2 show that the peak site-specific activity at the Victoria Embankment Foreshore site would occur in Site Year 1 of construction.

12.3.10 The assessment of construction effects also considers the extent to which the assessment findings would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

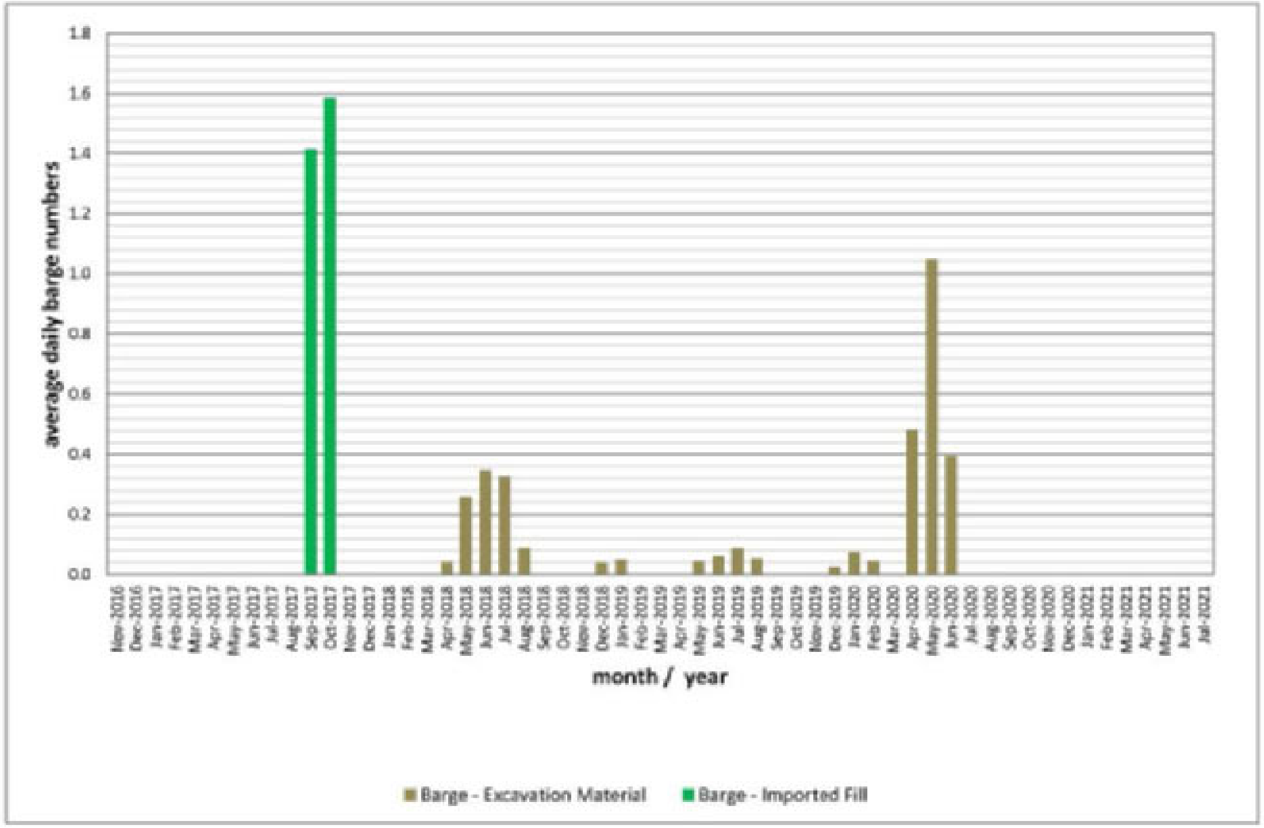
[ii] Distances derived from the Public Transport Accessibility Level (PTAL) methodology described in Vol 2.

Vol 17 Plate 12.3.1 Transport – estimated construction lorry profile



Note: Plate shows approximate volumes and number of lorry trips based upon assumed timings for the works. It is not a programme and remains subject to change.

Vol 17 Plate 12.3.2 Transport – estimated construction barge profile



Note: Plate shows approximate volumes and number of barge trips based upon assumed timings for the works. It is not a programme and remains subject to change.

Operation

12.3.11 The assessment methodology for the operational phase follows that described in Vol 2. There are no site-specific variations for undertaking the operational assessment of this site.

12.3.12 Once the Thames Tideway Tunnel project is operational it is not expected that there would be no significant effects on the transport infrastructure and operation within the local area, because maintenance trips to the site would be infrequent and short-term. On this basis it is not necessary to assess the effects on all the elements listed at para. 12.1.2. The only elements considered are:

a. effects on coach parking

b. effects on highway layout and operation.

12.3.13 These elements are considered qualitatively (as described in Vol 2) because the minimal effect on the highway network means that a quantitative assessment is not required. The scope of this analysis has been discussed with Westminster City Council and TfL.

12.3.14 Also, given the level of transport activity associated with the Thames Tideway Tunnel project during the operational phase, only the localised transport effects around the Victoria Embankment Foreshore site are assessed. Other Thames Tideway Tunnel project sites would not alter the local effects around the site and they are not considered in the assessment.

12.3.15 With regard to other developments in the vicinity of the site, all the developments detailed in Vol 17 Appendix N (site development schedule) would be complete and operational by Year 1 of operation meaning that they have been included within the operational base case. This takes into consideration the effects on highway layout, operation and parking. There are no operational cumulative effects requiring assessment.

Operational assessment area

12.3.16 The assessment area for the operational assessment remains the same as for the construction assessment as set out in paras. 12.3.7 and 12.3.8.

Operational assessment year

12.3.17 As outlined in Vol 2 the operational assessment year has been taken as Year 1 of operation. As the number of vehicles movements associated with the operational phase is low, there is no requirement to assess any other year beyond that date.

12.3.18 As with construction, the assessment of operational effects also considers the extent to which the assessment findings would be likely to be materially different should the programme for the Thames Tideway Tunnel project (and hence opening year) be delayed by approximately one year.

Assumptions and limitations

12.3.19 The general assumptions and limitations associated with this assessment are presented in Vol 2.

Assumptions

12.3.20 Local junction modelling for the construction base and development cases at this site has incorporated traffic signal optimisation on the basis that this would be implemented as necessary by TfL (as part of routine management) to ensure the effective operation of the highway network and respond to changes in traffic conditions.

12.3.21 There would be deliveries of fuel for construction plant to the site and a number of construction products may be classified as hazardous. For the Victoria Embankment Foreshore site, it is assumed that there would be one hazardous load per fortnight generated by the site.

12.3.22 With regard to construction workers travelling to the site it is assumed that no construction workers would drive to the site, as set out in para. 12.5.3.

Limitations

12.3.23 There are no site-specific limitations of the transport assessment undertaken for this site.

12.4 Baseline conditions

12.4.1 The following section sets out the baseline conditions for transport within and around the site. Future baseline conditions (base case) are also described.

Current baseline

12.4.2 Vol 17 Figure 12.4.1 (see separate volume of figures) provides a transport site location plan for the Victoria Embankment Foreshore site. There is road access to the site directly off Victoria Embankment (A3211) which forms part of the TLRN.

Pedestrian routes

12.4.3 The existing pedestrian network and facilities in the vicinity of the site are shown in Vol 17 Figure 12.4.2 (see separate volume of figures). Victoria Embankment (A3211) provides a continuous north-south link for pedestrians along the north bank of the River Thames. Victoria Embankment (A3211) starts at Westminster Bridge, and follows the course of the north bank, past Hungerford Bridge and Waterloo Bridge, before ending at Blackfriars Bridge.

12.4.4 The footways along either side of Victoria Embankment (A3211) are wide, between 4m and 11m, and have viewing / rest points located along the riverside footway every 10-20m.

12.4.5 Signalised pedestrian crossings are provided at the junction of Victoria Embankment (A3211) and Northumberland Avenue (A400) with dropped kerbs at all crossing points.

12.4.6 Additional pedestrian crossing facilities are provided to the west and south of the junction of Victoria Embankment (A3211) and Horse Guards Avenue.

12.4.7 A pedestrian crossing facility is located on Victoria Embankment (A3211) to the north of the site in front of Embankment Underground station to aid east-west pedestrian movements. Further to the north, a zebra crossing is provided on Victoria Embankment (A3211) in front of Savoy Pier.

12.4.8 The Thames Path runs along the riverside footway of Victoria Embankment (A3211), adjacent to the river. The Thames Path continues to the north along Victoria Embankment (A3211) and Paul's Walk, under Blackfriars Bridge, and to the south along Bridge Street (A302) and St Margaret Street (A302).

Cycle facilities and routes

12.4.9 The existing cycle network and facilities in the vicinity of the site are shown in Vol 17 Figure 12.4.2 (see separate volume of figures).

12.4.10 The nearest main cycle route to the site is National Cycle Network (NCN) Route 4 (on road) which routes through central London along Chelsea Embankment (A3212), Lambeth Palace Road, Belvedere Road, Upper Ground, Southwark Street (A3200) on the south side of the River Thames. Belvedere Road 900m to the southeast of the site is the closest point to NCN Route 4 from the Victoria Embankment Foreshore site.

12.4.11 An on-road cycle lane is provided along the northbound carriageway of Victoria Embankment (A3211) between its junctions with Horse Guards Avenue and Westminster Bridge Road (A302) and Bridge Street (A302).

12.4.12 Advanced cycle stop lines are provided for cyclists on the northern approach of the Victoria Embankment (A3211) / Northumberland Avenue (A400) junction, and the southern approach of the Victoria Embankment (A3211) / Horse Guards Avenue junction.

12.4.13 Five cycle stands capable of accommodating up to ten bicycles are provided on the western footway of Victoria Embankment (A3211) to the north of the junction with Northumberland Avenue (A308), outside Embankment Underground station.

12.4.14 The closest Cycle Superhighway (CS) to the site is CS8 which runs between Westminster and Wandsworth. Westminster Bridge 600m to the south of the site is the closest point to CS8 from the Victoria Embankment Foreshore site.

12.4.15 The closest cycle hire docking station is located on Victoria Embankment (A3212) to the north of the junction with Horse Guards Avenue in the northbound carriageway and accommodates 29 bicycles. A further 45 docking spaces are provided on Northumberland Avenue (A400) to the east of the junction with Whitehall Place.

Public Transport Accessibility Level

12.4.16 The Public Transport Accessibility Level (PTAL) of the site has been calculated using TfL's approved PTAL methodology (TfL, 2010)[5] and assumes a walking speed of 4.8km/h and considers rail stations within a 12 minute walk (960m) of the site and bus stops within an eight minute walk (640m).

12.4.17 Using this methodology the site has a PTAL rating of 6b, rated as 'excellent' (with 1 being the lowest accessibility and 6b being the highest accessibility).

12.4.18 Vol 17 Figure 12.4.3 (see separate volume of figures) shows the public transport network around the Victoria Embankment Foreshore site.

Bus routes

12.4.19 As shown in Vol 17 Figure 12.4.3 (see separate volume of figures), a total of 20 daytime bus routes and 28 night bus routes operate within a 640m walking distance of the site.

12.4.20 The following bus routes operate from the bus stops indicated:

a. Northumberland Avenue bus stop on Northumberland Avenue (A400) – northbound and southbound, 410m to the northwest

b. Whitehall Horse Guards bus stop on Whitehall (A3212) – northbound and southbound, 420m west of the site

c. Charing Cross Station bus stop on Strand (A4) – northbound and southbound, 550m northwest of the site

d. Trafalgar Square bus stop on Cockspur Street – eastbound and westbound, 585m northwest of the site

e. Embankment Station bus stop on Victoria Embankment (A3211) – northbound and southbound, 620m north of the site

12.4.21 These routes would also serve other stops further from the site as shown on Vol 17 Figure 12.4.3 (see separate volume of figures).

12.4.22 On average there are 402 daytime bus services in total per hour in the AM peak and 400 bus services in total per hour in the PM peak within a 640m walking distance of the site.

12.4.23 There are approximately 44 night-time bus services per hour Monday – Friday between 00:00 – 06:00 and a total of 50 night-time bus services per hour on Saturdays between 00:00 – 06:00 (two-way direction) within a 640m walking distance of the site.

London Underground

12.4.24 Embankment, Charing Cross, and Westminster Underground stations are located within a 960m walking distance of the site to the north, west, and south of the site respectively.

12.4.25 As shown on Vol 17 Figure 12.4.3 (see separate volume of figures), Embankment Underground station, which is served by the Northern, Bakerloo, Circle and District lines, is located approximately 200m walking distance to the north of the site. Charing Cross Underground station is located approximately 420m walking distance to the northwest of the site and is served by the Northern and Bakerloo lines, and Westminster Underground station is 520m walking distance to the south of the site and is served by the Jubilee, Circle and District lines.

12.4.26 Northern Line trains from Charing Cross and Embankment Underground stations travel north to High Barnet and Edgware, and south to Kennington and Morden. The AM and PM peak frequencies of the Northern Line trains from Embankment and Charing Cross Underground stations are approximately one every two to five minutes providing 20-24 services per hour in each direction. Bakerloo Line trains travel north to Harrow and Wealdstone and south to Elephant and Castle with AM and PM peak frequencies of approximately one every two to five minutes providing 20-24 services per hour in each direction.

12.4.27 Circle Line trains from Westminster Underground station travel clockwise to Edgware Road and anti-clockwise to Hammersmith, with AM and PM peak frequencies of approximately one every eight to 12 minutes providing five to eight services per hour in each direction. District Line trains travel west to Edgware Road, Ealing Broadway, Richmond, Wimbledon, and Kensington (Olympia), and east to Upminster with AM and PM peak frequencies of approximately one every two to six minutes providing 12-20 services per hour in each direction.

12.4.28 In the AM and PM peak hours, the frequency of the Jubilee Line trains from Westminster Underground station is approximately one every two to five minutes providing 20-24 services per hour towards Stanmore, and one every two to four minutes providing 20-24 services per hour towards Stratford.

12.4.29 On average there are 322 and 324 Underground services in total during each of the AM and PM peak hours respectively within a 960m walking distance of the site.

National Rail

12.4.30 The closest National Rail station to the site is Charing Cross, located approximately 420m walking distance to the northwest of the site.

12.4.31 Charing Cross provides access to Southeastern train services to and from Hastings, Dartford, Ramsgate, Dover Priory and Ashford (Kent).

12.4.32 In the AM peak hour there are approximately 43 services (23 arrivals and 20 departures). In the PM peak hour there are approximately 44 services (19 arrivals and 25 departures).

River passenger services

12.4.33 There are four piers within walking distance of the site which provide river passenger services. Westminster Millennium Pier lies 450m south of the site and Embankment Pier is 200m north of the site on the north bank of the River Thames. London Eye Millennium Pier and Festival Pier are located on the opposite side of the river, some 600m walk upstream and 580m walk downstream of the site respectively. Walking distances between the site and these two piers are considerably longer than the direct distance as it is necessary to cross the river at Westminster Bridge or the Golden Jubilee footbridge. Savoy Pier is located 450m to the northeast of the site but scheduled river bus services no longer stop at this pier.

12.4.34 Westminster Millennium, London Eye Millennium and Embankment Piers are used for both river bus and leisure cruise services, while Festival Pier is used only by leisure cruise services. These river services are shown on Vol 17 Figure 12.4.3 (see separate volume of figures).

12.4.35 The closest pier, Embankment Pier, is served by Thames Clippers and Thames Executive Charters services. Thames Clippers services run between Embankment and London Eye Millennium Piers in the west and Woolwich Arsenal Pier in the east. During the AM and PM weekday peaks, there is a frequency of approximately one Thames Clipper service every 20-25 minutes in the westbound direction and one every 30 minutes in the eastbound direction. During the PM peak hour, the number of services increases to three with a frequency of one every 20 minutes. The frequency of both eastbound and westbound services during the weekend is approximately one every 20 minutes in peak hours.

12.4.36 Embankment Pier is also served by Thames Executive Charters and Bateux London. Thames Executive Charters serves Putney Pier to the west and Blackfriars Millennium Pier in the northeast. Onward connections can be made at Blackfriars Millennium Pier for eastbound piers as far as Woolwich Arsenal. Bateux London is a leisure cruise service that has three scheduled departures a day for specific breakfast, lunch and dinner cruises.

River navigation and access

12.4.37 With respect to the number of vessels passing the Victoria Embankment Foreshore site, it is estimated that the peak hour is between 15:00 and 16:00, Monday to Friday. During this hour it is estimated that about 32 vessels typically pass the site. This figure is not constant as freight vessel transit patterns are influenced by the rising and falling tide. Therefore, such a peak will only occur every 10 to 12 days when the tide is at its highest[6].

Parking

12.4.38 Vol 17 Figure 12.4.4 (see separate volume of figures) shows the locations of the existing car parks, car club spaces and coach parking within the vicinity of the site.

Existing on-street car and motorcycle parking

12.4.39 There are ten pay and display parking bays along Victoria Embankment (A3211) (westbound) between Savoy Pier and Embankment Underground station. There are a further ten pay by phone parking bays along Northumberland Avenue (A400).

12.4.40 There are a total of 68 resident car parking bays on Whitehall Court and Whitehall Place. Two blue badge parking bays are provided along Whitehall Place.

12.4.41 A free motorcycle parking bay is located along Victoria Embankment (A3211) (northbound) to the south of the junction with Northumberland Avenue (A400) which accommodates 30 motorcycles. A further motorcycle parking bay is located along Victoria Embankment (A3211) (northbound) close to Savoy Pier which accommodates 11 motorcycles.

12.4.42 A pay by phone motorcycle parking bay is located along Northumberland Avenue (A400) to the west of the junction with Craven Street. The bay accommodates 23 motorcycles.

Existing off-street/private car parking

12.4.43 The nearest off-street council car park to the site is approximately 500m walking distance to the west of the site on Spring Gardens. The 24-hour car park is managed for the City of Westminster by Q-Park and it has 205 car spaces and 58 motorcycle spaces.

Coach parking

12.4.44 A coach parking bay is provided on Victoria Embankment (A3211) (northbound) to the south of the junction with Northumberland Avenue (A400). The parking bay accommodates two coaches.

12.4.45 Seven coach parking bays are located along Victoria Embankment (A3211) (southbound) to the south of the junction with Northumberland Avenue (A400), and a further eight coach parking bays are located to the south of the junction with Horse Guards Avenue (southbound).

12.4.46 Along Victoria Embankment (A3211), close to Savoy Pier, two coach parking bays are located in the northbound direction and five bays are located in the southbound direction.

Car clubs

12.4.47 There are currently no car club parking spaces within a 640m walking distance of the site.

Servicing and deliveries

12.4.48 Two loading bays are located along Victoria Embankment (A3211), one to the north of the junction with Northumberland Avenue (A400) in the northbound carriageway approximately 300m walking distance to the north of the site, and one to the south of the junction with Savoy Place in the southbound carriageway on Victoria Embankment (A3211), approximately 500m walking distance to the north of the site.

12.4.49 Additionally, a loading bay with double yellow lines is located along Northumberland Avenue (A400) to the west of the junction with Great Scotland Yard, outside Club Quarters, approximately 360m walking distance to the northwest of the site.

Taxis

12.4.50 The nearest taxi ranks to the site are located on Whitehall Place (150m walking distance) and Whitehall Court (200m walking distance) with one taxi rank provided on each road, each accommodating two taxis.

Highway network and operation

12.4.51 Victoria Embankment (A3211) forms part of the TLRN and is a wide dual carriageway. A 30mph speed limit applies and the road is suitable for HGVs and long vehicles. The road links to New Bridge Street (A201), Blackfriars Bridge (A201) and Upper Thames Street (A3211) 1.4km to the northeast, and Bridge Street (A302) and Westminster Bridge Road (A302) 500m to the southwest.

12.4.52 Victoria Embankment (A3211), northbound and southbound, separates into three lanes on the approach to the signalised junction with Northumberland Avenue (A400). It then reduces to one (wide) lane in the southbound carriageway of Victoria Embankment (A3211) immediately having passed through the junction with Northumberland Avenue (A400).

12.4.53 Northumberland Avenue (A400) is a single carriageway with two lanes on the approach and two lanes on the exit from the junction with Victoria Embankment (A3211). Northumberland Avenue (A400) is not part of TLRN or SRN.

12.4.54 There are a number of signalised junctions along Victoria Embankment (A3211) to the north of the site including Northumberland Avenue (A400), Temple Place, and Savoy Street. The signalised junction of Victoria Embankment (A3211) and Horse Guards Avenue is located to the south of the site.

Data from third party sources

Description of data

12.4.55 The following data have been sourced from TfL:

a. five year accident data on roads within the vicinity of the site

b. Automatic Traffic Counts (ATCs)

c. TRANSYT 12 model of Victoria Embankment and associated junction movement data.

Accident analysis

12.4.56 A total of eight serious accidents and 41 slight accidents have occurred in the Victoria Embankment Foreshore assessment area over the five year accident data analysed. There have been no fatal accidents.

12.4.57 Of the total accidents, three involved light goods vehicles (LGVs) and two involved medium goods vehicles (MGVs), all of which were slight accidents.

12.4.58 In total, 18 pedestrians were involved in the accidents. Of these eight were recorded as serious and ten as slight accidents.

12.4.59 Of the total accidents, three accidents involved cyclists of which all were classified as slight.

12.4.60 On Victoria Embankment (A3211) between the junction with Horse Guards Avenue and the entrance to Embankment Gardens there have been a total of 44 accidents including those at the junctions. Of the total accidents, eight were classified as serious and the remaining 36 accidents were recorded as slight.

12.4.61 Of the five years of accident data analysed none of the accidents happened as a result of the road geometry.

Traffic flow data analysis

12.4.62 ATC data for Victoria Embankment (A3211) were obtained from TfL and analysed to identify the traffic flows along the road in 2011. The weekday vehicle flows for a 12-hour period (07:00-19:00) shows that the PM peak for Victoria Embankment (A3211) is the busiest hour with a two-way flow of approximately 3,225 vehicles.

12.4.63 In addition, junction movement data and a TRANSYT model for Victoria Embankment (A3211) were also obtained from TfL and analysed to validate the traffic surveys undertaken in 2011 for the project.

12.4.64 Junction movement data from TRANSYT model indicate that there is a total flow of 2,919 and 3,438 vehicles in the AM and PM peak hours respectively using Victoria Embankment (A3211) / Northumberland Avenue (A400) junction with a predominant traffic flow of 1,031 and 1,254 vehicles along the southbound carriageway of Victoria Embankment (A3211) in the AM and PM peak hours.

12.4.65 Junction movement data from the TRANSYT model indicate that a total traffic flow of 2,266 and 2,473 uses the junction of Victoria Embankment (A3211) and Horse Guards Avenue in the AM and PM peak hours with a predominant traffic flow of 1,093 and 1,283 vehicles along the southbound carriageway of Victoria Embankment (A3211) in the AM and PM peak hours respectively.

Survey data

Description of surveys

12.4.66 Baseline survey data were collected in May, July, and August 2011 and May 2012 to establish the existing transport movements and usage of parking in the area. Vol 17 Figure 12.4.5 (see separate volume of figures) shows the survey locations in the vicinity of the site.

12.4.67 As part of the surveys in May and July 2011, manual and automated traffic surveys were undertaken to establish specific traffic, pedestrian and cycle movements including turning volumes, queue lengths, and traffic signal timings. Parking surveys were undertaken to establish the usage of pay and display parking, coach parking, loading bays and motorcycle bays. Pedestrian and cycle movement surveys were conducted in August 2011 for the signalised pedestrian crossings at the junction of Victoria Embankment (A3211) with Northumberland Avenue (A400) and Horse Guards Avenue, and the signalised pedestrian crossing on Victoria Embankment (A3211) outside Embankment Underground station. As part of surveys in May 2012, journey time surveys were undertaken along Victoria Embankment (A3211) from Westminster Bridge into the City of London.

Results of the surveys

12.4.68 The surveys inform the baseline situation in the area surrounding the site.

Pedestrians and cyclists

12.4.69 Pedestrian surveys around the site during the AM, inter-peak, PM and weekend peak hours indicate that there is a balanced flow of pedestrians during the AM peak hour along the footway directly outside the site of approximately 90 pedestrians in each direction. During the PM peak hour the flow is considerably heavier with approximately 586 southbound pedestrians and 418 northbound pedestrians on the footway immediately outside the site.

12.4.70 To establish the pedestrian Level of Service[iii] (LoS – see Vol 2) along the footways surrounding the site, a Level of Service assessment was undertaken and the results indicate there is adequate capacity for pedestrians within the existing network. The footway immediately adjacent to the Victoria Embankment Foreshore site (ie, the eastern footway of Victoria Embankment) and the western footway of Victoria Embankment operate at LoS A during the AM and PM peak hours for pedestrians, which indicate adequate space and capacity for pedestrians to circulate without obstruction or delay. The crossings at the junction of Victoria Embankment (A3211) and Northumberland Avenue (A400) and Horse Guards Avenue operate at LoS A during the AM peak hour and LoS B during the PM peak hour indicating that there would be some restriction on pedestrian movement due to opposing pedestrian flows. However, this would not cause any considerable delay and pedestrians should generally continue to move freely.

12.4.71 During the AM peak hour, there is a heavy flow of cyclists northbound along Victoria Embankment (A3211). During the PM peak hour the predominant flow of cyclists is southbound along Victoria Embankment (A3211). Northumberland Avenue (A400) experiences moderate cycle flows during the AM and PM peak hours, with a predominant eastbound flow in the AM peak hour and balanced cycle flows during the PM peak hour.

Traffic flows

12.4.72 The ATC data have been analysed to identify the existing traffic flows along Northumberland Avenue (A400). The weekday vehicle and HGV flows for a 12-hour period (07:00-19:00) show that the AM peak for Northumberland Avenue (A400) is the busiest hour with a maximum of approximately 170 vehicles in the eastbound direction every 15 minutes.

12.4.73 The junction surveys undertaken have been validated against the TfL junction data and TRANSYT model. The traffic flows for the busiest period within the area are indicated in Vol 17 Figure 12.4.6 and Vol 17 Figure 12.4.7 (see separate volume of figures).

12.4.74 Traffic surveys indicate that there is a total traffic flow of 3,396 and 3,180 vehicles in the AM and PM peak hours respectively using the junction of Victoria Embankment (A3211) and Northumberland Avenue (A400). The predominant traffic flows are 1,254 vehicles northbound on Victoria Embankment (A3211) in the AM peak hour and 1,114 vehicles southbound on Victoria Embankment (A3211) in the PM peak hour.

Parking

12.4.75 The results of the surveys indicate that usage of the coach, loading and motorcycle parking bays along Victoria Embankment (A3211) is heavy,

---

[iii] Pedestrian Level of Service is a way of relating pedestrian densities to the degree of convenience that people experience on footways.

although there is still spare capacity available on both weekdays and at weekends during the peak and off-peak periods.

12.4.76 Surveys were also undertaken to establish the availability of pay and display parking in the vicinity of the site to understand existing occupancy and capacity. Results indicate there is ample capacity along Victoria Embankment (A3211) and Temple Place as the spaces in these locations are not heavily used for the majority of the day.

Local highway modelling

12.4.77 To establish the existing capacity on the local highway network, a scope was discussed with TfL and City of Westminster to model the junctions of Victoria Embankment (A3211) with Northumberland Avenue (A400) and Horse Guards Avenue using a TfL TRANSYT model. The baseline model accounts for the current traffic and transport conditions within the vicinity of the site and followed the methodology outlined in Vol 2.

12.4.78 The weekday AM, inter-peak, PM and weekend baseline model queues for Victoria Embankment (A3211) were compared against observed queue lengths for the peak periods (from junction surveys) to validate the TRANSYT model and ensure reasonable representation of existing conditions.

12.4.79 Vol 17 Table 12.4.1 shows the modelling outputs for the baseline case for the junction of Victoria Embankment (A3211) with Northumberland Avenue (A400) and Horse Guards Avenue. The modelling results for the junction of Victoria Embankment (A3211) with Northumberland Avenue (A400) indicate that overall, the junction is currently operating above theoretical capacity in the weekday AM peak hour and below capacity in the weekday PM peak hour.

12.4.80 The AM peak hour is the busiest with maximum queues of approximately 45 vehicle lengths on the Victoria Embankment northbound ahead movement. The delay to vehicles is most significant during the AM peak hour for vehicles turning right from Victoria Embankment southbound into Northumberland Avenue westbound, which currently experiences an average of 111 seconds of delay per PCU. In the PM peak hour, the maximum delay to vehicles is from Victoria Embankment (A3211) northbound turning left to Northumberland Avenue (A400) with an average of 58 seconds per PCU.

12.4.81 The overall performance of Victoria Embankment (A3211) and Horse Guards Avenue junction shows that the junction is also currently operating above capacity in the AM peak hour and below capacity in the PM peak hour. The validated model indicates that the maximum delay per PCU in the AM peak hour is along the northbound carriageway of Victoria Embankment (A3211) moving ahead with an average of 106 seconds of delay per PCU. In the PM peak hour, the delay to vehicles is most significant for vehicles turning into Victoria Embankment (A3211) from Horse Guards Avenue with an average of 63 seconds of delay per PCU.

Vol 17 Table 12.4.1 Transport – baseline TRANSYT model outputs

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (PCU)	DoS	MMQ (PCU)	Delay (seconds per PCU)	Flow (PCU)	DoS	MMQ (PCU)	Delay (seconds per PCU)
Junction of Victoria Embankment (A3211) and Northumberland Avenue (A400)									
Victoria Embankment (A3211) southbound	Right	354	95%	15	111	412	79%	11	53
	Ahead	1059	88%	31	41	1115	85%	20	25
Victoria Embankment (A3211) northbound	Ahead	1254	99%	45	55	943	71%	11	8
	Left	99	28%	3	49	73	23%	2	58
Northumberland Avenue (A400)	Left right	275	67%	8	47	249	67%	7	50
	Left	366	72%	10	43	397	84%	12	55
		PRC		**Total delay (PCU hours)**		**PRC**		**Total delay (PCU hours)**	
Overall junction performance		-10%		51		+6%		27	
Junction of Victoria Embankment (A3211) and Horse Guards Avenue									
Victoria Embankment (A3211) southbound	Right	402	72%	9	34	506	69%	13	31
	Ahead	657	52%	7	11	729	53%	9	9
Victoria Embankment (A3211) northbound	Ahead	1183	102%	55	106	843	83%	23	43
	Left	18	3%	0	26	18	4%	0	30
Horse Guards Avenue	Left right	180	51%	5	36	183	77%	6	63

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (PCU)	DoS	MMQ (PCU)	Delay (seconds per PCU)	Flow (PCU)	DoS	MMQ (PCU)	Delay (seconds per PCU)
		PRC		Total delay (PCU hours)		PRC		Total delay (PCU hours)	
Overall junction performance		-13%		43		+8%		20	

Note: DoS represents Degree of Saturation; the ratio of flow to capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes.Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with four or more axles are 2.3 PCUs. Buses and coaches are two PCUs. Motorcycles are 0.4 PCUs and pedal cycles are 0.2 PCUs.

Transport receptors and sensitivity

12.4.82 The receptors and their sensitivities in the vicinity of the Victoria Embankment Foreshore site are summarised in the table below. The transport receptor sensitivity is defined as high, medium or low using the criteria detailed in Vol 2.

12.4.83 The transport effects identified in this assessment are directly related to changes to the operation of transport networks which may occur as a result of physical changes to transport networks or of additional vessel or vehicle movements or additional public transport patronage. These changes in operation could lead to effects which would be experienced by people using those transport networks, whether as pedestrians, cyclists, public transport or private vehicle users. The assessment identifies several 'generic' groups of transport users in the list of transport receptors.

12.4.84 Receptors who are occupiers and users of or visitors to existing or committed developments in the vicinity of each of the project sites may experience transport effects on their journeys to and from those developments. In many cases those effects would be similar (or identical) to the effects identified for the 'generic' groups of transport users. However, the assessment specifically includes these receptors to ensure that any particular effects that they would be likely to experience (for instance because they make use of particular routes or transport facilities) have been identified.

Vol 17 Table 12.4.2 Transport – receptors and sensitivity

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Pedestrians and cyclists (including sensitive pedestrians[iv]) using the Thames Path and Victoria Embankment (A3211)	Construction	High sensitivity to diversions and footway closures, resulting in increases to journey times.
Private vehicle users (including taxis) in the area using the local highways or on-street parking.	Construction Operation	Medium sensitivity to increases in HGV traffic resulting in journey time delays.
Emergency vehicles travelling on Victoria Embankment (A3211)	Construction Operation	High sensitivity to journey time delays due to time constraints on journey purposes.

[iv] Sensitive pedestrians include those with mobility impairments, including wheelchair users.

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Marine emergency vehicles	Construction	High sensitivity to changes in vessel movements / moorings
Coaches and service vehicles using parking facilities and loading bays on the Victoria Embankment (A3211) southbound carriageway adjacent to the site	Construction Operation	High sensitivity to changes to parking capacity due to limited availability of parking.
Bus users (passengers) travelling along Northumberland Avenue (A400) and Victoria Embankment (A3211) north of the junction with Northumberland Avenue (A400)	Construction Operation	Medium sensitivity to journey time delays as a result of increases to traffic flows. However as these users are at a distance from the site, overall sensitivity has been rated as low.
River vessel operators and operators and passengers using Embankment Pier	Construction	Medium sensitivity to increases in passage of construction barges and changes to river service and navigation patterns
Public transport users using rail or river services within the area	Construction	Low sensitivity due to distance from the site and low numbers of construction workers
Residents in Whitehall Court, 65m west of site	Construction	High sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays.
Users of National Liberal Club, 65m west of site	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
		delays.
Commercial operators and users of bar/restaurant ship Hispaniola, 20m north of site, and bar/restaurant ship Tattershall Castle, 20m south of site (once relocated)	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays for staff and customers. Medium sensitivity in relation to servicing from Victoria Embankment carriageway (A3211). Medium sensitivity to changes in mooring operation
Users of recreational spaces at Whitehall Gardens and Victoria Embankment Gardens, 20m west of site	Construction	Low sensitivity to changes to footways and highway operations, vulnerable pedestrian groups are likely to be present (eg, children).

Construction base case

12.4.85 As described in Section 12.3 above, the construction assessment year for transport effects in relation to this site is Site Year 1 of construction.

12.4.86 There are no known proposals to change the cycle or pedestrian network by Site Year 1 of construction and it is assumed that the network will operate as indicated in the baseline situation. The LoS on the surrounding pedestrian network would remain as indicated in the baseline situation, with sufficient capacity and no obstructions to movements.

12.4.87 In terms of the public transport network, it is expected that as a result of the TfL *London Underground Upgrade Plan* (TfL, 2011)[7], compared to the current baseline, capacity will increase by approximately 20% and journey times will reduce by approximately 18% on the Northern Line. On the Jubilee Line there will be increases to capacity of approximately 33% and a reduction in journey times of approximately 22%. The *TfL Upgrade Plan* envisages a combined increase in capacity on the Circle and Hammersmith & City Line of 65% although it is clear that a significant proportion of this increase is attributed to the revised service patterns implemented in 2009, which will already be reflected in the baseline data. A 24% increase in capacity is anticipated on the District Line. Further works will take place on the Bakerloo Line to increase capacity however changes have not yet been detailed. It is envisaged that London Underground and National Rail patronage will also increase by the peak construction year.

12.4.88 In order to ensure that a busiest case scenario is addressed in assessing the result of additional construction worker journeys by public transport, the capacity for public transport services in the construction base case has been assumed to remain the same as capacity in the baseline situation. This ensures a robust assessment as outlined in Vol 2.

12.4.89 It is expected that river services between Putney and Blackfriars may increase from baseline conditions as a result of planned service changes which were being tendered at the time of writing.

12.4.90 Baseline traffic flows (from the junction surveys) have been used and forecasting carried out to understand the capacity on the highway network in the vicinity of the Victoria Embankment Foreshore site in Site Year 1 of construction without the Thames Tideway Tunnel project. The construction base case traffic flows (derived from the survey data) providing input to the TRANSYT model are shown on Vol 17 Figure 12.4.6 and Vol 17 Figure 12.4.7 (see separate volume of figures).

12.4.91 The key findings from the construction base case model for the Victoria Embankment Foreshore site indicate that there will be changes to queue lengths and average delays at the junction of Victoria Embankment (A3211) with Northumberland Avenue (A400) and Horse Guards Avenue in the construction base case, compared to baseline conditions. This includes some decreases in average delays in the AM and PM peak hours in the construction base case in comparison to the baseline situation despite of the traffic growth. This is because of the optimisation of the traffic signal timings as detailed in Vol 2.

12.4.92 Results also indicate that in the construction base case the junction of Victoria Embankment (A3211) with Northumberland Avenue (A400) would continue to operate above capacity while the junction with Horse Guards Avenue would operate below capacity

12.4.93 The base case in Site Year 1 of construction takes into account the developments described in Vol 17 Appendix N (site development schedule) anticipated to be complete and operational by Site Year 1 of construction. With regard to the identification of additional receptors associated with the other developments, the only development within 250m of the site which is relevant to the transport assessment is the London Eye Pier Extension, as detailed in Vol 17 Table 12.4.3. The London Eye Pier Extension would result in provision of a mooring for an additional vessel 140m crow-fly distance from the Victoria Embankment Foreshore site located on the opposite side of the River Thames. Impacts could be experienced by the river vessel operator as a result of the passage of construction barges and on this basis it has been taken into consideration as a receptor in the assessment.

Vol 17 Table 12.4.3 Transport – construction base case additional receptors

Receptors (relating to developments within 1km of the site)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
River vessel operator and users at the London Eye Pier extension	Construction	Medium sensitivity to increases in passage of construction barges

Operational base case

12.4.94 The operational assessment year for transport is Year 1 of operation.

12.4.95 As explained in para. 12.3.12, the elements of the transport network considered in the operational assessment are highway layout and operation and coach parking. For the purposes of the operational base case, it is anticipated that the highway layout and coach parking will be as indicated in the construction base case.

12.4.96 The operational base case, Year 1 of operation, takes into account all the developments described in Vol 17 Appendix N (site development schedule). The only development within 250m of the Victoria Embankment Foreshore site is the London Eye Pier Extension which would be complete and operational by Year 1 of operation. Given infrequent and short-term nature of maintenance activity and the limited effects which are anticipated in the operational phase, this development does not present an additional relevant transport receptor that requires consideration in the operational effects assessment.

12.5 Construction effects assessment

12.5.1 This section summarises the findings of the assessment undertaken for the peak year of construction at the Victoria Embankment Foreshore site (Site Year 1 of construction).

12.5.2 The anticipated mode split of worker trips (covering all types of construction worker as set out in Vol 17 Table 12.2.2) for Victoria Embankment Foreshore is detailed in Vol 17 Table 12.5.1 and has been generated based on 2001 Census data[v] for journeys to workplaces within the vicinity of the Victoria Embankment Foreshore site. This shows that the predominant mode of travel for construction workers would be public transport.

12.5.3 At this site there would be no parking provided within the site boundary for workers. As parking on surrounding streets is also restricted, and measures to reduce car use will be incorporated into site-specific *Travel Plan* requirements, it is highly unlikely that workers would travel by car.

[v] Based on 2001 Census as this type of data had not been released from the 2011 Census at the time of assessment.

The Census mode shares have therefore been adjusted to reflect increased levels of non-car use by workers at this site. This forms the basis of the assessment.

Vol 17 Table 12.5.1 Transport – mode split

Mode	Percentage of trips to site	Equivalent number of worker trips (based on 65 worker trips)	
		AM peak hour (07:00-08:00)	PM peak hour (18:00-19:00)
Bus	10%	7	7
National Rail	41%	27	27
Underground	40%	26	26
Car driver	<1%*	0	0
Car passenger	<1%*	0	0
Cycle	2%	1	1
Walk	4%	3	3
River	0%	0	0
Other (taxi/motorcycle)	3%	2	2
Total	100%	65	65

** Assumed to be zero for the purposes of the assessment.*

Pedestrian routes

12.5.4 The Thames Path runs along the riverside footway of Victoria Embankment (A3211) and would require closure and diversion throughout the construction works. It would be diverted to the west side of Victoria Embankment (A3211) between Horse Guards Avenue and Northumberland Avenue (A400). Pedestrians would be able to cross the road at the junctions of Victoria Embankment (A3211) with Horse Guards Avenue and at Northumberland Avenue (A400).

12.5.5 The construction phase – phase 1-5 plans (see separate volume of figures – Section 1) show the layout of pedestrian footways during construction.

12.5.6 To assess a busiest case scenario, it has been anticipated that all worker trips would finish their journeys by foot. As a result the 65 worker trips generated by the site have been added to the construction base case pedestrian flows during the AM and PM peak hours.

12.5.7 Taking into consideration the pedestrian diversions and increase in worker trips, the greatest effect would be on the western footway along Victoria Embankment (A3211) to which pedestrians would be diverted from the riverside footway of Victoria Embankment (A3211). However, the analysis shows that pedestrian LoS values would not change from those in the construction base case. The western footway of Victoria Embankment would continue to operate at LoS A, indicating free flow of pedestrian movements and no obstructions.

12.5.8 In determining the magnitude of impacts on pedestrian routes, the relevant impact criteria are pedestrian delay, pedestrian amenity and accidents and safety (as set out in Vol 2).

12.5.9 It is anticipated that the pedestrian diversions around the Victoria Embankment Foreshore site would result in a journey time increase of approximately two minutes, due to two additional crossings and extension of the journey by 40m, based on a walking speed of 1.3m/sec. This results in a medium adverse impact on pedestrian delay, for those walking along the riverside footway of Victoria Embankment (A3211). Other pedestrian movements in the area would experience a negligible impact.

12.5.10 With regard to pedestrian amenity and accidents and safety, the closure of the eastern Victoria Embankment footway would result in pedestrians having to make an additional two road crossings. On this basis, the impact magnitude for pedestrian amenity and accidents and safety would be classified as high adverse using the criteria set out in Vol 2.

12.5.11 For residents of Whitehall Court and users of the National Liberal Club and Victoria Embankment Gardens it is anticipated that there would be no increase in journey times as they would not be affected by diversion. This results in a low adverse impact on pedestrian delay. The impact on pedestrian amenity would also be low adverse due to no change to the footway routes. The impact on pedestrian accident and safety would be classified as medium adverse due to the diversion route increasing pedestrians crossing Victoria Embankment (A3211).

Cycle facilities and routes

12.5.12 The relevant impact criteria for determining the magnitude of impacts on cycle facilities and routes are cycle delay and accidents and safety (as set out in Vol 2).

12.5.13 Cyclists using the highway would experience an additional delay to journey time as a result of the construction works at the Victoria Embankment Foreshore site. The effect on journey times is identified in the highway operation and network assessments and would be an increase of a maximum of five seconds per PCU at the junction of Victoria Embankment (A3211) and Northumberland Avenue (A400) and a maximum of 12 seconds per PCU at the junction of Victoria Embankment (A3211) and Horse Guards Avenue over that in the construction base case. This represents a negligible impact.

12.5.14 With regard to accidents and safety, cyclists would not be required to make any additional road crossings as a result of the construction works at the Victoria Embankment Foreshore site. During the construction period, from time to time as required by the construction works, an intermittent lane closure of one lane would be required on Victoria Embankment (A3211) to accommodate construction vehicles arriving at and departing from the site. Cyclists would remain on the carriageway and minimum lane widths of 3.25m for the inside lanes in both directions would be maintained. This represents a low adverse.

12.5.15 Measures set out in the *CoCP* (Section 5) described in para. 12.2.16 include increasing driver awareness of restrictions on the road network and marshalling of traffic at the site access. During all construction work and on any section of road subject to temporary diversions or restrictions imposed by road works associated with the Victoria Embankment Foreshore site, the risk to all road users would be managed by the contractor(s) in accordance with the provision made under the *Traffic Signs Manual Chapter 8 – Traffic Safety Measures and Signs for Road Works*. This would include compliance with TfL guidance (*Cyclists at Roadworks – Guidance* (DfT, 1999)[8]) to ensure safe passage for cyclists.

Bus routes and patronage

12.5.16 No bus services run immediately past the site. However, additional construction vehicles serving the site and the traffic management arrangements along Victoria Embankment (A3211) may affect some bus journey times further east along Victoria Embankment (A3211) after the junction with Northumberland Avenue (A400), as well as on Northumberland Avenue (A400) and within the wider area. The effect on journey times is detailed in the highway operation and network assessment and would be an increase of a maximum of five seconds per PCU at the junction of Victoria Embankment (A3211) and Northumberland Avenue (A400) and a maximum of 12 seconds per PCU at the junction of Victoria Embankment (A3211) and Horse Guards Avenue. This represents a negligible impact.

12.5.17 It is expected that approximately seven additional two-way worker trips would be made by bus during the AM and PM peak hours, which would result in less than one worker trip per bus (based on a service of 402 buses and 400 buses within a 640m walking distance during the AM and PM peak hours respectively).

12.5.18 Based on the impact criteria outlined in Vol 2, the additional worker trips made by bus in peak hours would have a negligible impact on bus patronage.

London Underground and National Rail and patronage

12.5.19 No underground or rail stations are directly adjacent to the site and therefore none would be directly affected by the construction site development. It is anticipated that approximately 53 construction workers and labourers would use London Underground or National Rail services to access the site which would result in 27 additional person trips on National Rail services and 26 additional person trips on London Underground services in each of the AM and PM peak hours.

12.5.20 On London Underground services this equates to less than one person per train during the AM and PM peak hours based on a frequency of approximately 320 trains during the peaks. On National Rail services there would be approximately one additional passenger per train based on the AM peak hour service of 23 arrivals and PM peak hour service of 25 departures.

12.5.21 Based on the quantitative assessment of patronage and the impact criteria on rail patronage in Vol 2, this would result in a negligible impact on London Underground and National Rail patronage.

River passenger services and patronage

12.5.22 To facilitate construction works, the Tattershall Castle, a permanently moored bar/restaurant vessel, would be moved to a new location upstream of the construction site. The Hispaniola would remain in its current location.

12.5.23 In determining the magnitude of impacts on patrons of these two moored vessels, the relevant impact criteria are pedestrian delay and pedestrian amenity which are described in paras. 12.5.4 to 12.5.10. This indicates a medium adverse impact on pedestrian delay due to the diversions of pedestrians around the Victoria Embankment Foreshore site, and a high adverse impact on pedestrian amenity.

12.5.24 In terms of impact on operators of these two vessels the relevant impact criterion is parking and loading which is discussed in paras. 12.5.32 to 12.5.40. This describes a medium adverse impact on parking and a low adverse impact on loading.

12.5.25 During construction, no river passenger services would be directly affected. There may be some operational changes to the path and location that the vessels take to berth on and off the pier but this would not affect the service timetable. It is anticipated that very few construction workers and labourers would use the river services to access the construction site. In accordance with the impact criteria for river patronage set out in Vol 2, this would result in a negligible impact on river passenger service patronage.

River navigation and access

12.5.26 This section addresses the effects on river navigation and access in the vicinity of the Victoria Embankment Foreshore site. The wider effects of transporting construction materials by river from a number of sites within the project are dealt with in Vol 3.

12.5.27 During construction it is intended that the cofferdam fill (import and export), shaft excavated and ‘other’ material (export) would be transported by barge. For assessment it is assumed that 90% of these materials would be transported by river to take into account periods where river transport is unavailable or the material is unsuitable. The peak number of barge movements would be within Site Year 1 of construction with a daily average of four barge movements a day.

12.5.28 Barges would be hauled by tugs which may haul two barges at a time where possible. The number of transit movements required on the river may therefore be lower than the number of individual barge movements.

12.5.29 Due to the low number of barges arriving at the site and based on the impact criteria outlined in Vol 2, it is anticipated that the impact on river navigation and access in the vicinity of the site as a result of the barges arriving at Victoria Embankment Foreshore would be negligible.

12.5.30 Based on the mooring impact criteria for river navigation and access as outlined in Vol 2, the impact on the operator of Tattershall Castle would be low adverse due to the relocation of the vessel and the impact on Hispaniola would be negligible due to no change to the location of the vessel.

12.5.31 It is noted that a separate *Navigational Issues and Preliminary Risk Assessment* has been undertaken for the permanent structures and temporary construction works and barges to be used at the Victoria Embankment Foreshore site. This is reported separately outside of the *Environmental Statement* and *Transport Assessment* and accompanies the application.

Parking

12.5.32 Parking for five essential construction site operations and contractor activity operation vehicles would be provided on site. However, there would be no on-site parking for workers and *Travel Plan* measures would discourage workers from travelling by car to and from the site. Additionally, parking on the surrounding streets is restricted as Victoria Embankment (A3211) does not have any on-street car parking available due to TLRN restrictions in the area. Therefore there would be no impact on on-street parking or private parking in the vicinity of the site due to the changes to local roads during the construction phase.

12.5.33 To accommodate the site access and the diversion of traffic along Victoria Embankment (A3211) during construction works, nine coach parking bays (operational from 08:30 to 00:00) would however require temporary relocation, seven from the southbound carriageway and two from the northbound carriageway. The coach parking bays in the northbound carriageway would be reinstated to their baseline locations following the utility diversions; however, the coach parking bays in the southbound carriageway would be temporarily restricted throughout the construction period.

12.5.34 The alternative locations for coach parking spaces would be on Albert Embankment (A3036) between Tinworth Street and Black Prince Road, on Millbank (A3212) between Thorney Street and Atterbury Street, or on Lambeth Palace Road (A3036) to the north of Lambeth Road (A3203) / Lambeth Bridge (A3203) / Albert Embankment (A3036) / Lambeth Palace Road (A3036) roundabout. Following the construction works, the coach parking bays would be reinstated to their original location. The relocation of these coach bays has been discussed with TfL and Westminster City Council.

12.5.35 The existing coach parking bays along Victoria Embankment (A3211) between the junctions with Richmond Terrace and Horse Guards Avenue, and to the south of the junction with Savoy Place would be used for drop-off and picking-up passengers and the coach parking bays mentioned in para. 12.5.34 would be used a coach waiting area. The proposed relocation would increase the distance passengers would have to walk from Victoria Embankment (A3211) by between 200m and 400m, but would result in only a slight increase to journey times for coaches using the relocated bays.

12.5.36 In determining the magnitude of impacts on parking, the relevant criteria are vehicle parking and loading changes (as set out in Vol 2).

12.5.37 The temporary relocation of the coach bays over 400m from their existing location equates to a medium adverse impact.

12.5.38 The loading bay in the southbound carriageway to the north of the coach parking bays would also be temporarily restricted during the construction works to enable the diversion around the construction site. The loading bays on Victoria Embankment (A3211) to the north of its junction with Northumberland Avenue (A400) and to the south of the junction with Derby Gate would be utilised as an alternative during this period. This would result in a medium adverse impact on the loading facilities as the alternatives would be between 200m and 300m of the moored vessels Tattershall Castle and Hispaniola.

12.5.39 The motorcycle bay in the northbound carriageway of Victoria Embankment (A3211) to the south of its junction with Northumberland Avenue (A400) would be restricted temporarily during the utility diversion works. This would result in a medium adverse impact on the motorcycle parking bay as there would be equivalent spare capacity in the local area to the site and the alternative would be within 200m of the existing facility.

12.5.40 The highway layout during construction – phases 1-5 plan (see separate volume of figures – Section 1) summarise the proposed restriction of coach and motorcycle parking bays associated with the construction works at the Victoria Embankment Foreshore site.

Highway network and operation

12.5.41 The highway layout during construction – phases 1-5 plan (see separate volume of figures – Section 1) shows the highway layout during the construction works at the Victoria Embankment Foreshore site. The site is on the eastern side of Victoria Embankment (A311) and would be accessed from the southbound lane. The highway layout during construction vehicle swept path analysis plans (see Victoria Embankment Foreshore *Transport Assessment* Figures) demonstrates that construction vehicles are able to safely enter and leave the site.

12.5.42 During the early stages of utility diversion works, the central reservation would be removed and lane widths would be reduced to allow two lanes in the northbound carriageway and two lanes in the southbound carriageway of Victoria Embankment (A3211) to continue to operate. The width of the inside lane would be 3.25m and the outside lane would be 3m in each direction. For short periods it may be necessary to reduce the southbound carriageway of Victoria Embankment (A3211) to a single lane to undertake construction works. This would take place outside of peak hours or overnight; therefore, this has not been modelled.

12.5.43 During the later stages of utility diversions, the required working area would be smaller and the northbound lanes of Victoria Embankment

(A3211) would be reinstated to their existing lane widths and the southbound lanes would continue to operate at 3.25m and 3m.

12.5.44 During phases 1-4 of construction, intermittent closure of one southbound lane would be required; however, two-way traffic would be maintained throughout the works. From time to time as required by the construction works, a 3.8m wide lane would be created on the nearside lane of the southbound carriageway of Victoria Embankment (A3211) to accommodate construction vehicles arriving and departing from the site.

12.5.45 Phase 5 of construction would involve removal of all the temporary traffic restrictions along Victoria Embankment (A3211) and the highway layout would be reinstated to the baseline condition.

12.5.46 There would be a gated access for the left-turn in / left turn out movement for construction traffic travelling southbound along Victoria Embankment (A3211). Construction lorry movements would be limited to the day shift only (08:00 to 18:00 Monday to Friday, 08:00 to 13:00 Saturday).

12.5.47 Vol 17 Table 12.5.2 shows the construction lorry movement assumptions for the local peak traffic periods. These are based on the peak months of construction activity at this site.

Vol 17 Table 12.5.2 Transport – peak construction works vehicle movements

Vehicle type	Vehicle movements per time period				
	Total daily	07:00 to 08:00	08:00 to 09:00	17:00 to 18:00	18:00 to 19:00
Construction lorry vehicle movements 10%*	28	0	3	3	0
Other construction vehicle movements**	36	4	4	4	4
Worker vehicle movements***	nominal	0	0	0	0
Total	**64**	**4**	**7**	**7**	**4**

** The assessment has been based on 10% of the daily construction lorry movements associated with materials taking place in each of the peak hours.*
*** Other construction vehicle movements includes cars and light goods vehicles associated with site operations and contractor activity.*
****Worker vehicle numbers based on less than 1% of workers driving (Vol 17 Table 12.5.1),on the basis that there would be no worker parking on site; on-street parking in the area restricted; and site-specific Travel Plan measures would discourage workers from driving. In practical terms, this would be close to zero.*

12.5.48 An average peak flow of 64 vehicle movements a day is expected during the months of greatest activity during Site Year 1 of construction at this site. At other times in the construction period, vehicle flows would be lower than this average peak figure.

12.5.49 The relevant impact criteria for determining the magnitude of impacts on the highway network and operation are accidents and safety, road network delay and hazardous loads (as set out in Vol 2).

12.5.50 It is anticipated that along Victoria Embankment (A3211) there would be an additional three two-way HGV movements per hour as a result of the construction at Victoria Embankment Foreshore, plus two HGV movements during the peak hour associated with other Thames Tideway Tunnel project sites passing along the westbound carriageway of Victoria Embankment (A3211) during Site Year 1 of construction at the Victoria Embankment Foreshore site. This results in a low adverse impact on accidents and safety although taking into consideration the changes to the highway layout and due to the site access entering directly onto the TLRN, it is considered that this elevates the accident and safety impact to medium adverse.

12.5.51 It is assessed that potentially one hazardous load per fortnight would be generated by the site. This equates to a low adverse impact in relation to the number of hazardous loads anticipated to be generated by the site.

12.5.52 The local TRANSYT model has been used to apply the construction traffic demands and local geometrical changes to the construction base case to determine the changes in the highway network operation due to the project (ie, comparison of base and development cases). The development case traffic flows (providing input to the TRANSYT models) are shown on Vol 17 Figure 12.4.6 and Vol 13 Figure 12.4.7 (see separate volume of figures).

12.5.53 A summary of the construction assessment results for the weekday AM and PM peak hours is presented in Vol 17 Table 12.5.3 and Vol 17 Table 12.5.4.

12.5.54 The construction traffic generated in the construction development case would produce a marginal increase in demand in the AM peak hour resulting in a slight increase to delay on this part of the network with a maximum increase in delay of five seconds per PCU on Northumberland Avenue (A400) for left and right turning traffic at the Victoria Embankment (A3211) / Northumberland Avenue (A400) junction.

12.5.55 In the PM peak hour, the increase in demand would result a slight increase in delay to road users with a maximum increase in delay of two seconds per PCU on Victoria Embankment (A3211) northbound ahead movement at the junction of Victoria Embankment (A3211) and Northumberland Avenue (A400).

12.5.56 At the junction of Victoria Embankment / Horse Guards Avenue there would be no significant change to the capacity, queues or average delays in the AM peak hour. The maximum delay to vehicles would be one second per PCU on Victoria Embankment (A3211) southbound. In the PM peak hour, there would be a maximum increase in average delay of 12 seconds per PCU for traffic turning from Horse Guards Avenue to Victoria Embankment (A3211).

12.5.57 Overall the impact on road network delay would be negligible based on the impact criteria set out in Vol 2.

Vol 17 Table 12.5.3 Transport – construction TRANSYT model outputs (AM peak hour)

Approach	Arm	Flow (PCU)	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCU)			Delay (seconds per PCU)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Junction of Victoria Embankment (A3211) and Northumberland Avenue (A400)											
Victoria Embankment (A3211) southbound	Right	372	95%	95%	0%	16	16	0	99	99	0
	Ahead	1118	86%	86%	0%	29	32	+3	24	24	0
Victoria Embankment (A3211) northbound	Ahead	1316	94%	94%	0%	40	40	0	27	27	0
	Left	105	39%	39%	0%	3	3	0	61	61	0
Northumberland Avenue (A400)	Left / right	293	92%	93%	+1%	12	12	0	92	97	+5
	Left	385	92%	92%	0%	14	14	0	77	77	0
			PRC						**Total delay (PCU hours)**		
Overall junction performance			-6%	-6%	0%				45	45	0
Junction of Victoria Embankment (A3211) and Horse Guards Avenue											
Victoria Embankment (A3211) southbound	Right	425	80%	81%	+1%	11	11	0	40	41	+1
	Ahead	697	50%	50%	0%	6	6	0	7	8	+1
Victoria Embankment (A3211) northbound	Ahead	1242	84%	84%	0%	31	31	0	32	32	0
	Left	19	3%	3%	0%	0	0	0	19	19	0
Horse Guards Avenue	Left / right	189	78%	78%	0%	6	6	0	63	63	0
			PRC						**Total delay (PCU hours)**		

Approach	Arm	Flow (PCU)	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCU)			Delay (seconds per PCU)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Overall junction performance			+7%	+7%	0%				20	21	+1w

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity . MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with four or more axles are 2.3 PCUs. Buses and coaches are two PCUs. Motorcycles are 0.4 PCUs and pedal cycles are 0.2 PCUs. Thames Tideway Tunnel project construction vehicles would be a mixture of three- and four-axle vehicles and have therefore been given a PCU value of two.

2. Assessment has assumed that traffic signal optimisation has been undertaken as detailed in para. 12.3.20.

Vol 17 Table 12.5.4 Transport – construction TRANSYT model outputs (PM peak hour)

Approach	Arm	Flow (PCU)	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCU)			Delay (seconds per PCU)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Junction of Victoria Embankment (A3211) and Northumberland Avenue (A400)											
Victoria Embankment (A3211) southbound	Right	441	82%	82%	0%	12	14	+2	55	53	-2
	Ahead	1194	91%	91%	0%	28	36	+8	31	26	-5
Victoria Embankment (A3211) northbound	Ahead	1009	79%	79%	0%	15	10	-5	11	13	+2
	Left	78	24%	24%	0%	2	2	0	57	57	0
Northumberland	Left / right	271	71%	73%	+2%	8	8	0	52	53	+1

Approach	Arm	Flow (PCU)	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCU)			Delay (seconds per PCU)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Avenue (A400)	Left	426	90%	90%	0%	15	15	0	67	67	0
			(PRC)						Total delay (PCU hours)		
Overall junction performance			-1%	-1%	0%				33	32	-1
Junction of Victoria Embankment (A3211) and Horse Guards Avenue											
Victoria Embankment (A3211) southbound	Right	544	82%	82%	0%	14	14	0	34	32	-2
	Ahead	784	59%	56%	-3%	7	5	-2	8	7	-1
Victoria Embankment (A3211) northbound	Ahead	902	80%	78%	-2%	24	23	-1	38	37	-1
	Left	19	4%	4%	0%	0	0	0	27	27	0
Horse Guards Avenue	Left right	196	78%	83%	0%	7	7	0	60	72	+12
			PRC						Total delay (PCU hours)		
Overall junction performance			+10%	+8%	-2%				20	20	0

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity . MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with four or more axles are 2.3 PCUs. Buses and coaches are two PCUs. Motorcycles are 0.4 PCUs and pedal cycles are 0.2 PCUs. Thames Tideway Tunnel project construction vehicles would be a mixture of three- and four-axle vehicles and have therefore been given a PCU value of two.

2. Assessment has assumed that traffic signal optimisation has been undertaken as detailed in para. 12.3.20.

Significance of effects

12.5.58 The significance of the effects has been determined based on the transport impacts described above, considered in the context of the sensitivity of the receptors identified in Vol 17 Table 12.4.2 and Vol 17 Table 12.4.3.

12.5.59 Vol 17 Table 12.5.5 sets out the effects on each receptor in the vicinity of the site.

Vol 17 Table 12.5.5 Transport – significance of effects during construction

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Pedestrians and cyclists (including sensitive pedestrians) using the Thames Path and Victoria Embankment (A3211)	Major adverse effect on pedestrians Minor adverse effect on cyclists	**Pedestrians:** • High sensitivity • Medium adverse impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to majority of impacts of high adverse magnitude, equates to major adverse effect. **Cyclists:** • High sensitivity • Negligible impact on cycle delay • Low adverse impact on accidents and safety • Due to impacts being low adverse or negligible magnitude, equates to minor adverse effect.
Private vehicle users (including taxis) in the area using the local highways or on-street parking	Minor adverse effect on highway users Minor adverse effect on parking users	**Highway users:** • Medium sensitivity • Negligible impact on road network delay • Medium adverse impact on accidents and safety • Low adverse impact from hazardous loads • Due to negligible, low and medium adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect.

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		Parking users: • Medium sensitivity • Negligible impact on on-street car parking • Medium adverse impact on motorcycle parking • Due to negligible and medium adverse impact magnitudes, equates to minor adverse effect.
Emergency vehicles travelling on Victoria Embankment (A3211)	Minor adverse effect	• High sensitivity • Negligible impact on road network delay • Medium adverse impact on accidents and safety • Low adverse impact from hazardous loads • Due to negligible, low and medium adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect.
Marine emergency services	Negligible effect	• High sensitivity • Negligible impact from barge movements • Due to negligible impact, equates to negligible effect.
Coaches and service vehicles using parking facilities and loading bays on the Victoria Embankment (A3211) southbound carriageway adjacent to the site	Moderate adverse effect	• High sensitivity • Medium adverse impact on coach parking (relocation) and loading bay • Due to impacts of medium adverse magnitude, equates to moderate adverse effect.
Bus users (passengers) travelling along Northumberland Avenue (A400) and	Negligible effect	• Low/medium sensitivity • Negligible impact on road network delay and patronage • Due to negligible impacts, equates to

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Victoria Embankment (A3211) north of the junction with Northumberland Avenue (A400)		negligible effect
River vessel operators, operators and passengers using Embankment Pier, and London Eye Pier Extension	Negligible effect	• Medium sensitivity • Negligible impact from barge movements • Due to negligible impact, equates to negligible effect.
Public transport users using rail or river services within the area	Negligible effect	• Low sensitivity • Negligible impact on patronage. • Due to negligible impact, equates to negligible effect.
Residents of Whitehall Court Users of National Liberal Club Users of recreational spaces at Whitehall Gardens and Victoria Embankment Gardens	Moderate adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Minor adverse effect on parking users	**Pedestrians:** • High sensitivity • Low adverse impact on pedestrian delay and pedestrian amenity • Medium adverse impact on accidents and safety • Due to majority of impacts of low adverse magnitude, equates to moderate adverse effect. **Cyclists:** • High sensitivity • Negligible impact on cycle delay • Low adverse impact on accidents and safety • Due to impacts being low adverse or negligible magnitude, equates to minor adverse effect. **Highway users:** • Medium sensitivity • Negligible impact on road network delay • Medium adverse impact on accidents and safety

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Low adverse impact from hazardous loads • Due to negligible, low and medium adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect **Parking users:** • Medium sensitivity • Negligible impact on on-street car parking • Medium adverse impact on motorcycle parking • Due to negligible and medium adverse impact magnitudes, equates to minor adverse effect.
Commercial operators and users of bar / restaurant ship Hispaniola, and bar / restaurant ship Tattershall Castle	Minor adverse effect on operators Major adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Minor adverse effect on parking users	**Operators:** • Medium sensitivity • Low adverse impact on loading bay and operation of Tattershall Castle (relocation) • Negligible impact on operation of Hispaniola • Due to majority of impacts of low adverse magnitude, equates to minor adverse effect. **Pedestrians:** • Medium sensitivity • Medium adverse impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to majority of impacts of high adverse magnitude, equates to major adverse effect. **Cyclists:** • Negligible impact on cycle delay • Low adverse impact on accidents and safety • Due to impacts being low adverse or

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		negligible magnitude, equates to minor adverse effect. **Highway users:** • Medium sensitivity • Negligible impact on road network delay • Medium adverse impact on accidents and safety • Low adverse impact from hazardous loads • Due to negligible, low and medium adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect. **Parking users:** • Medium sensitivity • Negligible impact on on-street car parking • Medium adverse impact on motorcycle parking • Due to negligible and medium adverse impact magnitudes, equates to minor adverse effect.

Sensitivity test for programme delay

12.5.60 The assessment has been based on an estimated programme for the construction of the Thames Tideway Tunnel project. That programme has been used to derive construction vehicle numbers and to understand the relationships between the project and other developments in the vicinity of project sites, in order to allow appropriate receptors to be identified.

12.5.61 If the overall programme were to be delayed by approximately a year, the implications in relation to the transport effects would be as follows:

a. It is unlikely that the effects on pedestrians and cyclists would change. Over the course of one year, it is unlikely that pedestrian or cycle traffic in the vicinity of the project site would increase by a sufficient amount to change the magnitude of impacts or the significance of effects reported, nor that the arrangements for pedestrian diversions would be any different to those currently proposed

b. Effects on public transport are unlikely to change as the rate of public transport patronage growth is relatively low and over the course of one year, any reduction in spare capacity on existing public transport networks would be small. Additionally, there is a general trend towards the enhancement of the public transport network through the provision of additional bus, rail and river services in order to meet future demand and accommodate future patronage growth. The transport assessment typically indicates that the additional public transport patronage arising from Thames Tideway Tunnel project sites would be small and not significant in the context of the capacity available on the wider networks

c. Effects on river navigation and access would not be significantly different as the rate of change in patterns of river usage is comparatively small

d. Effects on the operation of the highway network are derived from the use of the TfL Highway Assignment Models (HAMs), which have a forecast model year of 2021. To provide consistency within the assessment, it has been agreed with TfL that this is an appropriate approach. Since the local highway capacity models for the base case also use traffic flow information from the HAMs, it follows that both the strategic and local capacity assessments are effectively based on a year of 2021. As the peak months of activity at the Victoria Embankment Foreshore site fall before 2021 based on the programme that has been assessed, it follows that a delay of up to one year would not alter the outcomes of the highway network modelling and therefore would not alter the effects reported

e. Based on the site development schedule (see Vol 17 Appendix N), it is possible that as a result of a one year delay, the St James Market development which has been assumed to be under construction in this assessment would be partially complete and occupied. However, it is not expected that new receptors would experience any different effects to those receptors which have been assessed above; rather it would be a case of the potential for some additional receptors to experience the same effects that have already been identified.

12.6 Operational effects assessment

12.6.1 This section summarises the findings of the assessment undertaken for Year 1 of operation at the Victoria Embankment Foreshore site.

12.6.2 The transport demands created by the development in the operational phase would be extremely low and limited to occasional maintenance visits every three to six months, with certain instances where larger cranes and other associated support vehicles may be required for access to the shaft and tunnel every ten years.

12.6.3 The assessment of the operational phase is therefore limited to the physical issues associated with accessing the site from the base case highway network as outlined in Section 12.2. This assessment approach has been discussed with Westminster City Council and TfL.

12.6.4 The operational assessment has taken into consideration those elements that would be affected, which comprise the short-term impacts on coach parking and on the highway layout and operation when maintenance visits are made to the site.

Parking

12.6.5 No change is expected to parking in the vicinity of the site, compared to the base case, as a result of the operational phase of the proposed development at the Victoria Embankment Foreshore site.

12.6.6 When large vehicles (cranes) are required to service the site, use of a maximum of four coach parking bays would have to be temporarily restricted to ensure the vehicles have sufficient space to manoeuvre into the site. This temporary restriction would be on an infrequent basis and would occur approximately every ten years.

12.6.7 Based on the impact magnitude criteria outlined in Vol 2, the temporary restriction of four coach parking bays would result in a low adverse impact on coach parking within the local area.

12.6.8 Taking into consideration the infrequent and temporary nature of the arrival of vehicles at Victoria Embankment Foreshore which would require parking restriction, and the sensitivity of the receptor (private vehicle users and coaches/service vehicles), it is anticipated that there would be a **negligible** effect on coach parking.

Highway layout and operation

12.6.9 During the operational phase, the site would be accessed via Victoria Embankment (A3211) from the westbound carriageway. The permanent highway layout plan (see separate volume of figures – Section 1) shows the highway layout during the operational phase.

12.6.10 For routine three or six monthly inspections vehicular access would be required for light commercial vehicles, typically a van. On occasion there may also be a need for flatbed vehicles to access the site.

12.6.11 During ten-yearly inspections, space to locate two large cranes within the site area would be required and the Thames Path may need to be temporarily diverted. The cranes would facilitate lowering and recovery of tunnel inspection vehicles and to provide duty/standby access for personnel. To assess the effect of these on the highway layout, swept paths have been undertaken for the largest vehicles including 11.36m mobile cranes, 10m rigid vehicle and 10.7m articulated vehicle. The permanent highway layout vehicle swept path analysis plan (see Victoria Embankment Foreshore *Transport Assessment* Figures) demonstrates that the maintenance vehicles would be able to safely enter and leave the site.

12.6.12 As identified above, as a result of the large turning circles of the cranes, a maximum of four coach parking bays would have to be restricted temporarily to ensure the vehicles have sufficient space to manoeuvre into the site. This would be every ten years.

12.6.13 When larger vehicles are required to service the site, there may also be some temporary, short-term delay to other road users while manoeuvres are made. However it is anticipated that the arrival of large vehicles would normally be scheduled to take place outside of the peak hours to minimise the effect on the local highway network.

12.6.14 In accordance with the criteria outlined in Vol 2, during the routine inspections of the operational site there would therefore be a negligible impact on road network delay.

12.6.15 Taking into consideration the various sensitivities of the receptors affected during the operational phase (private vehicle users, emergency vehicles, bus users, coaches and service vehicles), this would result in a **negligible** effect on highway layout and operation.

Sensitivity test for programme delay

12.6.16 If the opening year of the Thames Tideway Tunnel project were to be delayed by approximately one year, the results of the operational assessment would not be materially different to the assessment findings reported above.

12.7 Cumulative effects assessment

Construction effects

12.7.1 As detailed in para. 12.3.6, St James's Market (approximately 700m northwest of the site) would be under construction at the same time as works at the Victoria Embankment Foreshore site. This suggests that there are cumulative effects to assess for the construction development case. However, as previously explained, the TfL HAMs which have been used in the assessment already take account of population and employment growth forecasts in London.

12.7.2 Therefore the effects on transport would remain as described in Section 12.5 above. This would also be the case if the programme for the Thames Tideway Tunnel project were delayed by approximately one year.

Operational effects

12.7.3 As indicated in the site development schedule (see Vol 17 Appendix N), all the developments would be complete and operational by Year 1 of operation, therefore there is no need for a cumulative assessment on transport and the effects would remain as described in Section 0 above. This would also be the case if the programme for the Thames Tideway Tunnel project were delayed by approximately one year.

12.8 Mitigation

12.8.1 The project has been designed to limit the effects on transport networks as far as possible and many measures have been embedded directly in the design of the project.

Construction

12.8.2 During construction it is envisaged that the embedded measures set out in Section 12.2, including the *CoCP* and *Draft Project Framework Travel*

Plan, would minimise the effects resulting from construction works at the Victoria Embankment Foreshore site.

12.8.3 These are the most appropriate measures for this site and it is not possible to mitigate all significant effects.

Operation

12.8.4 No mitigation is required during the operational phase.

12.9 Residual effects assessment

Construction effects

12.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 12.5. All residual effects are presented in Section 12.10.

Operational effects

12.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 12.6. All residual effects are presented in Section 12.10.

12.10 Assessment summary

Vol 17 Table 12.10.1 Transport – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Pedestrians and cyclists (including sensitive pedestrians) using the Thames Path and Victoria Embankment (A3211)	• Loss of footway • Pedestrian diversion routes • Increased journey time for pedestrians and cyclists • Movement of large construction vehicles	Major adverse effect on pedestrians. Minor adverse effect on cyclists	None	Major adverse effect on pedestrians. Minor adverse effect on cyclists
Private vehicle users in the area using the local highways or on-street parking	• Movement of large construction vehicles • Highway layout changes including highway capacity modifications • Delay to journey time • No effect on on-street parking except motorcycle parking	Minor adverse effect on highway users Minor adverse effect on parking users	None	Minor adverse effect on highway users Minor adverse effect on parking users
Emergency vehicles travelling on Victoria Embankment (A3211)	• Movement of large construction vehicles • Highway layout changes including highway capacity modifications • Delay to journey time	Minor adverse effect	None	Minor adverse effect
Marine emergency services	• Additional barge movements in the vicinity of the Victoria Embankment Foreshore site	Negligible effect	None	Negligible effect

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Coaches and service vehicles using parking facilities and loading bays on the Victoria Embankment (A3211) southbound carriageway adjacent to the site	• Relocation of on-street coach parking • Temporary restriction of loading bay	Moderate adverse effect	None	Moderate adverse effect
Bus users (passengers) travelling along Northumberland Avenue (A400) and Victoria Embankment (A3211) north of the junction with Northumberland Avenue (A400)	• Movement of large construction vehicles • Highway layout changes including highway capacity modifications • Delay to journey time	Negligible effect	None	Negligible effect
River vessel operators, operators and passengers using Embankment Pier, and London Eye Pier Extension	• Additional barge movements in the vicinity of the Victoria Embankment Foreshore site	Negligible effect	None	Negligible effect
Public transport users using rail or river services within the area	• Some additional patronage from construction workers	Negligible effect	None	Negligible effect
Residents of Whitehall Court Users of National	• Movement of large construction vehicles • Pedestrian diversion routes	Moderate adverse effect on pedestrians Minor adverse	None	Moderate adverse effect on pedestrians Minor adverse effect on cyclists

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Liberal Club Users of recreational spaces at Whitehall Gardens and Victoria Embankment Gardens	• Highway layout changes including junction modifications • Delay to journey time	effect on cyclists Minor adverse effect on highway users Minor adverse effect on parking users		Minor adverse effect on highway users Minor adverse effect on parking users
Commercial operators and users of bar/restaurant ship Hispaniola and bar/restaurant ship Tattershall Castle	• Temporary restriction of on-street loading bay (alternative bay to be used). • Movement of large construction vehicles • Delay to journey time for visitors and staff arriving by foot due to pedestrian diversion routes • Relocation of Tattershall Castle	Minor adverse effect on operators Major adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Minor adverse effect on parking users	None	Minor adverse effect on operators Major adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Minor adverse effect on parking users

Vol 17 Table 12.10.2 Transport – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Emergency vehicles travelling on Victoria Embankment (A3211)	• Occasional maintenance trips resulting in some temporary, short-term road network delay.	Negligible effect	None	Negligible effect
Coaches and service vehicles using parking facilities and loading bays on the Victoria Embankment (A3211) southbound carriageway adjacent to the site	• Temporary restriction of up to four on-street coach parking spaces in the immediate vicinity of the site during maintenance.	Negligible effect	None	Negligible effect
Bus users (passengers) travelling along Northumberland Avenue (A400) and Victoria Embankment (A3211) north of the junction with Northumberland Avenue (A400)	• Occasional delay to bus users when large maintenance vehicles accessing site	Negligible effect	None	Negligible effect

References

[1] Defra. *National Policy Statement for Waste Water,* 2012.

[2] Transport for London*. Travel Planning for new development in London,* 2011.

[3] Transport for London. *Assessment Tool for Travel plan Building Testing and Evaluation, (ATTrBuTE),* 2011. Available at: http://www.attrbute.org.uk/

[4] Greater London Authority, *London Plan,* July 2011.

[5] Transport for London. *Transport Assessment Best Practice Guidance,* April 2010.

[6] The estimates are derived from study team calculations that use the arrival and departure times for piers published in TfL River Bus and Tour timetables (http://www.tfl.gov.uk/modalpages/2648.aspx) and information on barge movements obtained from barge operators and commercial users.

[7] Transport for London. *London Underground Upgrade Plan,* 2011. Available at: http://www.tfl.gov.uk/assets/downloads/corporate/our-upgrade-plan-london-underground-february-2011.pdf

[8] Department for Transport (DfT). *Traffic Advisory Leaflet 15/99 – Cyclists at Road Works*, December 1999.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 13: Water resources - groundwater

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 13: Water resources – groundwater

List of contents

Page number

13 Water resources – groundwater 1
13.1 Introduction 1
13.2 Proposed development relevant to groundwater 2
13.3 Assessment methodology 5
13.4 Baseline conditions 9
13.5 Construction effects assessment 14
13.6 Operational effects assessment 15
13.7 Cumulative effects assessment 16
13.8 Mitigation 16
13.9 Residual effects assessment 16
13.10 Assessment summary 18
References 20

List of tables

Page number

Vol 17 Table 13.2.1 Groundwater – methods of construction 2
Vol 17 Table 13.3.1 Groundwater – construction base case and cumulative assessment developments (2016) 6
Vol 17 Table 13.3.2 Groundwater – operational base case and cumulative assessment developments (2023) 7
Vol 17 Table 13.4.1 Groundwater – anticipated ground conditions/ hydrogeology 9
Vol 17 Table 13.4.2 Groundwater – water level summary 11
Vol 17 Table 13.4.3 Groundwater – receptors 13
Vol 17 Table 13.10.1 Groundwater – construction assessment summary 18
Vol 17 Table 13.10.2 Groundwater – operational assessment summary 19

This page is intentionally blank

13 Water resources – groundwater

13.1 Introduction

13.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on groundwater at the Victoria Embankment Foreshore site.

13.1.2 The proposed development has the potential to affect groundwater due to:

a. creation of pathways for pollution

b. use of grouts/ground treatment to control ingress of water.

c. obstruction to groundwater flows

d. seepages into and out of the CSO drop shaft during operations.

13.1.3 The groundwater assessment at this site should be read in conjunction with the supporting Volume 17 Appendix K (K.1 – K.9) and the land quality assessment (Vol 17 Section 8 Land quality).

13.1.4 This site is underlain by a thick layer of relatively impermeable London Clay Formation and construction would extend down a short distance into the Lambeth Group, which is of variable permeability. No dewatering of the upper aquifer would be required at the Victoria Embankment Foreshore site and instead the groundwater in the River Terrace Deposits (upper aquifer) would be cut off using a jacked caisson[i] and sheet pile[ii] walls. Depressurisation wells would be drilled into the Lambeth Group external to the site to lower water pressure and prevent possible inundation of the CSO drop shaft by groundwater during the construction of the shaft and base slab. There would be no effects from the Victoria Embankment Foreshore site on the lower aquifer because of the separation distance between the base of the shaft and the lower aquifer. The dewatering of the lower aquifer at the Blackfriars Bridge Foreshore CSO drop shaft site would assist with the depressurisation of the Lambeth Group by under-draining of the Chalk.

13.1.5 An assessment of project-wide environmental effects on groundwater is presented in Volume 3 Project-wide assessment.

13.1.6 The assessment of groundwater presented in this section has considered the requirements of the National Policy Statement for Waste Water (Defra , 2012)[1] Section 4.2. The physical characteristics of the groundwater environment including groundwater resources and quality are presented and the anticipated effects (including cumulative effects) on these

---

[i] Caisson – A watertight chamber, open at the bottom from which the water is kept out by air pressure and in which construction work may be carried out under water.

[ii] Piling - a sub-surface structure installed to support excavation and which amongst other things helps to control inflows of shallow groundwater typically formed of intersecting concrete or overlapping shafts of concrete.

resources addressed in the assessment that follows (further detail can be found in Vol. 2 Section 13.3).

13.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Vol 17 Victoria Embankment Foreshore Figures).

13.2 Proposed development relevant to groundwater

13.2.1 The proposed development has been described in Section 3 of this volume. The elements of the proposed development relevant to groundwater are set out below.

Construction

13.2.2 The elements of construction at the Victoria Embankment Foreshore site, relevant to groundwater, would include:

a. A combined sewer outflow (CSO) drop shaft of approximately 13m internal diameter (ID) and approximately 50m deep (or 55.03mATD[iii] based on an assumed ground level of 104.8mATD) (excluding a 3m thick base slab once constructed), constructed at the northern half of site.

b. An overflow weir chamber on the existing northern Low Level No.1 Sewer.

c. A connection culvert from this chamber to the CSO drop shaft.

d. A connection tunnel at depth from the base of the drop shaft to the main tunnel.

e. A temporary cofferdam in the foreshore

13.2.3 The proposed methods of construction for these elements of the site are described in Section 3 of this volume and summarised in Vol 17 Table 13.2.1. Approximate duration of construction and depths are also contained in Vol 17 Table 13.2.1.

Vol 17 Table 13.2.1 Groundwater – methods of construction

Design element	Method of construction	Construction periods (in years)*	Construction depth**
CSO drop shaft	Jacked caisson down as far as possible within London Clay and Lambeth Group.	< 1	Deep
	Underpinning		

[iii] In general, the measurements of depth are expressed as metres Above Tunnel Datum (mATD). The standard zero point for mATD scale is -100maOD (metres above Ordnance Datum is based on Newlyn datum point for mean sea level). The use of the mATD scale avoids the need for use of negative values, and is widely used for large scale sub-surface projects.

Design element	Method of construction	Construction periods (in years)*	Construction depth**
	techniques for lower portion of drop shaft, with additional depressurisation [iv] in Lambeth Group.		
Interception chambers and connection culverts	Piles	2	Shallow
Connection tunnel (from base of CSO drop shaft to main tunnel)	Sprayed Concrete Lined (SCL) with additional depressurisation and potentially ground treatment[v]	< 1	Deep

** The site would be used for construction purposes for up to 5 and a half years*
*** In terms of construction depth – shallow (<10m) and deep (>10m).*

Code of construction practice

13.2.4 All works would be undertaken in accordance with the *Code of Construction Practice (CoCP)*. The CoCP is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B). Relevant measures included within the *CoCP (Part A)* to ensure adverse effects on groundwater are minimised are as follows:

a. Measures include providing bunded stores for fuel/oils held on site and the settlement of dewatering from excavations to prevent silty water from entering watercourses, surface water drains and onto roads as per Environment Agency guidelines (EA, 2011)[2]. The contractor would have plans and equipment in place to deal with emergency situations as well as ensuring that staff are appropriately trained.

b. A precautionary approach, involving targeted risk-based audits and checks of water quality monitoring, would be applied to abstraction licences thought to be at risk.

c. Monitoring arrangements for dewatering permits and any permits required on change of licensing regulations would be developed in liaison with the EA (see also the groundwater monitoring strategy Vol 3 Appendix K.1).

[v] Ground treatment – stabilisation of soils/rocks by injection of grouts and or freezing techniques.

d. At the end of construction where temporary support does not form part of the operational structure it would be removed, piped through or cut down to avoid the build up of groundwater on the upstream side of underground structures.

13.2.5 There are no site specific groundwater measures contained within the *CoCP Part B*.

Other measures during construction

13.2.6 The depth of CSO drop shaft means that it would extend down into the Upper Mottled Beds which form the central part of the Lambeth Group (see Vol 17 Appendix K.1), with the base slab extending down into the top of the Lower Mottled Beds (LMB) of the Lambeth Group. The Lambeth Group and the overlying Harwich Formation are expected to contain confined groundwater.

13.2.7 For the purposes of this assessment it is not anticipated that dewatering of the River Terrace Deposits or upper aquifer would be required. Instead, the construction of the CSO drop shaft would involve jacking (pressing) a concrete collar (a caisson) into the ground to form the shaft and to seal out the River Terrace Deposits and any groundwater inflows from the London Clay Formation.

13.2.8 To prevent possible inundation of the CSO drop shaft by groundwater from the Harwich Formation and the Lambeth Group depressurisation wells would be drilled into the Lambeth Group external to the shaft. These wells would be pumped to lower the water pressure in the Lambeth Group. The pumped groundwater would be extracted and discharged directly to the River Thames on site, following any necessary treatment and subject to EA approval. The duration of pumping would be determined by ground conditions and groundwater volumes encountered. This is likely to be of the order of up to 12 months; the time required to build and excavate the shaft and connection tunnel.

13.2.9 The project-wide dewatering of the lower aquifer at a nearby Blackfriars Bridge Foreshore CSO drop shaft site would assist with the depressurisation of the Lambeth Group by under-draining the Chalk (see Section 13.5). The average amount of dewatering which would be needed at Victoria Embankment Foreshore is estimated to be less than 200m^3/d.

13.2.10 For the purposes of this assessment it is not anticipated that ground treatment such as grouting[vi] would be required for the construction of the CSO drop shaft at the Victoria Embankment Foreshore site. However, ground treatment may be required for the construction of junction structures between the main tunnel and the connection tunnel. No other ground treatment is anticipated to be required.

13.2.11 The site would extend partly into the River Thames and this part of the site would be protected from inundation by a cofferdam. The cofferdam would

---

[vi] Grouting – a thin, coarse mortar injected into various narrow cavities or voids , such as rock fissures, to fill them and consolidate the adjoining objects into a solid mass and to eliminate water.

be constructed from two sheet pile walls. The toe level of the sheet piles would be within the London Clay. Any water entering through the cofferdam would be pumped back to the river following any required treatment.

Operation

13.2.12 A groundwater monitoring strategy is one of the project's environmental design measures (see Vol 3 Appendix K.1). This covers groundwater levels and groundwater quality, and would outline the future monitoring and actions in the event of trigger levels being exceeded.

13.3 Assessment methodology

Engagement

13.3.1 Vol 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of groundwater are presented here.

13.3.2 The *main report on phase two consultation* has received comments from the Westminster City Council on the issue of modelling any obstruction to groundwater flow and seepage to and from the CSO drop shaft to ensure no increased groundwater flood risk in the future. These comments are addressed in Sections 13.5 and 13.6 respectively.

Baseline

13.3.3 The baseline methodology follows the methodology described in Vol 2. There are no site-specific variations for identifying the baseline conditions for this site.

13.3.4 The baseline describes receptors within a 1km radius of the CSO sites during both construction and operation.

13.3.5 There are unlikely to be any effects on groundwater beyond a kilometre at the Victoria Embankment Foreshore site given the hydrogeological setting and the method of construction (para. 13.1.4).

Construction

13.3.6 The assessment methodology for the construction phase follows that described in Vol 2. There are no site-specific variations for undertaking the construction assessment of this site. The baseline is not anticipated to vary before the construction phase.

13.3.7 The assessment year applied to the construction assessment is Site Year 1 of construction, when the caisson, piling could obstruct groundwater flows with small-scale pumping from within these pile walls and towards the end of that year when depressurisation of Lambeth Group would be required. The baseline is not anticipated to change substantially between 2011 and Site Year 1 of construction (2016) and so baseline data from 2011 has formed the basis (base case) for the construction assessment.

13.3.8 A number of proposed developments which are likely to be complete and operational before commencement of construction have formed part of the construction base case.

13.3.9 The developments considered as part of the base case and those included in the cumulative effects assessment are presented in Vol 17 Table 13.3.1. The developments relevant to groundwater are those which would contain basements.

Vol 17 Table 13.3.1 Groundwater – construction base case and cumulative assessment developments (2016)

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative effect assessment
London Eye Pier Extension	None	✗	✗
Elizabeth House, 39 York Road	Basement*	✗	✓
York House – Waterloo	Basement*	✓	✗
Odeon West End – land bounded by Leicester Square, Panton Street, Whitcomb Street, Orange Street and St. Martin's Street London	Basement*	✓	✗
Land bounded by Upper Ground and Doon St – east part of site (adjacent to Cornwall Rd)	Basement*	✓	✗
Redevelopment of St James's Market	Basement*	✗	✓

** Relevant to the upper aquifer*
Symbols ✓ applies ✗ does not apply

13.3.10 Section 13.5 details the likely significant effects arising from the construction at the Victoria Embankment Foreshore site. Other nearby Thames Tideway Tunnel project sites which could give rise to additional effects on groundwater resources are Blackfriars Bridge Foreshore and Kirtling Street. No dewatering of lower aquifer would be required at the Victoria Embankment Foreshore site but impacts on the Chalk and licensed abstractions as a result of nearby dewatering at other sites have been dealt with in project-wide assessment (see Vol 3 Section 9).

Operation

13.3.11 The assessment methodology for the operation phase follows that described in Vol 2. There are no site-specific variations for undertaking the operational assessment of this site.

13.3.12 The assessment year applied to the operational assessment is Year 1 of operation. The baseline is not anticipated to vary significantly before the start of the operational phase in 2023; and therefore, baseline data from 2011 has formed the basis for the operational assessment. In addition, information on proposed development schemes likely to have been completed before commencement of the operation of the Thames Tideway Tunnel have formed part of the operational base case.

13.3.13 The developments considered as part of the operational base case are included in Vol 17 Table 13.3.2. The developments relevant to groundwater are those which would contain basements.

13.3.14 No developments have been identified which would be considered as part of the cumulative effects assessment.

Vol 17 Table 13.3.2 Groundwater – operational base case and cumulative assessment developments (2023)

Development	Component or receptor relevant to groundwater	Operational base case	Cumulative effect assessment
London Eye Pier Extension	None	×	×
Elizabeth House	Basement*	✓	×
York House – Waterloo	Basement*	✓	×
Odeon West End – land bounded by Leicester Square, Panton Street, Whitcomb Street, Orange Street and St. Martin's Street London	Basement*	✓	×
Land bounded by Upper Ground and Doon St – east part of site (adjacent to Cornwall Rd)	Basement*	✓	×
Redevelopment of St James's Market	Basement*	✓	×

** Relevant to the upper aquifer*
Symbols ✓ applies × does not apply

13.3.15 Section 13.6 details the likely significant effects arising from the operation at the Victoria Embankment Foreshore site. There are no other Thames

Tideway Tunnel project sites which could give rise to additional effects on groundwater resources within the assessment area for this site during the operational phase and so no other Thames Tideway Tunnel project sites are considered in this assessment.

Assumptions and limitations

Assumptions

13.3.16 The construction assumptions relevant to this site are presented in Section 13.2.

13.3.17 The amount of groundwater which would be required to be pumped from outside of the shaft at the Victoria Embankment Foreshore site has been estimated at less than $200m^3/d$ (see modelling report included in Vol 3 Appendix K.2).

13.3.18 The assessment of obstruction effects in Sections 13.5 and 13.6 is based on estimated hydraulic gradient[vii] of 0.004 in the upper aquifer across the site.

13.3.19 Groundwater movement in the upper aquifer is to the east towards the River Thames at this site.

13.3.20 This assessment has assumed that the shaft would have a design criterion to limit the rate of seepage of $1l/m^2/d$ (see Vol 2 Appendix K.3).

13.3.21 It has been assumed that the separation distance of approximately 5.2m between the base of the CSO drop shaft and the lower aquifer is sufficient in addition to dewatering of the lower aquifer at a nearby Blackfriars Bridge Foreshore site assisting with the depressurisation of the Lambeth Group by under-draining the Chalk means that depressurisation of the lower aquifer would not be required at this site.

13.3.22 The measurements of the depth of shafts are quoted to two decimal places, however these measurements may be altered slightly in the future and are therefore indicative only.

13.3.23 For the purposes of this assessment, deep refers to greater than 10m below ground level (bgl) and shallow refers to less than 10m bgl.

Limitations

13.3.24 No site-specific pumping tests have yet been undertaken as part of the ground investigation. In the absence of site-specific hydrogeological data, published sources of hydrogeological information have been used in this assessment (see Vol 17 Appendix K.2).

13.3.25 Groundwater level data available for this assessment is limited, with monitoring data typically available from one borehole (or monitoring horizon) within the upper aquifer. This has meant that hydraulic gradients could only be estimated across the site. In addition, the range of hydrological conditions experienced during the monitoring period (2010-

[vii] Hydraulic gradient – the slope of the water table which drives groundwater movement.

2012) did not include a prolonged wet winter period when exceptionally high groundwater levels might occur.

13.3.26 There has also been limited groundwater quality data available locally for the assessment area.

13.3.27 Despite the limitations identified above, the assessment which uses the best available information is considered robust.

13.4 Baseline conditions

13.4.1 The following section sets out the baseline conditions for groundwater within and around the site. Future baseline conditions (base case) are also described.

13.4.2 This section of the assessment is supported by Vol 17 Appendix K.1 – K.9.

Current baseline

Hydrogeology

13.4.3 The CSO drop shaft would pass through Alluvium, River Terrace Deposits, London Clay, Harwich Formation and a sand unit encountered at the top of the Lambeth Group as summarised in Vol 17 Table 13.4.1. The base slab would be founded in the Lower Mottled Beds. The depths and thicknesses of geological layers have been determined by reference to ground investigation boreholes drilled on site (SA1066D and SR2050) and a number of other boreholes locally. The locations of these boreholes around the site are shown in Vol 17 Figure 13.4.1 (see separate volume of figures). The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS, 2009)[3], is shown in Vol 17 Figure 13.4.1 and Vol 17 Figure 13.4.2 respectively (see separate volume of figures).

Vol 17 Table 13.4.1 Groundwater – anticipated ground conditions/ hydrogeology

Formation	Top elevation* (mATD)	Depth (m)	Thickness (m)	Hydrogeology
Alluvium	100.00	0.00	3.00	Confining layer
River Terrace Deposits	97.00	3.00	3.10	Upper aquifer
London Clay B A3ii A3i	 93.90 85.50 75.60	 6.10 14.50 24.40	 8.40 9.90 2.50	Aquiclude[viii]

[viii] Aquiclude – a hydrogeological unit which, although porous and capable of storing water, does not transmit it at rates sufficient to furnish an appreciable supply for a well or spring.

Formation	Top elevation* (mATD)	Depth (m)	Thickness (m)	Hydrogeology
A2	73.10	26.90	11.85	
Harwich Formation	61.00	38.75	0.48	Aquitard[ix]/ aquifer
Lambeth Group				Aquitards/ aquifer
Sand Unit	60.52	39.23	2.85	
UMB	57.67	42.08	4.20	
LtB/LSB	53.47	46.28	1.40	
LMB	52.07	47.68	5.25	
UPN (Gv)	46.82	52.93	1.90	Lower aquifer
UPN	44.92	55.83	2.35	

** Based on an assumed ground level of 104.6mATD*
Note - UMB–Upper Mottled Beds; LtB–Laminated Beds; LSB-Lower Shelly Beds; LMB-Lower Mottled Beds; UPN (Gv)–Upnor Formation (Gravel); UPN–Upnor Formation

13.4.4 The River Terrace Deposits form the upper aquifer and are classified by the EA as a secondary A aquifer[x]. The Upnor Formation, Thanet Sands and Chalk form the lower aquifer and are classified by the EA as a principal aquifer[xi]. The presence of the London Clay Formation is expected to act as a confining layer between these two aquifers at the Victoria Embankment Foreshore site. The Harwich Formation is expected to be water-bearing and to contain groundwater under pressure. In addition, the Lambeth Group is expected to contain confined groundwater within several layers, such as in the sand unit, the Laminated Beds and the Upper Mottled Beds.

Groundwater level monitoring

13.4.5 Groundwater level monitoring was undertaken at a number of boreholes across the assessment area (1km radius of the site). In addition, the EA has a regional network of monitoring boreholes, mainly within the lower aquifer, across London, but unfortunately none are found in the vicinity of the Victoria Embankment Foreshore site.

13.4.6 Information on groundwater levels for this assessment has been collected from one ground investigation borehole (SA1066D) located at approximately 40m from the site. The location is shown in Vol 17 Figure 13.4.3 (see separate volume of figures). This borehole has response

[ix] Aquitard – a poorly-permeable geological formation that does not yield water freely, but may still transmit significant quantities of water to or from adjacent aquifers.

[x] Secondary aquifer – Either permeable strata capable of supporting local supplies or low permeability strata with localised features such as fissures (was previously preferred to as a minor aquifer).

[xi] Principal aquifer – a geological stratum that exhibits high inter-granular and /or fracture permeability (was previously referred to as a major aquifer)

zones[xii] (EA, 2006)[4] and monitor groundwater levels in both the upper aquifer and a section of Lambeth Group (Lower Mottled Beds). The average, minimum and maximum recorded water levels are detailed in Vol 17 Table 13.4.2.

Vol 17 Table 13.4.2 Groundwater – water level summary

Borehole ID	Formation	Average over period of record (mATD)	Minimum (mATD)	Maximum (mATD)
SA1066D	River Terrace Deposits	97.52	97.29	97.81
SA1066D	Lower Mottled Beds	60.13	58.32	60.82

13.4.7 The recorded water levels in the River Terrace Deposits at SA1066D suggest that the upper aquifer is fully saturated and confined[xiii] beneath the overlying Alluvium at this site.

13.4.8 The recorded water levels in the Lower Mottled beds at SA1066D consistently remained above the top of the formation at 57.67mATD, indicating that this formation is fully saturated and is confined by the overlying London Clay Formation at this site.

13.4.9 With one borehole in the upper aquifer near the site (SA1066D), it is difficult to determine the direction of groundwater flow. However, it is likely that the direction of groundwater movement is west to east with topography in these shallow deposits.

13.4.10 The EA network does not include any monitoring boreholes sufficiently close by to provide representative water level in the upper aquifer at the site. The nearest EA borehole, TQ28/119 records groundwater levels in the Chalk aquifer and a record of levels dating back to 1976 is shown in Vol 17 Figure 13.4.4 (see separate volume of figures).

13.4.11 Further detail on water level monitoring is provided in Vol 17 Appendix K.3.

Licensed abstractions

13.4.12 There are no licensed groundwater abstractions from the upper aquifer within 1km of the Victoria Embankment Foreshore site.

13.4.13 There are six licensed groundwater abstractions from the Chalk or lower aquifer located within 1km of the site. However, the licensed abstractions from the lower aquifer (Chalk) would be unaffected by construction phase and operational phase at the Victoria Embankment Foreshore site due to

xii Response zone – the section of a borehole that is open to the host strata (EA, 2006)
xiii Confined – a term used to describe an aquifer in which water is held under pressure, such that groundwater in a borehole penetrating a confined aquifer would rise to a level above the top of the aquifer.

construction taking place entirely within the upper aquifer, the London Clay Formation and the Lambeth Group.

13.4.14 There are no known unlicensed groundwater abstractions within the upper or lower aquifers within 1km of the Victoria Embankment Foreshore site.

Groundwater source protection zones

13.4.15 The EA defines Source Protection Zone (SPZ) around all major public water supply abstraction sources and large licensed private abstractions in order to safeguard groundwater resources from potentially polluting activities. The nearest modelled SPZ lies at approximately 1.7km away to the south. This source abstracts from the Chalk (lower aquifer) and would be unaffected due to construction taking place within the upper aquifer, London Clay and Lambeth Group.

Environmental designations

13.4.16 There are no designations relevant to groundwater within 1km of the site.

Groundwater quality and land quality

13.4.17 Historical land use mapping at the Victoria Embankment Foreshore site reviewed as part of the land quality assessment identified no potentially contaminative sites (See Vol 17 Appendix K.7).

13.4.18 The baseline groundwater quality data presented in Vol 13 Appendix K.7, Vol 17 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 within 1km of the site (SR1066D at 80m and SR1062 at 850m) (are shown in Vol 17 Figure 13.4.1 in separate volume of figures). The data has been compared with the UK drinking water standards (The Water Supply Regulations, 2000)[5] or relevant Environmental Quality Standards – EQS) (River Basin Districts Typology, Standards and Groundwater Threshold Values, 2010) (Defra, 2010)[6].

13.4.19 There are no exceedances of the relevant standards for the nearest of these two boreholes and only one exceedance for the more distant one.

Groundwater flood risk

There are no reported incidents of groundwater flooding in the vicinity of the site, based on information from the City of Westminster Strategic Flood Risk Assessment (SFRA) (Westminster City Council, 2010)[7].

Groundwater receptors

13.4.20 Groundwater receptors which could be affected during construction or operation are summarised in Vol 17 Table 13.4.3 below. It can be seen that the only receptor of relevance to the Victoria Embankment Foreshore site and which has therefore been assessed, is the upper aquifer.

Vol 17 Table 13.4.3 Groundwater – receptors

Receptor	Construction	Operation	Comment
Groundwater body – upper aquifer	✓	✓	Penetrated by CSO drop shaft, interception chamber and connection culvert
Groundwater body – lower aquifer	×	×	CSO drop shaft does not extend into lower aquifer
Licensed abstractions – upper aquifer	×	×	No licensed abstractions
Licensed abstractions – lower aquifer	×	×	Six Chalk abstractions unaffected by small-scale depressurisation within the Lambeth Group
Unlicensed abstractions	×	×	No known abstractions
Planned developments	×	×	No planned Ground Source Heat Pump (GSHP's)

Symbols ✓ applies × does not apply

Receptor sensitivity

13.4.21 The upper aquifer is classified by the EA as a secondary A aquifer and is allocated a medium value in terms of both quantity and quality in this assessment.

Construction base case

13.4.22 The construction base case in Site Year 1 is as per the current baseline and also includes any developments that are likely to be complete and partially or fully operational during construction at the Victoria Embankment Foreshore site, and which would have the potential to lead to a change in the setting in respect to groundwater in the upper aquifer.

13.4.23 The basements associated with other developments identified in Vol 17 Table 13.3.1 could cause disruption to groundwater flow in the upper aquifer. Any substantive changes to the baseline conditions prior to construction would be detected by monitoring of groundwater levels in the upper aquifer.

13.4.24 None of the proposed developments identified in Vol 17 Table 13.3.1 would impact on the lower aquifer and it can be concluded that there would be no change to the base case in Site Year 1 of construction.

Operational base case

13.4.25 The operation base case is as per the construction base case. Therefore, it can be concluded that there would be no change to the base case at the start of operation.

13.5 Construction effects assessment

Construction impacts

Groundwater quality

13.5.1 The baseline groundwater quality data available for the upper aquifer in the vicinity of the Victoria Embankment Foreshore site shows no exceedances of the relevant standards.

13.5.2 The CSO drop shaft construction would be tight to the ground and there would be dewatering of the upper aquifer, therefore there would be no potential for mobilisation of contamination at this site is minimal. The magnitude of this impact on the upper aquifer has been assessed to be negligible.

Physical obstruction

13.5.3 The presence of certain sub-surface structures on shore may disrupt groundwater flow and alter groundwater levels in the upper aquifer.

13.5.4 The method for assessing the impact of all below ground activities upon the groundwater levels in the upper aquifer is described in Vol 2 Appendix K.2. It has been estimated that the groundwater level would rise during the construction phase at Victoria Embankment Foreshore site by approximately 0.2m, based on an estimated hydraulic gradient of 0.004.

13.5.5 Based on the limited available data, groundwater levels in the upper aquifer can reach 97.8mATD, which is approximately 6.8m below the existing ground surface at Victoria Embankment Foreshore site (around 104.6mATD). The ground investigation borehole SR1066D suggests that the upper aquifer is confined by overlying Alluvium at this location. On this basis, the predicted rise in water levels (0.2m) would result in increased hydraulic pressure within the confined unit (upper aquifer). The magnitude of impact on the upper aquifer has been assessed to be negligible.

Construction effects

13.5.6 By combining the impacts above with the receptor value (see para. 13.4.20) the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 2). The results are described in the following sections.

Groundwater quality

13.5.7 A negligible impact on the upper aquifer, a medium value receptor for groundwater quality, would result in a **negligible** effect.

Physical obstruction

13.5.8 A negligible impact on the upper aquifer, a medium value receptor for groundwater quantity, would result in a **negligible** effect.

13.6 Operational effects assessment

Operational impacts

Physical obstruction

13.6.1 The presence of the CSO drop shaft, interception chamber and connection culvert in the upper aquifer may disrupt groundwater flow and alter groundwater levels.

13.6.2 The method for assessing the impact of these elements, upon the groundwater levels in the upper aquifer is described in Vol 2 Appendix K.2. It is estimated that the groundwater level rise during the operational phase at Victoria Embankment Foreshore site would be less than 0.1m based on an estimated hydraulic gradient of 0.004.

13.6.3 The predicted rise in water levels (less than 0.1m) would result in increased hydraulic pressure within the confined unit (upper aquifer) rather than an increase of the water table. The magnitude of impact on the upper aquifer would be negligible.

Seepage into CSO drop shaft

13.6.4 An estimate of the seepage volumes into the CSO drop shaft at Victoria Embankment Foreshore site is included in Vol 2 Appendix K.3. The estimated loss of water resources from the upper aquifer is $57m^3$/annum (Vol 2 Appendix K Table K.4). The magnitude of impact on the upper aquifer would be negligible.

Seepage from CSO drop shaft

13.6.5 An estimate of the seepage volumes from the CSO drop shaft at Victoria Embankment Foreshore site is included in Vol 2 Appendix K.3. The shaft would be full for only approximately 3% of the year or 11 days per year (see Vol 3 Section 9). The estimated volume of seepage from the CSO drop shaft into the upper aquifer is $1.4m^3$/annum (Vol 2 Appendix K Table K.5). In addition, higher heads outside the drop shaft means that any risk of seepage from the drop shaft into the upper aquifer would be further reduced. The magnitude of impact on the upper aquifer would be negligible.

13.6.6 No other operational impacts are envisaged on the upper aquifer.

Operational effects

13.6.7 By combining the receptor value (para. 13.4.20) with the impacts above, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 2). The results are shown in the following sections.

Physical obstruction

13.6.8 A negligible impact on the upper aquifer, a medium value receptor for groundwater quantity, would lead to a **negligible** effect.

Seepage into CSO drop shaft

13.6.9 A negligible impact on a medium value receptor would lead to a **negligible** effect.

Seepage from CSO drop shaft

13.6.10 A negligible impact on the upper aquifer, a medium value receptor for groundwater quality, would lead to a **negligible** effect.

13.7 Cumulative effects assessment

Construction effects

13.7.1 Two developments identified Vol 17 Table 13.3.1 could potentially give rise to cumulative effects to groundwater in the upper aquifer through the inclusion of basements. It is considered that although there may be local impacts on groundwater levels in the upper aquifer due to the vicinity of the developments, these impacts are not expected to be significant. Any substantive changes would be detected by monitoring of groundwater levels in the upper aquifer.

Operational effects

13.7.1 No assessment of cumulative effects during operation has been undertaken, as no major development schemes within 1km of the site have been identified which would be under construction in Year 1 of operation of the Thames Tideway Tunnel at the Putney Embankment Foreshore site.

13.8 Mitigation

13.8.1 There are few impacts from the construction phase and those which have been identified would have negligible effects and therefore no mitigation is required.

13.8.2 Similarly, no significant effects are identified in the operational assessment and no mitigation is required.

13.9 Residual effects assessment

Construction effects

13.9.1 As no mitigation measures are required, the residual construction effects remain as described in Section 13.5. All residual effects are presented in Section 13.10.

Operational effects

13.9.2 As no mitigation measures are required, the residual operational effects remain as described in Section 13.6. All residual effects are presented in Section 13.10.

13.10 Assessment summary

Vol 17 Table 13.10.1 Groundwater – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Upper aquifer (groundwater quality)	Deterioration in groundwater quality caused by creation of a pathway	Negligible	None	Negligible
Upper aquifer	Change in groundwater storage as a result of physical obstruction	Negligible	None	Negligible

Vol 17 Table 13.10.2 Groundwater – operational assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Upper aquifer	Change in groundwater levels as a result of physical obstruction	Negligible	None	Negligible
Upper aquifer	Seepage into drop shaft affecting groundwater resources	Negligible	None	Negligible
Upper aquifer	Deterioration in water quality in the upper aquifer from seepage out of drop shaft	Negligible	None	Negligible

References

[1] Defra. *National Policy Statement for Waste Water* (2012)

[2] Environment Agency*. Introducing pollution prevention: PPG 1 – EA Consultation* (2011).

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

[4] 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.

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

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

[7] Westminster City Council. *City of Westminster Strategic Flood Risk Assessment* (2010).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 14: Water resources - surface water

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17 Victoria Embankment Foreshore site assessment

Section 14: Water resources – surface water

List of contents

Page number

14 Water resources – surface water 1
14.1 Introduction 1
14.2 Proposed development relevant to surface water 2
14.3 Assessment methodology 4
14.4 Baseline conditions 6
14.5 Construction effects assessment 10
14.6 Operational effects assessment 15
14.7 Cumulative effects assessment 18
14.8 Mitigation 19
14.9 Residual effects assessment 19
14.10 Assessment summary 20
References 21

List of plates

Page number

Vol 17 Plate 14.5.1 Surface water – prediction deposition around temporary works at the Victoria Embankment foreshore site 12
Vol 17 Plate 14.6.1 Surface water – prediction deposition around permanent works at the Victoria Embankment foreshore site 17

List of tables

Page number

Vol 17 Table 14.3.1 Surface water – scoping responses 4
Vol 17 Table 14.4.1 Surface water – receptors 7
Vol 17 Table 14.4.2 Surface water – London Bridge spot samples 8
Vol 17 Table 14.10.1 Surface water – construction assessment summary 20
Vol 17 Table 14.10.2 Surface water – operational assessment summary 20

14 Water resources – surface water

14.1 Introduction

14.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on surface water at the Victoria Embankment Foreshore site. The assessment of surface water presented in this section has considered the requirements of the *National Policy Statement for Waste Water*, 2012 (NPS)[1]. The physical characteristics of the surface water environment including surface water resources and quality are presented and the anticipated effects (including cumulative effects) on these resources addressed in the assessment that follows. Further details on how the NPS requirements relevant to surface water resources have been met can be found in Volume 2 Environmental assessment methodology Section 14.3.

14.1.2 The proposed development has the potential to affect surface water resources (ie, surface waterbodies including the tidal reaches of the River Thames [tidal Thames]) due to:

a. construction activities

b. operation of the main tunnel.

14.1.3 The assessment of construction and operational effects on surface water includes the following:

a. identification of existing surface water resources baseline conditions

b. determining base case conditions against which the proposed development has been assessed

c. assessment of significant effects from the proposed development during construction and operation

d. identification of mitigation measures and the residual effects both during construction and operation.

14.1.4 The assessment of surface water effects partially overlaps with that for groundwater, land quality, aquatic ecology and flood risk. Effects on groundwater resources are assessed separately in Section 13 Water resources – groundwater. Land quality is addressed in Section 8 Land quality. Effects on aquatic ecology as assessed in Section 5 Ecology – aquatic. A Flood Risk Assessment (FRA), which assesses the effects of the proposed development on surface water run-off and considers the use of Sustainable Drainage Systems (SuDS), has been carried out separately and is included in Section 15 Water resources – flood risk.

14.1.5 This assessment covers the effects of the proposed development at the Victoria Embankment Foreshore site and in particular in relation to the control of the Regent Street combined sewer overflow (CSO). It is however important to recognise that whilst the reductions in spills from the Regent Street CSO would be important to water quality in the immediate area of the CSO outfall, the overall water quality benefits in any part of the tidal Thames would accrue as a result of the project as a whole, rather than a single part of it. The catchment-wide effects on the tidal Thames, particularly in relation to the water quality improvements anticipated from the proposed Thames Tideway Tunnel project are assessed separately and presented in Volume 3 Project-wide effects assessment.

14.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

14.2 Proposed development relevant to surface water

14.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to surface water are set out below.

Construction

14.2.2 The Victoria Embankment Foreshore site is partly located within the River Thames channel, which means that some of the proposed working area would be within the river bed. A temporary cofferdam would be constructed in the foreshore to enable construction of the permanent works site (as shown on the Construction plans, see separate volume of figures – Section 1).

14.2.3 Barges would be used to import the majority of the cofferdam fill, although it is assumed that other imported materials would be brought in by road. Barges would also be used to export the majority of the cofferdam fill and excavations from the CSO drop shaft and other structures. In order to facilitate the use of barges, a campshed would be constructed adjacent to the working area.

14.2.4 A CSO drop shaft would be constructed at the site. Based on the geology at the site no dewatering of the upper aquifer would be required, although depressurisation of the Lambeth Group may be required. Disposal of pumped groundwater effluent can have an impact on surface water. See Section 13 of this volume for further details on the dewatering requirements.

14.2.5 The Tattershall Castle and Hispaniola bar/restaurant vessels are currently moored at or adjacent to the proposed working area and while the Hispaniola would remain in its current location, the Tattershall Castle would be temporarily relocated and then permanently relocated upstream in order to construct the proposed cofferdam and campsheds. The construction of new permanent mooring would therefore be required after construction.

14.2.6 The construction of in-river structures, and in particular the temporary cofferdam, would affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore, or deposition of sediments. The scour could occur around the face of the cofferdam or at the adjacent bridge supports (abutment scour) or across the channel width (contraction scour). Any potential scour development during construction would be monitored and if relevant trigger levels are reached, appropriate protection measures would be provided. Further details are provided in the *Scour and Accretion Monitoring and Mitigation Plan for Temporary Works in the Foreshore* (Vol 3 Appendix L.4).

Code of Construction Practice

14.2.7 There is a direct pathway for pollutants to be discharged to the tidal Thames due to the location of part of the construction area within the river channel. The *Code of Construction Practice (CoCP)*[i] Part A (Section 8) includes a number of measures to minimise the potential for impacts to surface waters, including impacts such as discharge of pollutants via surface water drains, and these are summarised below.

14.2.8 Appropriate drainage, sediment and pollution control measures are included in the *CoCP* (Section 8). These are in accordance with the relevant Pollution Prevention Guidelines (PPGs) issued by the Environment Agency (EA) and other Construction Industry Research and Information Association (CIRIA) documents.

14.2.9 All site drainage would be drained and discharged to mains foul or combined sewers. Where this is not practicable, the site would be drained such that accumulating surface water would be directed to holding or settling tanks, separators and other measures prior to discharge to the surface water drains. Foul drainage from the site welfare facilities would be connected to the mains foul or combined sewer.

14.2.10 Suitable spill kits would be provided and positioned in vulnerable areas, staff would be trained in their use and a record would be kept of all pollution incidents or near-misses, to ensure appropriate action is taken and lessons are learned from any incidents. Regular 'toolbox talks' would be held to raise staff awareness of pollution prevention and share lessons learned from any recorded incidents. There would be written procedures in place for dealing with spillages and pollution (the *Pollution Incident Control Plan* or *PICP*).

14.2.11 There are no site specific measures incorporated in the CoCP Part B (Section 8) relevant to the surface water assessment.

Operation

14.2.12 The operation of the main tunnel would enable the control of combined sewage flows generated during storms which would otherwise discharge to the tidal Thames at the Victoria Embankment Foreshore site from the Regent Street CSO. There would therefore be a reduction in the frequency, duration and volume of spills from this CSO.

14.2.13 The construction of the new permanent structure in the river would affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore, or deposition of sediments. Scour protection for the new permanent works would be provided and this

---

[i] *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B)

would be located within the parameter plan for the site. The approach to scour on third party structures, contraction scour and accretion during the operational phase would be a reactive approach with mitigation measures only provided if required. Further details of the approach are provided in the *Engineering Design Statement*.

14.3 Assessment methodology

14.3.1 The methodology used for the assessment of effects on surface water and their significance differs from the standard Website Transport Analysis Guidance (WebTAG) (DFT, 2003)[2] environmental impact assessment (EIA) methodology for water resources, in that the requirements of the Water Framework Directive (WFD) have also been taken into account. In the absence of an EIA specific assessment methodology for WFD compliance, an assessment methodology has been derived specifically for the Thames Tideway Tunnel project to assess significance of effects. The methodology also takes into consideration the requirements of the Urban Waste Water Treatment Directive (UWWTD)[3] and is outlined in Vol 2 Section 14. A WFD assessment for the project as a whole is presented in Vol 3 Section 14.

Engagement

14.3.2 Vol 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Vol 2 Section 14 summarises the engagement that has been undertaken for the surface water assessment and the consultation responses relevant to surface water.

14.3.3 Site-specific comments relevant to the surface water assessment at the Victoria Embankment Foreshore site are provided in Vol 17 Table 14.3.1.

Vol 17 Table 14.3.1 Surface water – scoping responses

Consultee	Comment	Response
EA (October 2012)	Relocation of Tattershall Castle should be included within EIA. There is potential it will impact flow regime and result in scour issues	The relocation of Tattershall Castle has been included in this assessment, see Section 14.5.

Baseline

14.3.4 The baseline methodology follows the methodology described in Vol 2 Section 14. There are no site-specific variations for identifying baseline conditions for this site.

Construction

14.3.5 The assessment methodology for the construction phase follows that described in Vol 2 Section 14. There are no site-specific variations for undertaking the construction assessment of this site.

14.3.6 The assessment year for construction effects is Site Year 1 when construction would commence. No modelled water quality data are available for this year. The water quality conditions for the base case have therefore been derived from available modelled simulation data which uses population projections for 2021. This assumption is considered reasonable as substantial changes in water quality are considered unlikely between 2016 and 2021.

14.3.7 The Lee Tunnel and the sewage works upgrades proposed at Mogden, Beckton, Crossness, Long Reach and Riverside sewage treatment works (STWs) would be operational by the time construction of the Thames Tideway Tunnel project commences, as described in Vol 2 Section 14. Significant improvements in the water quality in the tidal Thames are anticipated as a result of these projects. Both the construction base case and the operational base case would be the water quality in the tidal Thames with the Lee Tunnel and sewage works upgrades in place.

14.3.8 The construction base case has considered the developments that are scheduled to be complete and in operation by Site Year 1 (presented in Vol 17 Appendix N). The developments in Vol 17 Appendix N would not result in additional surface water receptors (ie, waterbodies) and are considered unlikely to result in changes in water quality as the majority of these developments are remote from the tidal Thames. It is considered unlikely that the proposed London Eye Pier Extension development would affect water quality as the development would extend the existing pier, therefore not substantially altering the use of the site. The base case would therefore not change from that outlined above.

14.3.9 The Elizabeth House and St James's Market developments would be under construction during Site Year 1. These developments have been considered in the cumulative effects assessment (see Section 14.7).

14.3.10 The assessment area for the assessment of effects of construction activities at Victoria Embankment Foreshore site would be limited to two sections of the river, namely the Thames Upper and Middle waterbodies listed below in Vol 17 Vol 17 Table 14.4.1 below.

14.3.11 Section 14.5 details the likely significant effects arising from the construction at the Victoria Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on surface water within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

Operation

14.3.12 The assessment methodology for the operation phase follows that described in Vol 2 Section 14. There are no site-specific variations for undertaking the operational assessment of this site.

14.3.13 The assessment year for operation effects is Year 1 of operation. As with the construction assessment, the operational assessment also relies on modelled water quality data which uses population projections for 2021. In addition, the influence of climate change on the proposed development has been assessed in 2080.

14.3.14 The operational base case has considered the developments that are scheduled to be complete and in operation by Year 1 of operation (presented in Vol 17 Appendix N). The developments in Vol 17 Appendix N would not result in additional surface water receptors and are considered unlikely to result in changes in water quality as the majority of these developments are remote from the tidal Thames. It is considered unlikely that the proposed London Eye Pier Extension development would affect water quality as the development would extend the existing pier. The base case would therefore not change from that outlined above.

14.3.15 No developments have been identified that would be under construction during Year 1 of operation, therefore a cumulative effects assessment has not been undertaken for the operational phase (see Section 14.7).

14.3.16 The operational assessment uses the same assessment area identified above for the construction assessment.

14.3.17 Section 14.6 details the likely significant effects arising from the operation at the Victoria Embankment Foreshore site.

Assumptions and limitations

14.3.18 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 14. Based on the geology at the site, it is assumed that depressurisation of the Lambeth Group would be required. There are no other assumptions and limitations specific to the assessment of this site.

14.4 Baseline conditions

14.4.1 The following section sets out the baseline conditions for surface water within and around the site. Future baseline conditions (base case) are also described.

Current baseline

Water quality

14.4.2 A list of all surface water receptors and their WFD status given in the *River Basin Management Plan* (*RBMP*) (EA, 2009)[4], which are either adjacent to the site or downstream of the site and therefore have the potential to be affected by the proposed development, is included in Vol 17 Vol 17 Table 14.4.1 below.

14.4.3 The overall classification of status or potential under the WFD is a detailed process, which includes an assessment of water quality, physico-chemical and hydromorphological elements. Reference should be made to the United Kingdom Technical Advisory Group (UKTAG)[5] guidance, as given in the *RBMP* (EA, 2009)[6].

Vol 17 Table 14.4.1 Surface water – receptors

Waterbody name/ID	Hydro-morpho-logical status	Current ecological quality	Current chemical quality	2015 Predicted ecological quality	2015 Predicted chemical quality	2027 target status
Thames Upper GB530603911403	Heavily modified	Moderate potential	Good	Moderate potential	Good	Good
Thames Middle GB530603911402	Heavily modified	Moderate potential	Fail	Moderate potential	Fail	Good

14.4.4 The River Thames and its Tidal Tributaries are designated as a Site of Importance for Nature Conservation (Grade III of Metropolitan importance). The Thames Upper (which stretches from Teddington to Battersea Bridge) and the Thames Middle (which stretches from Battersea Bridge to Mucking Flats) waterbodies are considered to be high value waterbodies as although its current and predicted status in 2015 (target date from *RBMP* (EA, 2009)[7]) is moderate potential; there is a status objective of good by 2027. In addition, the tidal Thames is a valuable water resource, habitat, and source of amenity, recreation, and transport route throughout London.

14.4.5 Sediment levels within the tidal Thames are estimated to currently reach a peak of 4,000kg/s in the lower tidal Thames estuary, or more than 40,000t of sediment a day during spring tides (HR Wallingford, 2006)[8].

14.4.6 In addition to the Regent Street CSO, which discharges to the tidal Thames, there are two other consented discharges within 1km of Victoria Embankment Foreshore site:

a. Northumberland St CSO, less than 100m downstream

b. Savoy St CSO, approximately 600m downstream

14.4.7 There is one licensed surface water abstraction within 1km of the Victoria Embankment Foreshore site, which is located adjacent to the London Eye.

14.4.8 The Victoria Embankment Foreshore site is approximately 1.5km upstream of the EA's spot sample site at London Bridge, as shown on Vol 17 Figure 14.4.1 (see separate volume of figures). Summary data from this monitoring point, which gives 90 percentile values for ammonium (concentration that is exceeded 10% of the time) and 10% percentile values for dissolved oxygen (DO) (concentration exceeded 90% of the time) for spot sample results collected between 2005 and 2009 are presented below in Vol 17 Table 14.4.2.

Vol 17 Table 14.4.2 Surface water – London Bridge spot samples

EA spot sample site	DO (mg/l) (10%)	Ammonium (mg/l) (90%)
Thames at London Bridge	4.81	10.92

14.4.9 The discharge from the Regent Street CSO has the effect of depleting DO in the tidal Thames as a result of the biological breakdown of organic matter in the discharges. This causes both a localised (at Victoria Embankment Foreshore site) and a more widespread (tidal Thames wide) effect of rapidly dropping DO levels. Vol 3 Section 14 details half-tide plots displaying the changes in DO levels along the tidal Thames.

14.4.10 Historical mapping has identified no contaminative uses on site and while a 250m search radius[ii] has identified pockets of historical industrial activities in the vicinity of the site, it is unlikely that any of these nearby sources would have impacted upon the channel substrate at Victoria Embankment Foreshore.

14.4.11 Foreshore sediment sampling carried out at the Victoria Embankment Foreshore site has showed contamination of the near surface sediments with concentrations of arsenic, copper, mercury, lead, chromium and zinc as well as the majority of PAHs recorded to be above approved sediment guidelines[iii] (Canadian Council for the Environment)[9]. An assessment of potential on-site contamination is provided within Section 8 of this volume.

Current CSO operation

14.4.12 The current operation of the Regent Street CSO has been characterised using the catchment model of the sewer system (see Vol 3 Section 14 for further details of catchment modelling), and the annual average duration, frequency and volume of spill has been defined as follows:

a. the CSO spills on average five times in the Typical Year[iv]

b. the CSO spills for a total duration of 13 hours in the Typical Year

c. the spill volume from the CSO is approximately 22,000m^3 in the Typical Year, representing 0.05% of the total volume discharged to the Tidal Thames in the Typical Year from all CSOs.

14.4.13 Using the same model, the annual polluting loading of biochemical oxygen demand (BOD), ammonia and total Kjeldahl nitrogen (TKN) (the sum of organic nitrogen, ammonia (NH_3), and ammonium (NH_4^+)) of spill from the Regent Street CSO has been defined as follows:

[ii] 250m buffer has been included within the assessment area in order to take account of any off-site sources / receptors, as discussed in the Vol 2 Section 8.

[iii] In order to assess potential risk to aquatic organisms, reference was made to PLA approved sediment quality guidelines, namely the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. The guidelines provide contaminant concentration limits in the form of Threshold Effect Level (TEL) and Probable Effect Level (PEL).

[iv] Typical Year: single year which is most representative of an observed typical year of rainfall with the dataset. The 1979-1980 'water year' defined as the 12 month period ending on the 30th September 1980.

a. the CSO discharges 2,000kg of BOD in the Typical Year

b. the CSO discharges 50kg of ammonia in the Typical Year

c. the CSO discharges 180kg of TKN in the Typical Year.

14.4.14 Each discharge increases the risk of exposure to pathogens for river users who come into contact with the water. An assessment of health impacts upon recreational users of the River Thames was conducted and reported by the Health Protection Agency in 2007 (Lane *et al.,* 2007)[10]. The study concluded that risk of infection can remain for two to four days following a spill as the water containing the sewage moves back and forward with the tide[v]. The same study also noted that analysis of the illness events reported against discharges on the tidal Thames shows that 77% of cases related to rowing activities undertaken within three days of a CSO spill.

14.4.15 Assuming the average five spills per annum from the Regent Street CSO occur on separate days, there could be up to a maximum of 20 days per year where recreational users are at risk of exposure to pathogens in the vicinity of the outfall as a result of the Regent Street CSO spills alone (Lane et al., 2007)[11].

14.4.16 The operation of the Regent Street CSO results in the discharge of sewage litter along with the discharge of effluent. It has been estimated by the *Thames Tunnel Strategic Study (TTSS)* that overflows from all the CSOs along the tidal Thames introduce approximately 10,000t of sewage derived solid material to the tidal Thames annually. Catchment modelling of the current CSO operation has defined the average volume of discharge from the Regent Street CSO and assuming litter tonnages are proportional to discharge volumes, this would indicate that approximately 6t of sewage derived litter is discharged from the Regent Street CSO in the Typical Year. An assessment of the amenity effects of the sewage litter is given in Vol 3 Section 10.

Construction base case

14.4.17 As explained in Section 14.3, both the construction base case and the operational base case would therefore include the water quality in the tidal Thames with the Lee Tunnel and sewage works upgrades in place and this is defined below under operational base case.

14.4.18 The base case in Site Year 1 of construction taking into account the schemes described in Section 14.3 would not change since no new sensitive receptors would be introduced.

Operational base case

14.4.19 As noted above, the operational base case would be the same as the construction base case and would include water quality improvement achieved by the Lee Tunnel and the sewage works upgrades.

---

[v] The EA has provided advice on CSO excursion areas, which states that CSOs below Tower Bridge will only impact the Thames Middle waterbody and those upriver of Tower Bridge will impact both the Thames Upper and Thames Middle waterbodies.

14.4.20 The base case in Year 1 of operation taking into account the schemes described in Section 14.3 would not change since no new sensitive receptors would be introduced.

14.4.21 Catchment modelling results of the base case have demonstrated that by Year 1 of operation (assumed using 2021 modelled assumptions), the frequency, duration and volume of the Regent Street CSO would have increased (as a result of increased population) beyond the current baseline as follows:

a. the CSO would spill ten times in the Typical Year (five more than the current baseline)

b. the CSO would spill for 21 hours in the Typical Year (eight hours more than the current baseline)

c. the spill volume from the CSO would be approximately 26,000m^3 in the Typical Year (4,000m^3 more than the current baseline).

14.4.22 The same catchment modelling has demonstrated that by the operational assessment year, the annual polluting loading of BOD, ammonia and TKN would have increased (as a result of increased population) beyond the current baseline as follows:

a. the CSO would discharge 3,100kg of BOD in the Typical Year (1,100kg more than the current baseline)

b. the CSO would discharge 70kg of ammonia in the Typical Year (20kg more than the current baseline)

c. the CSO would discharge 270kg of TKN in the Typical Year (90kg less than the current baseline).

14.4.23 Following on from the interpretation of the current baseline as per para.14.4.15 the number of risk days for river users being exposed to pathogens during the operational base case year (taking into account 2021 modelled assumptions) would be a maximum of 40 days in the Typical Year as a result of spills from the Regent Street CSO alone.

14.4.24 Similarly, the tonnage of sewage derived litter discharged from the Regent Street CSO can be expected to increase by approximately 15%, from approximately 6t to approximately 7t in the Typical Year.

14.5 Construction effects assessment

14.5.1 This section presents the construction impacts that could occur at the site and identifies where no further assessments of effects is required (eg, where the impact pathway has been removed). The second part of the section identifies any effects that may occur and the likely significance of these effects.

Construction impacts

Temporary land take and morphological changes

14.5.2 In order to accommodate the temporary works at the Victoria Embankment Foreshore site, construction of a temporary cofferdam within the river channel would be required as described in Section 3 of this volume. The channel would be more constricted than at present and together with the new profile of the structure, this would be likely to lead to changes in flows (velocities, directions) and lead to changes in scour and deposition of sediments.

Release of sediments from piling and scour

14.5.3 Dredging is not likely to be required at the Victoria Embankment Foreshore site. Minor amounts of sediment could be released during piling operations. The total volume of sediment released to the tidal Thames by the proposed pilling activity at all construction sites has been estimated to be 890t[vi]. The proportion of this estimate that would originate from the Victoria Embankment Foreshore site is approximately 66t.

14.5.4 It is also possible that the temporary cofferdam would affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore and could result in the mobilisation of suspended solids (see Section 14.2). Any potential scour development during construction would be monitored and protection measures provided if set trigger levels are reached.

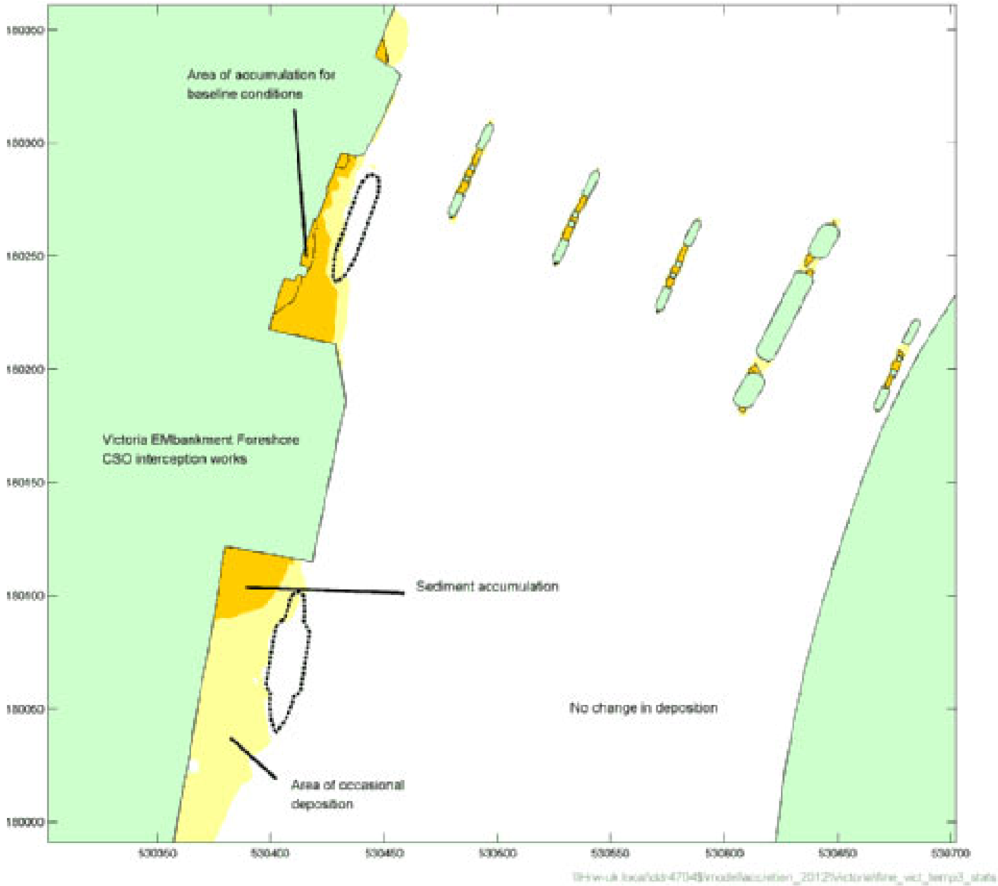
14.5.5 The tidal Thames is a high sediment environment and levels already present within the tidal Thames are estimated to be a peak of 4,000kg/s in the lower Thames estuary or more than 40,000t of sediment passing the site four times a day during spring tides (HR Wallingford, 2006)[12] . In this context, the volumes produced by the construction works from piling, dredging or scour would not be detectable against natural fluctuations in sediments and would not have an impact on surface water resources (HR Wallingford, 2006)[13] and are therefore not considered further within the assessment.

Deposition

14.5.6 The temporary cofferdam would be likely to lead to changes in flows (velocities, directions) and cause changes in deposition of sediments around the Victoria Embankment Foreshore site. These sediments could be those generated by the project itself but would also include sediments occurring naturally in the water column. Modelling carried out (Vol 3 Appendix L.3) has predicted the extent of this deposition, as shown below in Vol 17 Plate 14.5.1.

[vi] An assessment of the potential sediment losses anticipated from construction activities within the foreshore is provided in the *Habitats regulation assessment.*

Vol 17 Plate 14.5.1 Surface water – prediction deposition around temporary works at the Victoria Embankment foreshore site



14.5.7 Most deposition likely to be localised and occur in newly created areas of slack water (as shown above in Vol 17 Plate 14.5.1) but may be remobilised by spring tides (for deposition during neap tides) or by large fluvial flows (for deposition during seasonal low fluvial flows). The overall impact on channel morphology would be negligible.

14.5.8 Impacts on channel morphology from deposition can have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

Pumping and pollution during cofferdam construction

14.5.9 The main pathways for surface water quality impacts during construction at the Victoria Embankment Foreshore site are as a result of the requirement for a cofferdam to be constructed in the river channel for both the main construction work and to house the permanent structures once construction is complete.

14.5.10 The cofferdam would be constructed by driving sheetpiles into the river bed, which would be sealed and the water pumped out into the river channel. As the works would be in the channel, there would be a direct pathway for pollutants to be discharged to the river during the construction of the cofferdam which could impact on water quality in this location of the tidal Thames. The adoption of appropriate drainage and pollution control measures as included in the *CoCP* Part A (Section 8) (see para. 14.2.7) should remove the impact pathway.

14.5.11 Before being released to the river, the water to be pumped from behind the cofferdam would be subject to settlement using a lagoon/pond, silt trap or other suitable method (see *CoCP* Part A (Section 8)) to ensure excessive levels of potentially contaminated suspended solids are not discharged to the tidal Thames. It is considered that via the proposed management of pumping out water from the cofferdam area, the pollution pathway is removed and therefore no impact is anticipated from this source and this is not considered further in the assessment.

Foreshore and contamination within the river channel

14.5.12 Samples taken of foreshore sediment at Victoria Embankment indicated the presence of arsenic, copper, mercury, lead, zinc, chromium and polycyclic aromatic hydrocarbon (PAH) at levels elevated against the threshold effect level (TEL), although overall the mobility of metal and PAH contaminants has been recorded to be low. Given the current environment (ie, significant water flow), it is expected that the majority of mobile contaminants have already been leached from the sediment, although the disturbance of sediments caused by the proposed construction works could cause additional sediment contamination to be leached.

14.5.13 Any additional sediment input to the river as a result of construction processes would be minimal in comparison to the already high background levels (see para. 14.5.3) and any mobilised contaminants would be expected to be rapidly diluted and their potential impact on water quality attenuated. Sediments mobilised by the construction works (including piling for the cofferdam walls) are therefore likely to pose only a low risk of causing deterioration in water quality. Such sediments are continually transported along the tidal Thames as a natural action of erosion and deposition, as well as by other dredging operations and river users.

14.5.14 Therefore, there is considered to be no impact from this source and this is not considered further within this assessment.

Surface water drainage

14.5.15 Once constructed, the cofferdam area and the shaft construction work within it would be protected from flooding to ensure the construction activity is not affected by high water levels. This would require the cofferdam walls to be raised to at least the existing flood defence level. Surface water from rainfall on the CSO drop shaft construction area may need to be pumped periodically to ensure the working activities are not affected by ponding of rainwater, if drainage of surface water by gravity is not possible.

14.5.16 The construction of the working area and drainage of surface water from it could therefore create a direct pathway to the river for contaminated runoff, high suspended solids and other pollution from the site. However, appropriate site drainage would be used to control pollutants in the general site runoff, preventing the discharge of pollutants via combined or surface water drains as part of the surface water discharge from the construction site (see *CoCP* Part A (Section 8)). This would enable the pollution pathway to be removed and therefore there is considered to be no impact from this source. Surface water drainage is not considered further within this assessment.

Debris accumulation

14.5.17 The temporary cofferdam at the Victoria Embankment Foreshore site may interact with Hungerford Bridge and relocated Tattershall Castle to cause an area of slack 'dead' water between them. Floating debris, oils and other pollutants could build up in the area if the flow of the river is unable to clear the accumulation due to the shelter provided by the Victoria Embankment Foreshore site working area.

Dewatering

14.5.18 Based on the geology at the site depressurisation of the Lambeth Group would be required. Settlement of suspended solids within the dewatering would minimise the levels of contaminants within the effluent, which tend to be associated with particulates.

14.5.19 Pumped groundwater effluent would be subject to appropriate treatment prior to discharge to the tidal Thames and it is therefore considered that there is no pollution pathway and hence no impact from dewatering. This is therefore not considered further within the assessment.

Relocation of the Tattershall Castle

14.5.20 The vessel Tattershall Castle would be permanently relocated upstream in order to construct the proposed cofferdam and campsheds, with a new permanent mooring required. There is potential the relocation could impact flow regime and result in scour issues. However, modelling carried out by the project incorporated the relocated vessel (Vol 3 Appendix L.3). In addition any scour development would be monitored during construction and mitigation provided if the scour exceeded trigger values (see Vol 3 Appendix L.4).

Construction effects

14.5.21 The potential surface water impacts identified above as likely as a result of construction at Victoria Embankment Foreshore site have been assessed for their likely effects on WFD objective compliance, compliance with other legislation and effects on other users of the surface waters. The surface water receptors are identified in Vol 17 Table 14.4.1.

14.5.22 The WFD objectives set out in Article 4 of the WFD are as follows:

a. WFD1 – Prevent deterioration of the status of all bodies of surface water

b. WFD2 – Protect, enhance and restore all bodies of surface water, with the aim of achieving good surface water status by 2015

c. WFD3 – Protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status by 2015

d. WFD4 – Reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances.

14.5.23 The significance of these effects has then been assessed based on the magnitude of the impacts as described in Vol 2 Section 14.5.

Temporary land take and morphological changes

14.5.24 The presence of the temporary construction cofferdam in the channel would impact on the morphology of the tidal Thames in this location, altering it from its current state.

14.5.25 At the end of the construction, part of the riverbed would be reinstated following the removal of the temporary structures (see Vol 3 Appendix C4). The temporary change is also unlikely to alter the “in place” mitigation measures identified in the *RBMP* as necessary to achieve good ecological potential. Therefore, because mitigation measures required to meet the WFD objective of Good Ecological Potential could still be implemented irrespective of the proposed development at this site, works at this site would not prevent any of the WFD objectives being met in the future. However, there would be a measurable change in foreshore morphology during construction and hence the effect is considered to be **minor adverse**.

14.5.26 Impacts on channel morphology can have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

Debris accumulation

14.5.27 The change in flow regime of the tidal Thames due to piling activities may result in an area of slack ‘dead’ water between the construction area and the nearby Hungerford Bridge and the relocated Tattershall Castle, where floating debris, oils and other pollutants could build up and reduce the amenity value of the river for recreational users.

14.5.28 A change in appearance and aesthetic quality of the tidal Thames in the near vicinity of the site is likely, but it would not prevent or limit recreational use of the tidal Thames in this location. There are no abstractions or discharges that could be affected by this change in debris accumulation, which would also not affect compliance with the WFD or other legislation as it is not assessed under this legislation. Therefore, the effect is considered to be **minor adverse**.

14.6 Operational effects assessment

14.6.1 This section presents the operational impacts that could occur at the site. The second part of the section identifies any effects that may occur and the likely significance of these effects.

Operational impacts

Reduction in Regent Street CSO spills

14.6.2 Catchment modelling of the operational development case (with the operational Thames Tideway Tunnel project) predicts that by Year 1 of operation, with the project in place, the Regent Street CSO would not spill into the tidal Thames in the Typical Year. The frequency, duration and volume of spill at Victoria Embankment Foreshore site would therefore be reduced by 100% as a result of the operation of the Thames Tideway Tunnel project.

14.6.3 Given the reductions in spills, the number of days in which river users would be exposed to pathogens in the development case year would be reduced to zero during the Typical Year (a reduction of up to 40 days of risk of exposure).

14.6.4 Similarly, the tonnage of sewage derived litter from the CSO can be expected to reduce by 100%, to zero in the Typical Year.

14.6.5 Catchment modelling of the 2080 development case (to account for the effects of climate change and predicted increases to population) has simulated that by 2080 with the project in place, the Regent Street CSO would not spill into the tidal Thames in the Typical Year

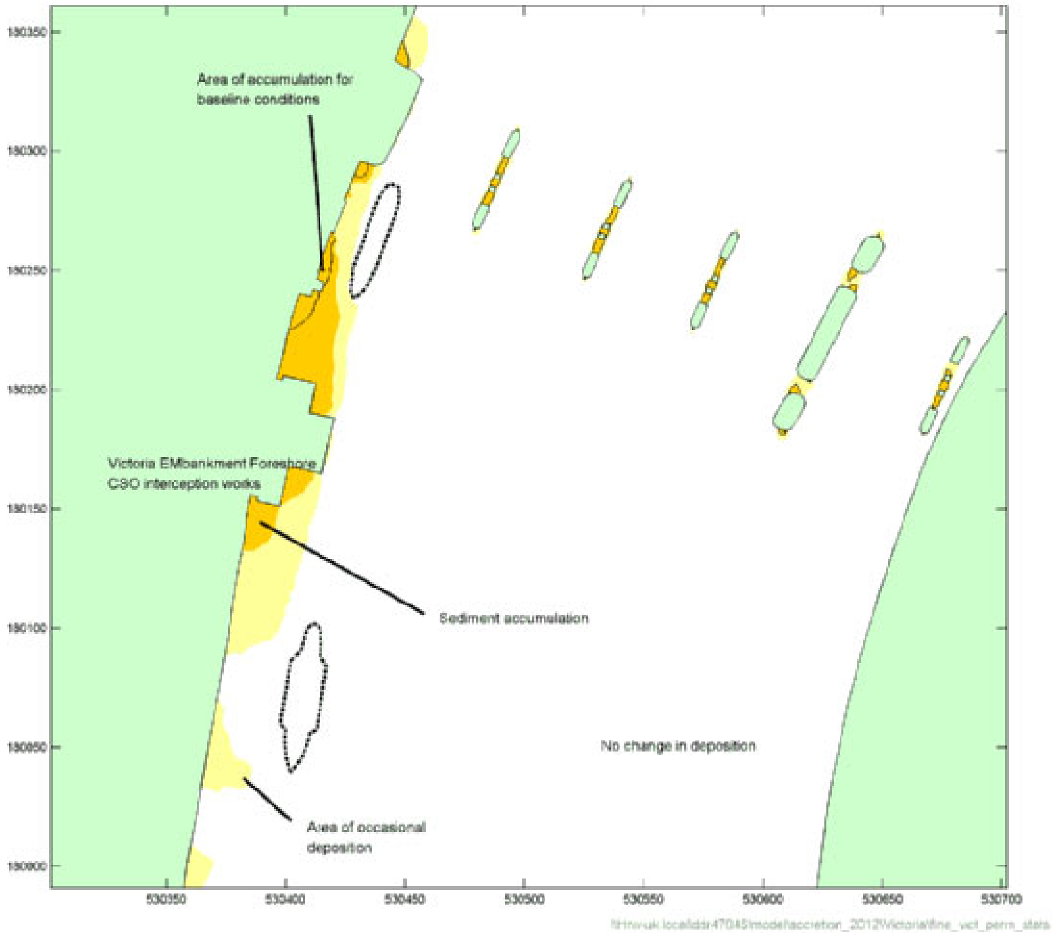
Permanent land take and morphological changes

14.6.6 In order to accommodate the permanent works at the Victoria Embankment Foreshore site, construction of a permanent structure within the river channel would be required. The permanent structure could affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore and could result in the mobilisation of suspended solids. The approach to scour protection for the permanent works is described in the *Engineering Design Statement* as described in Section 14.2 and scour is not considered further with the assessment.

Deposition

14.6.7 The permanent works cofferdam would be likely to lead to changes in flows (velocities, directions) and cause changes in deposition of sediments around the Victoria Embankment foreshore site. These sediments could be those generated by the project itself but would also include sediments occurring naturally in the water column. Modelling carried out (Vol 3 Appendix L.3) has predicted the extent of this deposition, as shown below in Vol 17 Plate 14.6.1.

Vol 17 Plate 14.6.1 Surface water – prediction deposition around permanent works at the Victoria Embankment foreshore site



14.6.8 Most deposition is likely to be localised (as shown above in Vol 17 Plate 14.6.1) but may be remobilised by spring tides (for deposition during neap tides) or by large fluvial flows (for deposition during seasonal low fluvial flows). The overall impact on channel morphology would be negligible.

14.6.9 Impacts on channel morphology from deposition can have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

Operational effects

Reduction in Regent Street CSO spills

14.6.10 The reduction in spills from the Regent Street CSO would represent an important contribution towards

a. meeting the requirements of the Urban Waste Water Treatment Directive[14] (UWWTD) in relation to the Regent Street CSO

b. meeting the required TTSS DO standards

c. moving the tidal Thames towards its target status under the WFD , both locally and throughout the tidal Thames.

14.6.11 Therefore, the reduction in spills would be a **major beneficial** effect, most notably in the context of the UWWTD. It should be noted that, as explained in Section 14.1, the water quality in the vicinity of Victoria Embankment Foreshore site also depends on the project-wide improvements, as documented in Vol 3 Section 14.

14.6.12 The associated reduction in exposure to pathogens would greatly improve the conditions for recreational users of the tidal Thames around Victoria Embankment, allowing the tidal Thames in this location to be used more frequently with a reduced risk of exposure. This is considered to be a **moderate beneficial** effect.

14.6.13 The reduction in sewage litter discharge would also improve the aesthetic quality of the tidal Thames locally, improving conditions for recreational users. This is considered to be a **moderate beneficial** effect. As explained in Section 14.4, an assessment of the amenity effects of the sewage litter is given in Vol 3 Section 10.

Permanent land take and morphological changes

14.6.14 The permanent structures proposed in the tidal Thames have been designed and engineered to minimise the impediment of flow and although some changes to flows are likely, the changes are unlikely to lead to further substantive deterioration of the morphological condition of the channel which is already modified by flood defences and channel dredging. In addition, the changes in flow are unlikely to lead to an area of slack ‘dead’ water around the permanent structures. The WFD objectives are not considered to be affected by this change, and hence the effect is considered to be **minor adverse**.

14.6.15 Impacts on channel morphology can also have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

14.7 Cumulative effects assessment

14.7.1 Considerable improvements in the water quality of the tidal Thames will occur as a result of the works associated with the Lee Tunnel and sewage works upgrades. These already form part of the base case and so are not considered as part of the assessment of cumulative effects.

14.7.2 Of the developments described in Section 14.3, which could potentially give rise to cumulative construction effects with the proposed development at the Victoria Embankment site, it is not considered that any would lead to cumulative effects on surface water. This is because the other developments are remote from the river and not of sufficient scale such that they are likely to generate significant effects in relation to surface water quality.

14.7.3 As explained in Section 14.3, no developments have been identified that would be under construction during Year 1 of operation, therefore a cumulative effects assessment has not been undertaken for this phase. No significant cumulative effects have therefore been identified for the construction or operational phases at this site. The effects on surface water would therefore remain as described in Section 14.5 and Section 14.6 above.

14.8 Mitigation

14.8.1 No significant adverse effects have been identified and therefore no mitigation is required.

14.9 Residual effects assessment

Construction effects

14.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 14.5. All residual effects are presented in Section 14.10.

Operational effects

14.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 14.6. All residual effects are presented in Section 14.10.

14.10 Assessment summary

Vol 17 Table 14.10.1 Surface water – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Upper	Temporary changes to channel morphology (cofferdam and associated scour protection construction)	Minor adverse	None	Minor adverse
Thames Upper	Changes in aesthetic quality due to debris accumulation in slack water between structures	Minor adverse	None	Minor adverse

Vol 17 Table 14.10.2 Surface water – operational assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Middle and Thames Upper	Compliance with UWWTD and WFD. Improved water quality in the vicinity of the Regent Street CSO by reduced pollutant loading and no reduction of DO levels due to reduced spill frequency, duration and volume from the Regent Street CSO	Major beneficial	None	Major beneficial
Thames Upper	Risk of exposure days to pathogens would be reduced to zero days in the Typical Year (a reduction of up to 40 days of risk of exposure)	Moderate beneficial	None	Moderate beneficial
Thames Upper	Sewage derived litter discharge at Regent Street CSO would be reduced by 100% improving the aesthetic quality of the river locally	Moderate beneficial	None	Moderate beneficial
Thames Upper	Change in channel morphology caused by permanent foreshore/in-channel structures	Minor adverse	See Section 5 of this volume	Minor adverse

References

[1] HM Government. *National Policy Statement for Waste Water: A framework document for planning decisions on nationally significant waste water* (March 2012). Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf

[2] Department for Transport (DFT). *Transport Analysis Guidance* (WebTAG) (2003). Available at: http://www.dft.gov.uk/webtag/documents/overview/unit1.2.php

[3] *The Urban Waste Water Treatment Directive, Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment.* Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0271:EN:NOT.

[4] Environment Agency. *River Basin Management Plan, Thames River Basin District* (2009).

[5] The United Kingdom Technical Advisory Group (UKTAG) to the WFD. Available at: http://www.wfduk.org/.

[6] Environment Agency (2009). See citation above.

[7] Environment Agency (2009). See citation above.

[8] HR Wallingford (report prepared for Thames Water). *Combined Sewer Overflow Foreshore Works Fluvial Modelling – Overall Impact upon the tidal Thames* (2012).

[9] Canadian Council for the Environment. *Sediment Quality Guidelines for the Protection of Aquatic Life*. Available at: http://st-ts.ccme.ca/.

[10] Lane, C, Surman-Lee, S, Sellwood, J and Lee, JV. *The Thames Recreational Users Study Final Report* (2007).

[11] Lane et al. See citation above.

[12] HR Wallingford. See citation above

[13] HR Wallingford. See citation above.

[14] *The Urban Waste Water Treatment Directive.* See citation above.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.17**

Volume 17: Victoria Embankment Foreshore site assessment

Section 15: Water resources - flood risk

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

Hard copy available in

Box **31** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 17: Victoria Embankment Foreshore site assessment

Section 15: Water resources – flood risk

List of contents

Page number

15 Water resources – flood risk 1

15.1 Introduction 1

15.2 Elements of the proposed development relevant to flood risk 2

15.3 Assessment of flood risk 4

15.4 Design measures 13

15.5 Assessment summary 16

References 20

List of tables

Page number

Vol 17 Table 15.3.1 Flood risk – modelled water levels 6

Vol 17 Table 15.5.1 Flood risk – FRA summary 18

This page is intentionally blank

15 Water resources – flood risk

15.1 Introduction

Background

15.1.1 This section forms a Flood Risk Assessment (FRA) for the Victoria Embankment Foreshore site. This FRA has been developed in line with the requirements of the National Policy Statement (NPS) for Waste Water (Defra, 2012)[1] Section 4.4 and includes a qualitative appraisal of the flood risk posed to the site, the potential impact of the development on flood risk on and off the site and an appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. Further details on how the NPS requirements relevant to flood risk have been met can be found in Volume 2 Environmental assessment methodology Section 15.3.

15.1.2 The proposed development is described in Section 3 of this volume. Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 17 Victoria Embankment Foreshore Figures).

15.1.3 A summary of the regulations and policy that have informed the assessment are presented in this section. Section 15.2 provides a summary of the proposed development in relation to flood risk. Section 15.3 provides an assessment of the flood risk to the site and elsewhere as a result of the development, during both the construction and operational phases. Section 15.4 provides details of the design measures that have been adopted within the proposals to ensure the flood risk to the site is not increased and ensure that flood risk does not increase elsewhere.

15.1.4 The assessment of flood risk should be considered in conjunction with the assessment of other water resources ie, groundwater and surface water. The assessment of effects on groundwater and surface water is presented in Section 13 and Section 14 of this volume respectively.

15.1.5 A project-wide FRA has been undertaken and is presented in Volume 3 Project-wide effects assessment

Regulatory context

15.1.6 The NPS, seeks to ensure that where the development of new waste water infrastructure is necessary in areas at risk of flooding, flood risk from all sources of flooding is taken into account at all stages in the planning process in order for the development to be safe without increasing flood risk elsewhere.

15.1.7 A review of planning policy relevant to the proposed development is provided in Vol 17 Appendix M.1.

NPS Sequential and Exception Tests

15.1.8 The Waste Water NPS aims to direct development towards low risk areas through the use of a sequential approach which avoids inappropriate development in areas at risk of flooding. Using this approach, preference should be given to locating projects in Flood Zone 1 although if there is no 'reasonably available site' in Flood Zone 1 then projects should be located in Flood Zone 2. However if there is no 'reasonably available site' in Flood Zones 1 or 2, then nationally significant waste water infrastructure projects can be located in Flood Zone 3 subject to the Exception Test.

15.1.9 The NPS states that the Exception Test should be applied where it is not possible for the project to be located in zones of lower probability of flooding than Flood Zone 3.

15.1.10 The Exception Test is detailed in Section 4.4.15 of the NPS. The test requires overall sustainability benefits (part a) to outweigh flood risk, whilst ensuring the development is safe and does not increase flood risk elsewhere (part c) and is preferably located on previously developed land (part b).

15.1.11 The overall project is considered to pass the Sequential Test, as detailed in Vol 3 Section 15. The project-wide Exception Test is also detailed in Vol 3 Section 15.

15.1.12 The proposed development at Victoria Embankment Foreshore would form an integral part of the Thames Tideway Tunnel project and so would help achieve the project-wide sustainability benefits outlined in the *Sustainability Statement*. Given the project-wide sustainability benefits, the proposed development is considered to satisfy part a) of the Exception Test.

15.1.13 The proposed development would not be entirely located on previously-developed land. However, as detailed in Vol 3 Section 15 no reasonably alternative sites on developable previously- developed land were identified during the sites selection process and as such the proposed development at Victoria Embankment Foreshore would satisfy part b) of the Exception Test.

15.1.14 This FRA shows that the proposed development would be appropriate for the area as flood risk to the development would be managed through appropriate design measures such as raising the site out of the functional floodplain and constructing new flood defences to protect the site to the 1 in 1000 year standard. As such, the development can be considered safe and the development would not lead to a significant increase in flood risk on the surrounding areas. Therefore, part c) of the Exception Test has also been met.

15.2 Elements of the proposed development relevant to flood risk

15.2.1 The proposed development at this site is described in Section 3 of this volume. The elements of the proposed development relevant to flood risk are set out below.

Construction

15.2.2 The construction elements of the proposed development relevant to flood risk would include:

a. A temporary cofferdam would be constructed to the same height as the existing flood defence level.

b. A barge grid/campshed would be constructed on the upstream side of the cofferdam to allow barge mooring and the loading and unloading of material.

c. The River Thames flood defence wall situated between the proposed site and the embankment would be removed to allow site access.

d. A connection would be made to the northern Lower Level Sewer No.1. To enable this, an overflow weir would be constructed on the northern Low Level Sewer No.1 upstream of the Regent Street combined sewer overflow (CSO) to control flows from the CSO. A connection culvert would also be constructed from the weir chamber to the drop shaft connecting to the main tunnel via the Regent Street connection tunnel.

e. The Regent Street sewer to the west of the outfall would be retained outside the overflow weir works. The Regent Street CSO would be retained below the works outside the temporary cofferdam or managed by extending a temporary flume through the temporary cofferdam walls.

f. The Tattershall Castle floating bar and restaurant and associated mooring would be permanently relocated just upriver to a position currently occupied by two service moorings which would require removal. This would require that the bar is moved twice, once during construction and a second time once the works are complete.

Code of Construction Practice

15.2.3 Appropriate guidance regarding flood defence construction and emergency planning is included in the *Code of Construction Practice (CoCP)*. *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B). The relevant measures are summarised below.

15.2.4 The *CoCP* (Section 8) states that no temporary living accommodation would be permitted onsite and that an evacuation route and safe refuge should be provided in the event of a flood event.

15.2.5 The *CoCP* (Section 8) states that the contractor would be responsible for providing and maintaining continuous flood defence provision, for both permanent and temporary works, to the statutory flood defence level[i] as detailed within the FRA. This is a requirement of the Thames River Protection of Floods Amendment Act 1879[2].

---

[i] The level to which the flood defences must be maintained to ensure that both the sites themselves and third-party land and assets in the surrounding area are protected from flooding.

Operation

15.2.6 The permanent structures at the Victoria Embankment Foreshore site would include:

a. A new flood defence wall would be constructed along the periphery of the operational area as part of the permanent works on Victoria Embankment Foreshore site.

b. The northern Low Level Sewer No. 1 would be connected to the main tunnel, which along with the connection to the low level sewer at Blackfriars Bridge Foreshore and Chelsea Embankment Foreshore would indirectly control 10 CSOs.

c. The stepped terraces around the front sides of the structure would sit below the defence level and would occasionally be flooded, although all are above highest astronomical tide level (HAT). This would be accessible public realm space.

d. As the site is adjacent to the River Thames surface water associated with the impermeable surfaces on the site would be discharged directly into the tidal reaches of the River Thames (tidal Thames) without attenuation.

15.3 Assessment of flood risk

Introduction

15.3.1 The NPS requires that all potential sources of flooding that could affect the proposed development are considered.

15.3.2 This assessment is based on a screening exercise that identified relevant potential flood sources and pathways. The tidal and fluvial assessments were based on the flood zones which do not take account of the presence of existing defences.

15.3.3 The assessment of flood risk from the proposed development takes into account the proposed design measures detailed in 15.4.

15.3.4 It should be noted that due to the nature of a flood risk assessment, the risk based approach outlined in the National Planning Policy Framework (NPPF) (Communities and Local Government, 2012)[3] was considered to be preferable to the general environmental impact assessment (EIA) methodology described in Vol 2 Section 3. This approach is based on the probability of an event occurring as a result of the proposed development rather than a direct change in conditions. This is detailed further in the methodology (see Vol.2).

Tidal flood risk to the development

Level of risk based on the flood zones

15.3.5 The majority of the Victoria Embankment Foreshore site is situated within the foreshore of the River Thames (with the exception of the footpath along the River Thames), adjacent to the northern river bank, upstream of the Hungerford Bridge. The Environment Agency (EA) Flood Map identifies the adjacent riverfront area as lying within Flood Zone 3. The location of the site in relation to the flood zones is shown in Vol 17 Figure 15.3.1 (see separate volume of figures). As the site is located within the foreshore, it is part of the active floodplain of the River Thames and subject to daily tidal inundation. This area is therefore considered as functional floodplain and is classified as Flood Zone 3b (land where water has to flow or be stored in times of flood).

15.3.6 Due to the undefended nature of the floodplain at this location and the frequency at which tidal inundation occurs, the current risk of flooding to this foreshore part of the site (without the design measures) is considered to be very high (see Vol 2 Section 15).

Existing tidal defences

15.3.7 A raised flood defence wall is aligned along the boundary between the River Thames and Victoria Embankment. The defence wall is landward of the proposed site (which is located in the foreshore) and the site (with the exception of the footpath along the River Thames) is therefore not currently protected from tidal flooding by flood defences other than the Thames Tidal Barrier located further downstream.

15.3.8 The EA stated that the statutory flood defence level relevant to the Victoria Embankment Foreshore site is 5.41m Above Ordinance Datum (AOD). The National Flood and Coastal Defence Database (NFCDD) (EA, 2011)[4] crest level of the flood defences along Victoria Embankment is 5.49mAOD.

15.3.9 Condition surveys carried out by the EA in April 2011[5] state that the flood defences are in a fair condition (Grade 3).

Tidal flood level modelling

15.3.10 The most extreme flood risk scenario that could affect the site would be a combination of a high tide with a storm surge in the Thames Estuary. This scenario, assuming the Thames Barrier is operational, is the EA's 'design flood' event, a hypothetical flood representing a specific likelihood of occurrence, in this case the 1 in 200 year (0.5% Annual Exceedance Probability [AEP][ii]) flood event.

15.3.11 The EA *Thames Tidal Defences Joint Probability Extreme Water Level Study* (EA, 2008)[6] provides modelled tidal flood levels for the 1 in 200 year (0.5% AEP) for specific locations within the River Thames.

15.3.12 Vol 17 Table 15.3.1 presents the modelled tidal levels from this study for model node 2.33 which is the most relevant (ie, closest) to the site (Vol 17 Figure 15.3.1, see separate volume of figures). It should be noted that the water levels are expected to decrease in the future due to an amended future Thames Barrier closure rule (see Vol 2 Section 15) therefore the 2005 scenario (ie, the present day scenario provided by the EA) produces the highest water level.

[ii] A flood with a 0.5% AEP has a one in 200 year probability of occurring

15.3.13 Vol 17 Table 15.3.1 also confirms that the existing defence levels at the site are above the 0.5% AEP tidal flood level, therefore the site is protected from tidal flooding to the statutory level.

Vol 17 Table 15.3.1 Flood risk – modelled water levels

Return period	Flood level (mAOD)	Statutory flood defence level (mAOD)
0.5% AEP (2005)	4.97	5.41
0.5% AEP (2107)	4.96	

Tidal risk from the proposed development

New tidal defences

15.3.14 The presence of permanent structures within the foreshore has the potential to influence the flood risk to the site itself and to the surrounding environment. The proposed development includes building a new flood defence to the existing statutory level. As a result the majority of the site which is currently located in Flood Zone 3b would be protected by defences and would be located in Flood Zone 3a and defended from tidal flooding therefore the risk of tidal flooding is considered to be high and residual. Potential risks are described further in paras. 15.3.16 to 15.3.28 and measures included within the design are outlined in Section 15.4.

15.3.15 It should be noted that a small part of the permanent works (the front part) would be set below the flood defence level and therefore occasionally floodable (due the flood defence being set back from the perimeter of the permanent structure.) This small portion of the site would therefore be classified as at very high risk of flooding.

Flood defence integrity

15.3.16 The tunnel excavation process using tunnel boring machines (TBMs) and other construction methods, has the potential to create differential settlement (that is a gradual downward movement of foundations due to compression of soil which can lead to damage if settlement is uneven), which could affect the level of some of the existing flood defences. The proposed tunnel route runs immediately adjacent to the tidal Thames river wall and therefore has the potential to affect the defences at this site.

15.3.17 The proposed design has been informed by consideration of settlement and the alignment and methods used have been selected to minimise it as far as possible.

15.3.18 A potential settlement of 43mm of the river wall is estimated to occur at the site (based on information provided by Thames Water). The flood defence levels flowing settlement is estimated to be 5.45mAOD, and would remain above the EAs statutory flood defence level (5.41mAOD) following settlement of this degree.

15.3.19 An initial assessment of the effect of construction activities on the structural integrity of flood defences at the site was carried out by Thames Water and indicated potential structural impacts on the flood defences at the site arising from additional surcharge loading and increased water differential.

15.3.20 The proposed schedule of works (Schedule 1 of *The Draft Thames Water Utilities Limited (Thames Tideway Tunnel) Development Consent Order*) includes a provision for "works for the benefit of the protection of land or structures affected by the authorised project" which would provide the powers to mitigate for any impact that might affect the flood defences at the site.

Flood defence line

15.3.21 The proposed relocation of the Tattershall Castle and its associated moorings, as well as the two service moorings would not have an impact on the local flood defences as access to the boat would be placed over the existing defences present along the Embankment. The service moorings are only accessible by river.

15.3.22 Both temporary and permanent works to flood defences have the potential to impact on the level of tidal flood risk to the surrounding area. In this case the proposed cofferdam and the new flood defence wall would be constructed to the same height as the existing flood defences ensuring that the level of residual risk and therefore tidal flood risk to adjacent areas remains the same.

Scour management

15.3.23 The Thames Estuary 2100 Plan (TE2100) (EA, 2012)[7] includes an assessment of the River Thames foreshore at this location where there are long lengths of naturally eroding reaches of the tidal Thames. Results from this study show that works within the foreshore at this site may have an influence on downstream river structures if the pattern of sediment movement is greatly changed. In addition, should any temporary or permanent works within the river cause the channel width to be considerably altered, the flow velocity of the river at this point may increase, thereby altering contraction scour across the whole channel bed.

15.3.24 A scour summary report outlines the modelling studies that have been undertaken to determine the magnitude of scour associated with both the temporary and permanent works at ten foreshore sites on the River Thames (Vol.3, Appendix L.3) including the Victoria Embankment Foreshore site.

15.3.25 Scour is predicted at the Victoria Embankment Foreshore site to be greatest during construction with maximum estimated scour depths to temporary works of up to 0.3m. The contraction scour has been estimated during construction at 0.3m across the river bed and at 0.3m at the adjacent river walls.

15.3.26 During the permanent works local scour depths of up to 0.3m are predicted around the permanent works. Contraction scour has been estimated to be less than 0.1m. As a proactive approach permanent scour protection is envisaged at the base of the new flood defence wall.

15.3.27 Both the temporary and permanent works have the potential to influence scour and /or deposition rates within the river and affect river structures including flood defences.

Loss of volume from the Tideway

15.3.28 The presence of temporary and permanent structures within the foreshore has the potential to reduce the availability of flood storage within the tidal reaches of the River Thames (tidal Thames). The impact of the removal of flood storage on flood levels may propagate throughout the hydrological unit of the Thames reach and has been modelled on a project-wide basis.

15.3.29 The Victoria Embankment Foreshore site is located within the reach of Westminster to Tower in the tidal and fluvial modelling study. The modelling identifies that for this reach the potential maximum decrease in peak water level is 0.007m during the temporary works scenario reducing to 0.002m during the permanent scenario. The modelling also identifies a potential maximum increase of 0.012m in peak water level during the temporary works scenario reducing to 0.004m during the permanent scenario. As identified in para.15.3.8 the flood defences at this site are above the statutory level. When the flood defence levels are compared to the 1 in 200 year tidal level for the year 2107 these would provide between 0.34-0.86m in freeboard. These predicted changes in water level and freeboard are not considered to reduce flood protection at this site below design standard requirements and are therefore not deemed significant.

15.3.30 The results of the above modelling exercise show that the proposed project –wide works (both temporary and permanent works) are not considered to have a detrimental impact on the flood storage or tidal levels within the tidal Thames. This is discussed further in Vol 3 Section 15.

Fluvial flood risk to the proposed development

Level of risk based on the flood zones

15.3.31 At this location along the River Thames, both fluvial and tidal inputs are component parts of the resulting water level. The impacts of flooding from the tidal influence of the tidal Thames are judged to be of greater importance than those from fluvial influences (see methodology in Vol.2). As the majority of the Victoria Embankment Foreshore site is located within Flood Zone 3b, and as the tidal and fluvial floodplain cannot be distinguished from each other at this location the risk of flooding from this flood source is considered to be very high. Further detail is included in Vol 2 Section 15.

15.3.32 There are no other fluvial watercourses within the vicinity of the site that pose a fluvial flood risk to the site.

Fluvial flood risk from the proposed development

15.3.33 As explained in Vol.2, it is considered that a fluvial flood event on the tidal Thames with a return period of 1% AEP would result in lower water levels on the tidal Thames than those experienced during an extreme tidal flood event with the same return period. As such, the greatest risk posed by the tidal Thames is a combined tidal flood and fluvial flood risk.

15.3.34 As described above, both temporary and permanent works would be located in the functional floodplain of the tidal Thames. Para. 15.3.29 summarises the findings of the project-wide modelling undertaken to assess the potential loss of storage within the tidal Thames associated with the foreshore sites.

Surface water flood risk to the proposed development

15.3.35 Flooding of land from surface water runoff is usually caused by heavy rainfall that is unable to infiltrate into the ground or drain quickly enough into the local drainage network. Flooding can also occur at locations where the drainage network system is at full capacity and floodwater is not able to enter the system. This form of flooding often occurs in lower lying areas where the drainage system is unable to cope with the volume of water.

15.3.36 The *TE2100 Plan* states that Westminster in particular has a risk of surface water and urban drainage flooding that could be due to sewer capacity, pump station failure and tide locking of outfalls.

15.3.37 As part of the Drain London Project[iii], a *Surface Water Management Plan* (*SWMP*) has been prepared for the City of Westminster (GLA, 2011)[8]. This identifies the land adjacent to the Victoria Embankment Foreshore site, to be located within a Critical Drainage Area (CDA)[iv] which may be more susceptible to surface water flooding than other local areas. Modelling results for a 1 in 100 year (1% AEP) rainfall event plus climate change allowance show potential surface water flooding of 0.1-0.5m deep adjacent to the foreshore site.

15.3.38 Land to the west of the site is predominantly hard standing with the exception of Victoria Embankment Gardens. Ground levels along the Victoria Embankment footpath are approximately 4.5mAOD and 4.6mAOD at the base of the tidal defence. Ground levels to the west of the site are slightly higher (5.5mAOD) creating a potential overland flow route towards the site.

15.3.39 As the *SWMP* indicates the potential for flood depths up to 0.5m and there is a presence of a flow path for surface water runoff from the surrounding area, the flood risk from this source to the site is considered to be medium (see methodology in Vol.2).

Surface water flood risk from the proposed development

15.3.40 An assessment of the potential effects of surface water from the Victoria Embankment Foreshore site is provided in Section 14 of this volume.

15.3.41 The NPS requires that surface water runoff on new developments is effectively managed so that the risk of surface water flooding to the surrounding area is not increased. In accordance with the NPS, runoff rates following the proposed development should not be greater than the existing (pre-development) rates.

[iii] A London wide strategic surface water management study undertaken by the GLA and London Councils

[iv] Area susceptible to surface water flooding

15.3.42 Most of the Victoria Embankment Foreshore site naturally drains directly to the tidal Thames without inundating surrounding land. In agreement with the EA (as set out in their phase two consultation response), surface water runoff from the proposed site would also be discharged directly to the tidal Thames. Due to the tidal nature of the receiving watercourse, surface water runoff rates to the tidal Thames would not increase surface water flood risk to the site or surrounding area and would therefore not require attenuation prior to discharge.

15.3.43 In the event of a storm coinciding with a high tide event, surface water drainage from the site may be restricted by tide-locking of the surface water outfall, as it may on existing riverside areas. Whilst potentially this would pool on the surface of the public realm during this rare concurrence of events, it is considered feasible within the indicative design for on-site storage at or below the surface to be included to minimise the potential impacts.

15.3.44 Following the implementation of the above drainage measures the risk of flooding from this source would be unchanged and therefore would remain as medium.

Groundwater flood risk to the proposed development

15.3.45 Groundwater flooding occurs where groundwater levels rise above ground surface levels. Groundwater levels in the upper aquifer (river terrace deposits) have been recorded by Thames Water for the nearest borehole (SA1066D) to the site. At this location the average water level in the upper aquifer is approximately 7.1m below ground level (bgl). The ground investigation suggests that the upper aquifer is confined by the overlying alluvium at this location.

15.3.46 The City of Westminster SFRA indicates that there no recorded incidents of groundwater flooding within the vicinity of the site.

15.3.47 As the upper aquifer is confined, there is no pathway for groundwater to reach the surface of the site. There is therefore no risk of groundwater flooding to the site.

Groundwater flood risk from the proposed development

15.3.48 An assessment of the likely effects on groundwater at the Victoria Embankment Foreshore site is provided in Section 13 of this volume.

15.3.49 The CSO drop shaft would pass through made ground, river terrace deposits, London Clay, Harwich Formation and the Lambeth Group. No dewatering of the upper aquifer or lower aquifer is anticipated at this site. Sheet piles would be constructed around the Victoria Embankment Foreshore site to seal out the river terrace deposits (upper aquifer) and any inflows from the London Clay Formation.

15.3.50 The presence of the CSO drop shaft creating a physical barrier has been assessed as having a predicted rise in water levels (approximately 0.1m); however, this would result in increased hydraulic pressure within the confined unit rather than an increase of the water table. Therefore, there is no pathway for groundwater to reach the surface of the site. There is therefore no risk of an increase in groundwater flooding to the site as a result of the development.

Sewers flood risk to the proposed development

15.3.51 Sewer flooding arises when the local sewer network is exceeded or a problem arises such as a blockage or fracture.

15.3.52 The Victoria Embankment Foreshore site and surrounding area has numerous combined sewers running through it. The most notable of these is the 2362mm diameter (increasing to 2515mm downstream of the Regent Street outfall) northern Low Level Sewer No. 1, from which flow would be diverted as part of the Thames Tideway Tunnel project works at the site, and which was constructed as part of the Victoria Embankment river wall. It outfalls at Beckton Sewage Treatment works via Abbey Mills Pumping Station and the Northern Outfall Sewer.

15.3.53 The Regent Street CSO conveys overflows from the local combined network (including from the Northern Low Level Sewer No. 1, the 1676mm diameter Regent Street Sewer, 1219mm by 1829mm Victoria Street Sewer and an unknown 1143mm by 762mm sewer) to the tidal Thames at the northern end of the site during times of extreme rainfall. Flows from this CSO would not be directly intercepted as a result of the works at the Victoria Embankment Foreshore site, but would be indirectly relieved via the northern Low Level Sewer No. 1.

15.3.54 The Regent Street Sewer, Victoria Street Sewer and unknown sewer join approximately 100m to the west of the Victoria Embankment Foreshore site and flow eastward where they connect to the northern Low Level Sewer No. 1 and Regent Street CSO outfall. Manholes are present along two separate combined sewers of unknown size which connect to the northern Low Level Sewer No. 1 and Regent Street CSO outlet.

15.3.55 A further manhole is located approximately 30m west of the site, downstream of the confluence of the Victoria Street and Regent Street sewers. A 914mm by 610mm sewer runs westward along Horse Guards Avenue before connecting with the Victoria Street sewer which itself connects with the Regent Street sewer. Manholes are present along the length of this sewer.

15.3.56 The Northumberland Street CSO outfall is located approximately 30m to the north of the site (downstream of the Regent Street CSO along the river wall). This carries flow from the Northumberland Street sewer (1905mm by 1524mm diameter) and the northern Low Level Sewer No. 1 to the tidal Thames during times of extreme rainfall. This CSO would not be directly intercepted as a result of the works at the Victoria Embankment Foreshore site, however minor modifications to the existing weirs, whereby the weirs would be raised by 180mm, would be carried out as part of the Thames Tideway Tunnel project works. These works in combination with the overflow weir at the Victoria Embankment Foreshore site on the Low Level sewer control the discharges from the Northumberland Street CSO

15.3.57 A manhole connects to the Northumberland Street sewer upstream of its confluence with the Northern Low Level Sewer No. 1. Similarly a manhole connects to the Northumberland Street sewer approximately 5m upstream of the CSO outlet.

15.3.58 A branch of the 1219mm by 813mm combined Opera Sewer runs southwards underneath Victoria Embankment Gardens approximately 50m west of the southern end of the Victoria Embankment site where it joins a separate branch of the Opera Sewer and subsequently connects to the northern Low Level Sewer No. 1. Manholes are present along both branches of the Opera Sewer.

15.3.59 To the south of this the Victoria Street Sewer Main Line (1727mm by 1448mm) connects to the northern Low Level Sewer No. 1.

15.3.60 The capacity of the Regent Street and Victoria Street sewers is unlikely to be exceeded due to the Regent Street CSO outlet. Similarly the capacity of the Northumberland Street sewer is unlikely to be exceeded due to the Northumberland Street CSO outlet; therefore the flood risk from these sewers is considered to be low.

15.3.61 Should the capacity of the northern Low Level Sewer No. 1 be exceeded, sewage could surcharge through gullies and manholes along the reach of the sewer and those connecting to it.

15.3.62 The pathway for this combined sewage would be north/south along the carriageway of Victoria Embankment. There is also the potential for flood water to enter the utility subway situated on top of the Northern Low Level Sewer No. 1 (also constructed as part of the embankment wall) via gullies in the footpath or drains within the subway itself.

15.3.63 Thames Water flooding records (Thames Water, 2012)[9] show that there has been 1 record of flooding within 200m of the site since 1990.

15.3.64 Although there is a low incidence of sewer flooding in the area, due to the presence of potential pathways for sewage from the northern Low Level Sewer No. 1 to the site, the flood risk from this source is considered to be medium.

Sewers flood risk from the proposed development

15.3.65 It is proposed to make a connection to the northern Low Level Sewer No. 1 upstream of the Regent Street CSO so that high flows are diverted to the main tunnel. The flood risk during this phase would be managed using design measures described in Section 15.4.

15.3.66 Following construction, there would only be a restriction on flows entering the main tunnel should it become full or unavailable. In such a scenario, flows would be redirected to the tidal Thames through the replacement Regent Street CSO outfall constructed in the new foreshore structure.

15.3.67 Following the construction of the proposed development the risk of flooding from this source would be unchanged and therefore would remain medium.

Artificial sources to and from the proposed development

15.3.68 St. James Park Lake is situated approximately 500m from the proposed site. This lake is a remnant of a ‘hidden’ river and has the potential to flood as an outlet of the hidden river. The City of Westminster SFRA states that areas affected from this source are likely to be localised. As the proposed site is approximately 500m to the east of this source and the pathway is restricted flood risk from this source is considered to be low.

15.3.69 Due to the distance of St James Park Lake from the site there would be no increase in flood risk to the Lake as a result of the development.

15.4 Design measures

15.4.1 Design measures have been incorporated into the design of the proposed development to ensure that the risk of flooding to and from the site and surrounding areas is not increased during the construction and operational phases. These measures are described below although many have already been referred to in the preceding section.

Tidal and fluvial

Construction

Flood defences

15.4.2 As discussed in para. 15.3.16 the proposed tunnel alignment runs adjacent to the river wall flood defence and has the potential to affect the integrity of the defences. During construction the level of the flood defences at the site would be monitored, and where required repairs would be made to ensure crest heights of the flood defences at the site are maintained to the existing levels. With this strategy in place, no effects of settlement are anticipated.

15.4.3 Design measures to preserve the structural stability of the flood defences at the site would be dependent on the contractor's construction methodology. Potential options for the river wall to withstand surcharge loading and increased water differential may include temporarily supporting the wall within the temporary cofferdam while it is unfilled.

15.4.4 As discussed in para. 15.2.2 a cofferdam would be constructed to the same height as the existing flood defence level. This would ensure that the current level of flood protection and flood risk is maintained during construction. Further information is included in the *CoCP* (Section 8).

15.4.5 The tidal Thames flood defence wall situated between the proposed site and the embankment would be removed to allow site access. Care would be taken during the construction phase to ensure that existing defences are protected.

15.4.6 The proposed relocation of the Tattershall Castle and its associated moorings, as well as the two service moorings would not have an impact on the local flood defences as access to the boat would be placed over the existing defences present along the Embankment. The service moorings are only accessible by river.

15.4.7 Appropriate Protection Provisions would be agreed with the EA for any works within 16m of the flood defences on the landward side and within the river.

Scour management

15.4.8 During construction the formation of scour would be monitored and mitigation proposed if the scour exceeds agreed trigger values.

15.4.9 Mitigation options could include riprap or rock fill, articulated concrete blocks, gabion mattresses and grout filled mattresses. The detailed approach to the implementation of these mitigation measures would be informed by the monitoring results as well as site specific design requirements. Further details are provided in *Scour Monitoring and Mitigation Strategy* (Vol 3 Appendix L.4).

Emergency plan

15.4.10 Appropriate emergency planning procedures would be adopted by the contractor during the construction phase to mitigate the potential consequences in the event of a breach in the flood defence wall at the site or a failure of the Thames Barrier. Further information is included within the *CoCP* (Section 8).

Operation

Flood Defences

15.4.11 The majority of the permanent operational area would be protected from flooding through the provision of a new flood defence wall as outlined in para. 15.2.6. This would be located along the periphery of the operational area and would tie into existing flood defences, providing a continuous defence line along the Embankment at all times.

15.4.12 The new defence walls would be designed to ensure that flood defences can be raised in the future to meet the TE2100 requirements.

15.4.13 As the new flood defence wall would be constructed to the same height as the existing flood defence, the residual flood risk to the site would therefore be the same as it currently is behind the existing defences. As detailed in para. 15.5.5 and Vol 3 Section 15, the residual risk to the site is considered to be appropriate and no further mitigation is required.

Loss of volume from the tideway

15.4.14 As discussed in para. 15.3.28, the result of removal of tideway flood storage on flood levels has been considered on a project-wide basis and is discussed further in Vol 3 Section 15. The floodplain volume loss from river structures has been minimised whilst maintaining fundamental engineering requirements and therefore no further assessment is proposed.

Scour management

15.4.15 The shape of the protrusion for the permanent works has been designed to minimise the influence on river on the flow regime of the tidal Thames.

15.4.16 As a proactive approach permanent scour protection would be provided at the toe of the new flood defence river wall. It is assumed for the assessment that permanent scour protection would consist of loose large stone placed just below foreshore level. The size and type of the stone is yet to be defined. It is assumed therefore that a 1m depth of stone would be placed up to 0.5m below the existing foreshore level within the zone indicated on the Site parameter plan (see separate volume of figures – Section 1). It is assumed that these works would be undertaken towards the end of the construction period. This permanent protection would be within the area of the temporary cofferdam.

Emergency plan

15.4.17 During the operational phase the site would not be permanently staffed with the exception of visits from maintenance personnel. An emergency plan would only be required for staff undertaking maintenance visits.

Surface water

Construction

15.4.18 In accordance with the *CoCP* (Section 8) all site drainage during construction would be drained and discharged to mains foul or combined sewers and where this is not practicable, the site would be drained such that accumulating surface water would be directed to holding or settling tanks, separators and other measures prior to discharge to the combined or surface water drains. Foul drainage from the site welfare facilities would be connected to the mains foul or combined sewer. This approach would ensure that the risk of surface water flooding is managed during construction but would not reduce the overall level of flood risk associated with surface water

Operation

Scour management – surface water discharge

15.4.19 As outlined in para. 15.3.42 it is intended to discharge surface water from the operational site directly into the tidal Thames. This outfall would be of appropriate size for the potential discharge volumes. Scour protection is included within the operational layout. This would provide sufficient scour protection for the surface water outfall.

Surface water management

15.4.20 As described in para. 15.3.42, surface water runoff from the proposed site would be discharged directly to the tidal Thames. Due to the tidal nature of the receiving watercourse, surface water runoff rates to the tidal Thames would not increase surface water flood risk to the site or surrounding area and would therefore not require attenuation prior to discharge.

Groundwater

15.4.21 Groundwater monitoring is proposed during construction and operation. Further measures are described in Section 13 of this volume.

Sewers

Construction

15.4.22 Two surface water sewers to the south of the Regent Street CSO would be retained and temporarily re-connected across cable diversion and gas main trenches if required. The Regent Street sewer to the west of the outfall would be retained outside the overflow weir works. The Regent Street CSO would be retained outside the temporary cofferdam. It is proposed by London Underground to fill the abandoned foul sewer and outfall to the south of the Regent Street CSO. A foul sewer, previously unidentified, running approximately in a south-north direction across the path of Regent Street CSO would be abandoned and the connection relocated with Tattershall Castle.

15.4.23 The Regent Street CSO conveys overflows from the local combined network (including from the Northern Low Level Sewer No. 1, Regent Street Sewer and Victoria Street Sewer adjacent to the site) to the River Thames at the northern end of the site. A temporary outfall may need to be constructed to convey flows through the proposed site.

15.4.24 To protect the northern Low Level Sewer No. 1 the weir would be constructed around the existing sewer so that it would not be exposed until absolutely necessary. A re-enforced lining would be inserted into the sewer pipe to contain any sewage flow and the pipe subsequently broken out, following which the lining would be removed.

Operation

15.4.25 Following construction, there would only be a restriction on flows entering the main tunnel should it become full or unavailable. In such a scenario, flows would be redirected to the tidal Thames through the replacement Regent Street CSO outfall constructed in the new foreshore structure.

15.5 Assessment summary

Flood risk

15.5.1 The Victoria Embankment site is located in Flood Zone3b associated with the tidal Thames. As part of the proposed development, flood defences would be constructed, providing protection to the site from tidal flooding during both construction and operation.

15.5.2 In line with the NPS, this FRA shows that the proposed development would be appropriate for the area as flood risk to the development would remain unchanged as it would be managed through appropriate design measures and the development would not lead to a significant increase in flood risk on the surrounding areas. Therefore no significant flood risk effects are likely. Vol 17 Table 15.5.1 provides a summary of the findings of the FRA undertaken for this site.

Residual risk to the proposed development

15.5.3 The residual risk to the site is the risk that remains after all design measures have been incorporated.

15.5.4 Following the construction of the new flood defence wall adjacent to the tidal Thames, the site would be protected from tidal flooding. The site would be at residual risk of tidal flooding in the event of a breach in the new flood defence wall or overtopping of the defence wall as a result of a failure of the Thames Barrier.

15.5.5 It is considered that the consequence of a breach or failure of flood defences would not compromise the long term operational function of the main tunnel and therefore no additional measures above those outlined above are proposed. Further detail is provided in Vol 3 Section 15.

Residual Risk from the proposed development

15.5.6 Following the incorporation of the design measures outlined in Vol 17 Table 15.5.1, the level of residual risk from the development to adjacent areas would remain unchanged. The project-wide residual risks are discussed in Vol 3 Section 15.

Vol 17 Table 15.5.1 Flood risk – FRA summary

Source	Pathway	Current flood risk to the proposed development	Design measures	Flood risk from the proposed development (post design measures)	Flood risk to the proposed development post design measures
Tidal	tidal Thames	Very high	Flood Defence height maintained. New flood defences built around the site so site defended from tidal flooding to statutory level (changing the Flood Zone from 3b to 3a). Monitoring of scour and mitigation if trigger value exceeded. Scour protection measures for permanent works. Monitoring of flood defence levels and repaired as required to maintain existing crest level.	No increase in tidal flood risk as a result of proposed development.	High due to change from Flood Zone 3b to 3a (but risk is residual only)
Fluvial	tidal Thames	Very high	New flood defences built around the site so site defended from fluvial flooding to statutory level (changing the Flood Zone from 3b to 3a). Monitoring of scour and mitigation if trigger value exceeded. Scour protection measures for permanent works. Monitoring of flood defence levels and repaired as required to	No increase in fluvial flood risk as a result of proposed development.	High due to change from Flood Zone 3b to 3a (but risk is residual only)

Source	Pathway	Current flood risk to the proposed development	Design measures	Flood risk from the proposed development (post design measures)	Flood risk to the proposed development post design measures
			maintain existing crest level.		
Surface water	Surrounding area	Medium	Site drainage compliant with *CoCP* (Section 8) during construction, Discharge surface water to tidal Thames.	No increase in surface water flood risk as a result of proposed development.	Medium
Groundwater	Underlying geology and groundwater levels restricted pathway	No risk	Monitoring proposed during construction and operation. Sheet pilling to seal out flows from the upper aquifer and London Clay.	No increase in groundwater flood risk as a result of proposed development.	No risk
Sewers	Local drainage system	Medium	Sewers would be retained and diverted as required to remain operational during construction. Flows diverted to the tidal Thames through new CSO outfall when main tunnel full or unavailable.	No increase in sewer flood risk as a result of proposed development	Medium
Artificial sources	St James Park Lake	Low	Not applicable	Not applicable	Low

** Definitions of these classifications are included in Vol 2 Section 15.*
() indicate the flood risk is residual ie in the event of a failure or overtopping of flood defences

References

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

[2] Great Britain. *Thames River Protection of Floods Amendment Act 1879 London.* The Stationery Office.

[3] Communities and Local Government. *National Planning Policy Framework* (March, 2012).

[4] Environment Agency. *National Flood and Coastal Defence Database* (October, 2011).

[5] Environment Agency. Flood Defence Data (received January 2012).

[6] Environment Agency. *Thames Tidal Defences Joint Probability Extreme Water Levels 2008 Final Modelling Report* (April 2008).

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

[8] Greater London Authority. *Surface Water Management Plan for City of Westminster* (August, 2011).

[9] Thames Water. *Sewer Flooding Records* (received June 2012).

This page is intentionally blank

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

DCO-DT-000-ZZZZZ-060217