Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.03**

Albert Embankment Foreshore

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

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January 2013

Thames Tideway Tunnel

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Thames Tideway Tunnel

Albert Embankment Foreshore Navigational Issues and Preliminary Risk Assessment

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Albert Embankment Foreshore

Main Report

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1 Executive summary

1.1 Purpose

1.1.1 This report documents the activities and assessments undertaken to identify the navigational issues, risks and mitigation measures for the proposed permanent and temporary structures at the site known as Albert Embankment Foreshore as part of the Thames Tideway Tunnel project (the 'project').

1.1.2 It was developed through liaison and consultation with Port of London Authority (PLA) and the other key stakeholders. It is intended to support the application for development consent and identify the navigational issues at the site and how these are to be managed. The process was used to inform the design of the permanent and temporary works and a number of measures to address navigational hazards have been embedded into the design.

1.1.3 The preliminary risk assessment follows a specific methodology proposed by the PLA rather than the methodology detailed within the PLA Safety Management System. The risk assessment reflects the level of development of the design in the application for development consent, that is, an outline design. The Contractor would be required to prepare detailed risk assessments and method statements and submit these to the PLA for approval before commencing any works in the river at this site.

1.1.4 The assessment was divided into four distinct project phases to assess hazards and develop risk reduction measures commensurate with the risk posed by different operations associated with the project. These phases were specific to this assessment and comprise:

a. Phase A: construction of cofferdam

b. Phase B: construction of shaft/culvert/connections

c. Phase C: removal of cofferdam

d. Phase D: permanent works site.

1.2 Issues to be addressed

1.2.1 The proposed Albert Embankment Foreshore site is located on the south bank of the River Thames, running from Tintagel House in the east to Vauxhall Bridge in the west. The site is dissected by the Lack's Dock slipway, currently used by London Duck Tours vessels.

1.2.2 There would be two separate construction sites at Albert Embankment Foreshore with the northern one larger in size and accommodating vehicle access. There would be a requirement to transfer material and plant to and from the northern site to the southern one; it is proposed that this would be done at low tides using tracked vehicles across the exposed foreshore.

1.2.3 The issues to be addressed are:

a. interaction with existing river users
b. interaction with London Duck Tours operations at Lack's Dock
c. intrusion into the river - proximity to the authorised channel
d. bridge arch closures
e. changes in flow resulting from the temporary and permanent in-river structures.

1.3 Interaction with London Duck Tour operations at Lacks Dock

1.3.1 The London Duck Tours company operate several Second World War amphibious vehicles. They launch and recover their vessels from the slipway (Lack's Dock) adjacent to Vauxhall Cross, which is situated between the two working areas of the proposed site.

1.3.2 There are two navigational safety issues identified with the project's works at Albert Embankment Foreshore associated with London Duck Tours' operations.

1.3.3 The first is that when entering the water from Lack's Dock, the northern temporary and permanent works would obstruct the Duck masters' view of river traffic, leading to a potential collision between a London Duck Tours vessel and a vessel in transit through the area.

1.3.4 The second issue is that the shape and location of the temporary and permanent works would lead to a change in-river flow and as the Ducks enter the water they are taken, beam on, by the flow of the river towards Vauxhall Bridge. With the Ducks having limited power, limited manoeuvrability, and a low free board the potential for a river incident would be increased if this occurred.

1.3.5 Consultation with London Duck Tours' owners has identified a number of possible risk control mitigations that have the potential to reduce the likelihood of an incident occurring at this site, this is detailed in chapter 8.

1.4 Interaction with other existing river traffic

1.4.1 Observation of freight, commuter, charter and recreation vessel traffic was conducted at this location.

1.4.2 Analysis of Automatic Identification System (AIS) tracks were conducted for freight moving through this section of the river. Existing barge track analysis shows that the majority of freight movements are through Arch No3 of Vauxhall Bridge. This analysis was based on information provided by Cory Environmental Ltd and tracks tug and barge movements.

1.4.3 During observations, recreational craft including narrow boats, rigid inflatable boats (RIBs) and small leisure craft were witnessed in transit through the study area. The movement of these vessels is unpredictable

and consideration is given to these vessels in the Preliminary Navigational Risk Assessment.

1.5 Intrusion into the river and proximity to the authorised channel

1.5.1 During the construction of the temporary cofferdams there would be a requirement to use heavy plant and sheet piling machinery, this plant would be located within the area designated as the Limits of land to be acquired or used (LLAU).

1.5.2 For the northern site;

a. The boundary of the LLAU would be approximately 25m beyond the authorised channel at its furthermost point.

b. The temporary cofferdam would be approximately 28m from the authorised channel.

c. The permanent works would be greater than 60m from the authorised channel.

1.5.3 The southern site encompasses the whole of Vauxhall Bridge arch No5. During construction, a jack-up barge servicing piling operations may encroach into arch No4 for short periods of time. For the southern site, the site drawings show that;

a. The boundary of the LLAU would be approximately 10m from the authorised channel.

b. The temporary cofferdam would be approximately 27m from the authorised channel.

c. The permanent works would be located further than approximately 30m from the authorised channel.

1.5.4 This report examines the impact of the temporary and permanent in-river structures on all vessel types (freight, tugs & tows, high speed passenger vessels, passenger vessels, leisure craft and emergency vessels) transiting the study area.

1.5.5 The Automatic Identification System (AIS) records and additional observations indicate that the temporary works area would be away from the area used by the majority of freight and passenger vessels.

1.5.6 During phase A, phase B and phase C of the works at this site, it is assessed that the intrusion into the river and proximity to the authorised channel at this location would present a hazard to existing navigation, most notably to vessels under 13.7m in length proceeding downstream[1]. The extent of encroachment into the river, and therefore the probability of an incident occurring would reduce when construction plant is removed from the river, for example once the temporary cofferdams are constructed (and therefore there is no longer a jack-up barge supporting piling operations), and when barges are not berthed alongside the work site.

[1] In accordance with PLA General Directions, vessels less than 13.7m should normally navigate outside of the authorised channel.

1.6 Changes in flow

1.6.1 Any intrusion into the river would change the river flow. The analysis in this report has considered the worst cases, combining the extreme fluvial and tidal flows. It has been found that, even in these extreme cases, the change in maximum flow would be no more than 0.4 knots for the temporary in-river works and less than 0.2 knots for the permanent structure that would remain following site completion. It should be noted that because the structures would displace the flow pattern, the maximum flow would be found in a different location.

1.6.2 The change in maximum flow under Vauxhall Bridge would be less than 0.4 knots for both the temporary and permanent works.

2 Site overview

2.1 Purpose of this report

2.1.1 The purpose of this report is to provide information on the navigational issues, risk assessment and mitigation measures associated with the proposed Albert Embankment Foreshore site. The report informs the *Transport Assessment* and *Environmental Statement* and the PLA approval process.

2.2 Introduction

2.2.1 The Thames Tideway Tunnel project (the 'project') comprises tunnels to store and transfer discharges from combined sewer overflows (CSOs) from West to East London for treatment at Beckton Sewage Treatment Works. The primary objective of the project is to control CSO discharges in order to meet the requirements of the EU Urban Waste Water Treatment Directive (91/271/EEC) (UWWTD) and the related UK Urban Waste Water Treatment Regulations.

2.2.2 The project comprises the following elements:

a. a main tunnel from Acton Storm Tanks to Abbey Mills Pumping Station requiring five main tunnel sites (one of the sites would also intercept flows from one CSO)

b. control of 18 CSOs by diverting intercepted flows into the main tunnel requiring 16 CSO sites; two long connection tunnels (Frogmore connection tunnel and Greenwich connect tunnel) and 11 short connection tunnels

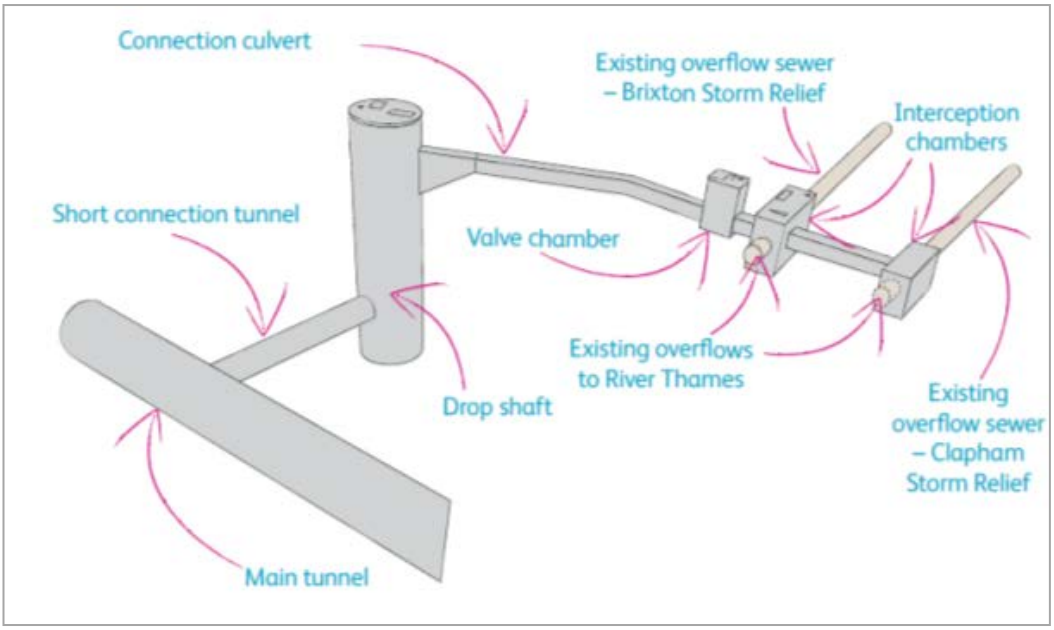
c. control of two CSOs by locally modifying the sewerage system requiring two system modification sites

d. works to drain down the system at Beckton Sewage Treatment Works.

2.2.3 The main tunnel would connect to the Lee Tunnel at Abbey Mills Pumping Station. All the flows from the Thames Tideway Tunnel and the Lee Tunnel would be transferred to Beckton Sewage Treatment Works via the Lee Tunnel.

2.2.4 The Albert Embankment Foreshore CSO site would be required to intercept the Clapham Storm Relief CSO and Brixton Storm Relief CSO, and to connect to the main tunnel. The proposed structures at this site are illustrated in Figure 2.1.

Figure 2.1 CSO site structures (below-ground)



2.2.5 It is proposed that the permanent in-river structure at the Albert Embankment Foreshore site would accommodate:

a. a CSO drop shaft – 16m internal diameter, approximately 47m deep
b. two interception chambers intercepting the Clapham and Brixton CSOs
c. connection culverts and valve chambers
d. air management structures
e. a new section of river wall.

2.2.6 Two cofferdams would be constructed (one at the north site, one at the south site), which would include the following areas to enable construction of the permanent in-river structures:

a. excavated material storage and handling facilities
b. cranes
c. maintenance workshop and storage
d. internal site roads
e. site support and welfare.

2.2.7 There would be two separate works sites, one to the north of Lack's Dock that would contain the CSO drop shaft and the other to the south of Lack's Dock that would house the interception structures. A below-ground connection culvert would take the flows from the interception structure to the CSO drop shaft.

2.2.8 The CSO drop shaft site would have road access for construction vehicles whereas the site to the south would not. The intention would be to use the CSO drop shaft site to receive and store materials for the southern site.

Materials would then be transferred between the two sites across the foreshore by a tracked vehicle.

2.3 Limits of land to be acquired or used

2.3.1 The proposed limit of land to be acquired or used (LLAU) for this site extends from under Vauxhall Bridge (arch No 5) along to Tintagel House, a total of approximately 315m.

2.3.2 At the northern site:

a. The boundary of the LLAU is approximately 25m beyond the authorised channel at its furthermost point.

b. The temporary cofferdam is approximately 28m from the authorised channel.

c. The permanent work site is greater than 60m from the authorised channel.

2.3.3 The southern site encompasses the whole of Vauxhall Bridge arch No 5. During construction, a jack-up barge servicing piling operations may encroach into arch No4. For this site:

a. The boundary of the LLAU is approximately 10m from the authorised channel.

b. The temporary cofferdam is approximately 27m from the authorised channel.

c. The permanent work site is greater than 30m from the authorised channel.

2.3.4 The LLAU does encroach into the authorised channel by approximately 25 metres at its furthermost point.

2.3.5 The LLAU encompasses the maximum working area required during construction. Two cofferdams would be constructed within this area during the construction phases. The permanent river wall works would take place within the cofferdam.

2.3.6 The LLAU would be used intermittently, depending on the progress, method and phasing of construction.

2.3.7 Appendix A lists the various design, construction and site layout drawings which also show the LLAU.

2.4 Project phases

2.4.1 This assessment was divided into four distinct project construction phases to assess hazards and develop risk reduction measures commensurate with the risk posed by different operations associated with the project. These phases were identified for use during the navigation risk assessment and comprise:

a. Phase A: temporary works construction

b. Phase B: drop shaft and associated works construction

c. Phase C: temporary works removal

d. Phase D: permanent works site

2.5 Construction methodology

2.5.1 All works would be undertaken in accordance with the project's *Code of Construction Practice (CoCP)*.

2.5.2 The code sets out a series of objectives and measures to protect the environment and limit disturbance from construction activities as far as reasonably practicable. The topics covered by the *COCP* include but are not limited to: working hours, traffic management, noise and vibration, air quality, waste management, recycling, ecology, archaeology and settlement.

2.5.3 The methodologies, layouts and plant requirements outlined in this document are for illustrative purposes only and may be varied by subsequent design and build construction contractors.

2.6 Phase A: Temporary works construction

2.6.1 The cofferdams would be constructed by installing sheet piled walls. It is currently envisaged that the cofferdams would be designed as twin walled cofferdams to accommodate the various loading conditions including external tidal loading and internal plant/construction loading.

2.6.2 It is intended to use the river to access and service the cofferdam construction activities, and a jack-up or spud leg barge would be mobilised at the site. A jack-up barge is a hydraulically operated self-elevating platform, which provides a stable platform from which marine piling works can be undertaken. The barge would be equipped with a crawler crane for off-loading and pitching the sheets for the sheet piled wall, a silent piling hammer, a small welfare cabin, a rescue boat and generated power.

2.6.3 A campshed would be constructed in the foreshore adjacent to the western wall of the northern cofferdam.

2.7 Phase B: Shaft and associated works construction

2.7.1 The CSO drop shaft would be constructed by diaphragm wall construction techniques and have a cast in-situ secondary lining. The connection tunnel would be constructed by sprayed concrete linings and the interception chambers by traditional reinforced concrete structures.

2.7.2 An attendant excavator would load the excavation material from the slurry separation plant into a dumper, which would deposit excavated material into the excavated material muck bin. A long reach excavator would load the excavated material into a barge moored alongside the cofferdam wall.

2.7.3 Equipment and plant would be transported between the two separate sites during times of low tide (i.e. when the foreshore is exposed).

2.8 Phase C: Temporary works removal

2.8.1 On completion of the CSO drop shaft and connection chambers, the permanent river walls would be constructed. The areas between the cofferdams and permanent river walls would be excavated.

2.8.2 Concrete blinding would be installed and then the permanent river walls constructed.

2.8.3 Only once the permanent river walls are in place would the cofferdams on the riverside be removed in order to maintain flood protection. The cofferdam piled walls would then be dismantled by jack-up barge.

2.9 Phase D: Permanent works site

2.9.1 Once all temporary works structures have been removed and construction work is complete, a permanent in-river structure would remain at the site. Access to various elements of the site and underground works would be required for maintenance. River-based access during the permanent works phase would only be anticipated in the event of failure of the outer flap valves on the permanent river walls.

2.9.2 The northern permanent structure would extend approximately 25m into the river from the foreshore and would be greater than 30m from the authorised channel.

2.9.3 The southern permanent structure would extend approximately 25m into the river and would be greater than 60m from the authorised channel.

Figure 2.2 Aerial view visualisation of the completed works (north of Vauxhall Bridge)

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3 Study aim and area

3.1 Introduction

3.1.1 The aim of this assessment is to identify and assess navigational hazards project-specific construction activities at the Albert Embankment Foreshore site and to assess how the proposed phases of the project would likely impact on existing river users and river infrastructure.

3.1.2 This assessment considers all river users and the hazards that project activities could pose to navigation on the River Thames.

3.1.3 In compiling this assessment, the project undertook extensive consultation with the PLA and current river users, along with observations of current river operations.

3.1.4 In order to consider the navigation impact on the wider river community, the scope of this assessment comprised an area from Westminster Bridge to Chelsea Bridge. This study area captures the majority of vessel types likely to transit this section of the river and pass the worksite.

3.1.5 The proposed development site is in close proximity to St George Wharf Pier, and the effects on traffic using St George Wharf Pier were considered within this assessment.

3.1.6 The project proposes to use barges during site set-up, drop shaft construction, and the completion of works and site restoration phases.

3.2 General navigation

3.2.1 The Central London stretch of the River Thames is extensively used by commuter, passenger and private pleasure craft as well as tugs, barges and other working vessels that transport freight.

3.2.2 Safety is the responsibility of all river users; however, overall responsibility for facilitating the safety of navigation on the River Thames rests with the PLA.

3.2.3 As part of its activities in maintaining navigational safety, the PLA produces Notices to Mariners (NTMs), which provide essential, up-to-date information and advice to those navigating within the Port of London. NTMs can range from information on special events, notifications of works (eg, the Network Rail works on Blackfriars Bridge), and notification of new and updated navigation rules and regulations. A full list of extant NTMs is available on the PLA website, http://www.pla.co.uk/notice2mariners/index.cfm/site/navigation.

3.2.4 The River Thames becomes tidal downriver of Teddington Lock, with a tidal range of between five and seven metres at different locations.

3.2.5 On the flood tide, the tidal current flows up-river (ie, predominantly east to west) whereas on the ebb tide, the tidal current flows downriver (ie, predominantly west to east).

3.2.6 A 15m exclusion zone exists in the vicinity of Albert Embankment - PLA Notice to Mariners No. U2 of 2003 provides further details.

3.3 Vauxhall Bridge

3.3.1 Vauxhall Bridge has five main arches, three of which are available for navigation, arch No2, 3 and 4 are designated as working arches. The work site is located under arch No5 and a small part of arch No4.

3.3.2 The following tables summarise the arch clearance under Vauxhall and Westminster Bridge, the latter offering the lowest arches required to be passed up to Albert Embankment Foreshore.

Table 3.1 Individual bridge arch clearances at Mean High Water Springs (Vauxhall Bridge)

Bridge Arch	1	2	**3**	4	5
Arch Clearance	3.9 m	5.1 m	**5.7** m	5.1 m	3.9 m

Table 3.2 Main arch bridge clearance (Vauxhall Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	12.2 m	6.9 m	11.4 m	12.0 m	5.2 m

3.3.3 Westminster Bridge has seven main arches, all of which are available for navigation with arch No's 3, 4, 5 & 6 designated as working arches.

Table 3.3 Individual arch bridge clearances at Mean High Water Springs (Westminster Bridge)

Bridge Arch	1	2	3	**4**	5	6	7
Arch Clearance	4.2 m	4.8 m	5.2 m	**5.4 m**	5.2 m	4.8 m	4.2 m

Table 3.4 Main arch (No.4) bridge clearance (Westminster Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	12.2 m	6.5 m	11.1 m	11.8 m	4.8 m

3.4 The authorised channel

3.4.1 The authorised channel is marked on both Admiralty and PLA charts as a pair of pecked lines that define where the majority of commercial vessels generally navigate. However, vessels cannot always be expected to navigate 'within' the authorised channel.

3.4.2 The authorised channel in the Albert Embankment Foreshore area varies between 90m and 105m width and incorporates the working arches of the Vauxhall Bridge.

3.4.3 The document *General Directions for Navigation in the Port of London 2011*[2] states the following:

> *"36. REQUIREMENT TO USE THE AUTHORISED CHANNEL*
> *(1) This Direction applies only to vessels navigating between the Margaretness Limit and Putney Bridge.*
>
> *(2) Except in an emergency or for the purposes of overtaking, or with the permission of the Harbourmaster, or when manoeuvring to or from piers, wharves, anchorages or other berths, all Reporting Vessels and vessels of 13.7mor more in Length Overall shall normally navigate only in the authorised channel as identified on PLA charts.*
>
> *(3) Where there is sufficient room, vessels less than 13.7m in Length Overall should normally navigate outside the authorised channel unless constrained by their draught or otherwise restricted in ability to manoeuvre, or in an emergency."*

[2] General Directions for Navigation in the Port of London 2011

3.5 Tide set

3.5.1 The term ‘tide set ’is used to describe the movement of water into the bight or outside edge of a bend of a river. In a tidal river like the River Thames, which is embanked in the central area, it also leads to an increase in velocity.

3.5.2 Every vessel is affected by tide set in varying degrees. Smaller, faster-moving craft are affected less than larger, slow-moving vessels such as tugs and tows, which have to make course and steering adjustments to counteract the impact of tide set.

3.5.3 The embankments of the River Thames deflect the water flow towards the outside of the next bend. This effect manifests itself particularly in the section of the river that contains the various bridges.

3.5.4 The tide set in and around Vauxhall Bridge is assessed as being ‘Moderate South’ on both the flood and ebb tides.

3.6 Vessels using St George Wharf

3.6.1 In September 2011 a new pier at St George Wharf was officially opened. The pier is situated on the south bank of the river, upriver from Vauxhall Bridge and in front of the large St George Wharf residential development.

3.6.2 Thames Clippers now operates its daily Tate-to-Tate & Service West commuter service to/from St George Wharf.

3.6.3 First departure from St George Wharf is at 06:49 and the last arrival is at 20:19 with up to twenty scheduled stops per weekday.

3.7 Vessels using Millbank Millennium Pier

3.7.1 Millbank Millennium Pier opened in 2003 and is located next to the Tate Britain. The pier is owned and operated by London River Services Limited (LRS), a wholly owned subsidiary of Transport for London.

3.7.2 From Millbank Millennium Pier Thames Clippers riverboat services run to Bankside, connecting passengers with the Tate Modern and other South Bank attractions.

Figure 3.1 Thames Clipper at Millbank Millenium Pier

3.8 Freight movements

3.8.1 Cory Environmental Limited, one of a number of freight operators operating within the study area, state on their current passage plan that tugs are required to depart Cringle Dock 1 hour before High Water on the spring tides and 30 minutes before High Water on the neap tides in order to clear the bridges in the Central Pool area of London, between London Bridge and Tower Bridge.

3.8.2 The majority of freight movements can be expected to be in the study area between 3 hours before and 1 hour before high water. This provides Cory with a sufficient operating window to deliver empty barges and remove full barges from facilities upriver at Cringle Dock and Wandsworth Riverside Waste Facility.

3.8.3 Figure 3.2 shows inbound Cory barge movements past the Albert Embankment Foreshore site.

Figure 3.2 Cory tug and barge at Albert Embankment

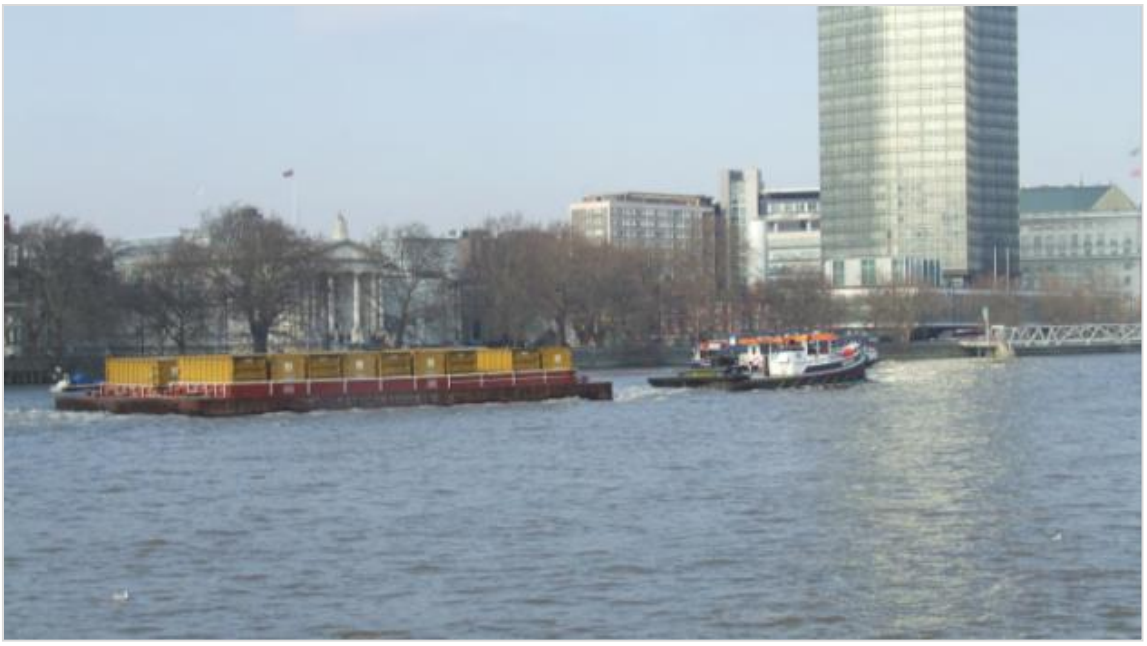
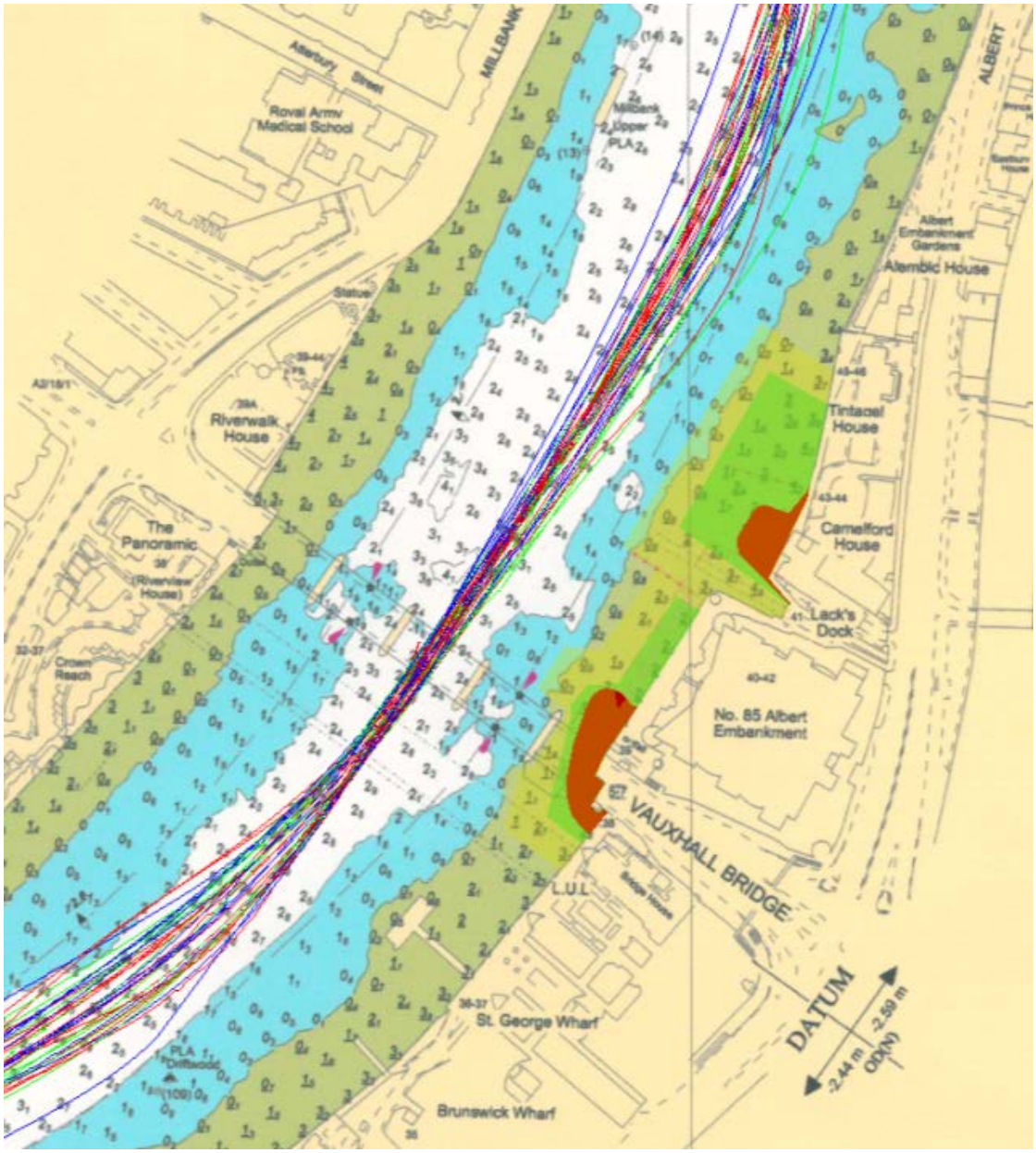


Figure 3.3 Tug and barge at Vauxhall Bridge

Figure 3.4 Cory AIS tracks in transit past Albert Embankment



3.9 London Duck Tours

3.9.1 The London Duck Tours company operates several Second World War amphibious passenger vehicles. They launch and recover their vessels from the slip way (Lack's Dock) adjacent to Vauxhall Cross which is situated between the two proposed working areas.

3.9.2 The tours depart from Chicheley Street (near the London Eye), pass though various areas of London (Big Ben, Houses of Parliament, Trafalgar Square etc.) before entering the tidal Thames at Lack's Dock. The water borne leg of the tour heads down river, approximately as far as Westminster Bridge, before returning to exit the river at Lack's Dock.

3.9.3 London Duck Tours operate approximately 80 movements (in and out) per day in the summer peak operating periods and the operating company expects to increase movements up to 100 daily movements by 2016. Current operating hours are from 09:15 to one hour before sunset.

3.10 Other traffic

3.10.1 A wide variety of recreational river users, using an array of vessels ranging from motor yachts, narrow boats, rigid inflatable boats (RIBs), rowing boats and kayaks frequently use this section of the river. Those vessels less than 13.7m in length can be expected to be navigating outside of the authorised channel in accordance with PLA guidance and directions.

3.10.2 The River Thames is used by tourists as a means of sightseeing and consequently traffic levels are seasonal with the greatest tourist traffic being around lunchtime in the summer months.

3.10.3 Charter vessels also have an element of seasonality with the majority of chartered vessels operating in the summer months (April - September). There are some increases around the Christmas party season.

4 Summary of navigational issues

4.1 Interaction with London Duck Tours: Access onto and off river

4.1.1 There would be two separate working areas at Albert Embankment Foreshore. The northern working area would have construction vehicle access from Albert Embankment whereas the southern working area would not have direct construction vehicle access. Therefore there would be a need to transfer material between the northern working area and the southern working area. This would be carried out at low tides using tracked vehicles across the exposed foreshore. Major items of plant (e.g. cranes, piling rigs, excavators) that would be required on the southern working area would access it from Lack's Dock and along the foreshore.

4.1.2 London Duck Tours operate several Second World War amphibious vehicles.

Figure 4.1 London Duck Tour vessel

4.1.3 They launch and recover their vessels from Lack's Dock slipway situated between the northern and southern working areas.

4.1.4 Three navigational safety issues related to the London Duck Tours operations have been identified at Albert Embankment Foreshore:

a. When entering the water from Lack's Dock, the temporary and permanent works could obstruct the Duck master's view of the traffic on the river and may lead to a collision between a Duck and a vessel transiting the area.

b. It is reported that Duck vessels sometimes lose propulsion and could therefore drift onto project's permanent structures.

c. The shape and location of the temporary and permanent works site could lead to a change in river flow. When the Ducks enter the water the flow of the river could move them beam untoward Vauxhall Bridge. If this occurred the potential for a river incident would be increased as a result of the Ducks having limited power, limited manoeuvrability and a low freeboard.

4.2 Interaction with other existing river traffic

4.2.1 The proposed temporary and permanent structures at Albert Embankment Foreshore are in close proximity to the following:

a. Lack's Dock - used by London Duck Tours,

b. St George Wharf - used by Thames Clippers Tate to Tate & Service West

c. Millbank Millennium Pier - used by Thames Clippers Tate to Tate & Service West, various pleasure boat operators

d. In-river mooring facilities (north bank).

4.2.2 Freight movements such as the Cory waste transfer service and other barge operators delivering aggregates to sites further up river transit past the site daily.

4.3 Intrusion into the river

4.3.1 The temporary cofferdam at Albert Embankment Foreshore extends approximately into the river from Vauxhall Cross and approximately 25m outside Camelford House.

4.3.2 Heavy plant and sheet-piling machinery would be required to construct the cofferdam. This plant would be located within the (LLAU). The furthermost boundary of this area is approximately 25m beyond the southern authorised channel boundary.

4.3.3 The intrusion into the river and proximity of plant and machinery to the authorised channel is assessed as a key marine issue for this site.

4.4 Arch closures: Vauxhall Bridge

4.4.1 The temporary cofferdam for the southern working area would include all of Vauxhall Bridge arch No5.

4.4.2 A jack-up barge servicing sheet piling activities may also obstruct part of arch No4 during construction and removal of the cofferdam (phases A and C). During these operations, there may be a requirement to close arch No4 to all navigation.

4.4.3 The available water depth and the exclusion zone outside of Vauxhall Cross prevent navigation through Arch No5 at most states of the tide, so it is rarely used. Arch No5 would be closed to navigation permanently as a result of the permanent structure (phase D).

4.5 Increase in river flow

4.5.1 Changes to the hydrodynamics of the River Thames may have an adverse effect on vessels operating in the vicinity of the works, most notably the London Duck Tours, and may affect passing vessels in transit through Vauxhall Bridge.

4.5.2 The shape, location and size of the permanent structure in the river at the Albert Embankment Foreshore site would lead to a change in river velocity that could have an adverse effect on existing, passing river traffic with certain vessel types expected to be affected more than others. However, the analysis of the results of fluvial modelling work carried out by HR Wallingford established that the introduction of the proposed temporary and permanent works structures at this site would have a minimal effect on existing river users. The changes in flows are expected to be low (approximately 0.4 knots peak to peak for the temporary and permanent in-river structures) and the majority of vessels that use this area are unlikely to be affected.

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5 Stakeholder consultation

5.1 Consultation meetings

5.1.1 Over the development of the design, the Thames Tideway Tunnel team engaged with the owner and vessel master of London Duck Tours, as stakeholders with regard to river operations and impact on operating conditions at this site. Additionally, planned site operations and the impact upon existing freight operations were discussed and assessed with Cory Environmental.

5.2 Observation notes

5.2.1 London Duck Tour vessels operating at Lack's Dock were observed on a number of occasions, during various states of the tide and weather conditions.

5.2.2 Observations and analysis of freight movements through Vauxhall Bridge were conducted. Full details of the analysis are contained within Appendix C - Freight Tracks and AIS Analysis.

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6 Risk assessment

6.1 Risk assessment: Methodology

6.1.1 For each of the identified hazards, the associated risk was assessed and classified. The following definitions were applied for the purposes of this report:

a. Hazard: eg, an object, activity or phenomenon that can cause an adverse effect.

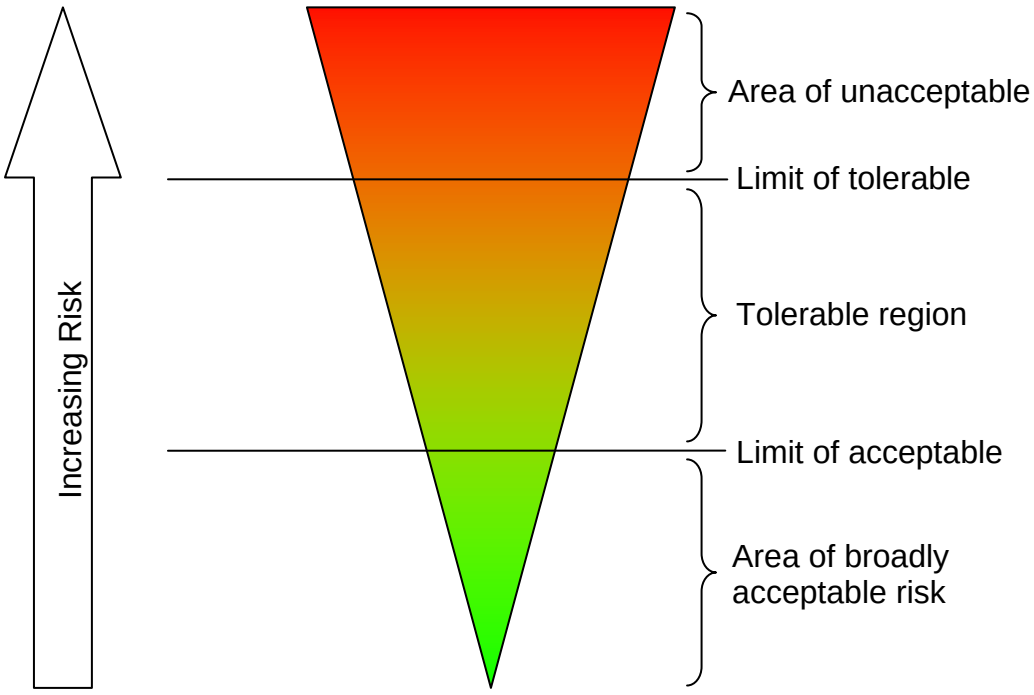
b. Risk: a relative measure of harm or loss, derived from the combination of the severity of a particular consequence together with the probability of the consequence occurring.

c. Consequence: a particular scenario (expressed as harm to people, damage to the environment, an operational impact and/or negative media attention) that result from a hazardous situation.

d. Probability: the chance of a particular hazard consequence occurring, measured as a frequency (per year).

6.1.2 The assessment used the principle of reducing navigational risks to a level that is As Low As Reasonably Practicable (ALARP).ALARP is part of the Health and Safety at Work Act 1974 and involves assessing the acceptability of a risk against the difficulty, time and expense needed to control it. The ALARP concept is illustrated in Figure 6.1.

Figure 6.1 The ALARP Principle



6.1.3 At the lower end of the ALARP triangle, risks are small due to either low probability or insignificant consequences. These risks can generally be accepted provided that common safeguards are implemented. Moving up the ALARP triangle to the tolerable region, risks increase in magnitude due to either an increase in probability or an increase in severity of consequences. Risks in the tolerable region can be accepted provided that risk controls are implemented that demonstrate that the risk is reduced to a level deemed to be ALARP; where any further risk reduction would be disproportionate in terms of cost, time and resources required to implement it compared to the benefit it would introduce. At the top of the ALARP triangle is a region of unacceptable risk that cannot be accepted without risk controls to reduce the risk to a tolerable and ALARP level.

6.1.4 This risk assessment was undertaken on a qualitative basis, using the engineering and operational judgement of representatives from the project team and representatives from river users and operators. Hazard consequences were considered based on most likely outcomes.

6.2 Risk assessment: Criteria

6.2.1 When commencing the assessment of the risk posed by the project's activities, the project's marine consultant recommended using the risk assessment criteria and methodology within the existing PLA Safety Management System (SMS). The rationale behind this recommendation was to provide the project team and the PLA with a consistent assessment score that could be transferred across into the PLA's existing SMS and enable an appreciation of the increase in risk resulting from the project's temporary and permanent works.

6.2.2 Consultation with the PLA highlighted the PLA's desire to use a specific risk terminology, as well as an alternative assessment matrix and risk classification scorecard. These changes have now been incorporated as requested.

6.2.3 This section details the risk criteria used throughout this assessment. The assessment process identifies four distinct areas of risk and the probable consequences associated with each hazard assessed in terms of harm or loss to:

a. people (life)

b. environment

c. operational impact

d. media attention.

6.2.4 Table 6.1 details the 'probability' criteria used to assess how likely each hazard is to occur in terms of average frequency in the PLA's jurisdiction.

Table 6.1 Probability Criteria

	Frequency	Score
Rare	Has not occurred in the in the last ten years	1

Unlikely	Has not occurred in the in the last three years	2
Possible	Has not occurred in the in the last year	3
Likely	Has occurred in the in the last year	4
Almost certain	Occurs several times per year	5

6.2.5 Table 6.2 details the severity criteria applied to the safety- related consequences of each hazard.

Table 6.2 Severity Criteria: People	**Level**
First aid case / Medical treatment case	1
Restricted work case	2
Lost Time Injury / Moderate permanent partial disability injury	3
Single Fatality / Severe permanent partial disability	4
Multiple fatalities	5

6.2.6 Table 6.3 details the severity criteria applied to the environmental loss related consequences of each hazard.

Table 6.3 Severity Criteria: Environment	**Level**
Low impact with no lasting effect	1
Temporary effect / Minor effect to small area	2
Short to medium term impact	3
Medium to long term effect / large area affected	4
Long term impact / severe impact on sensitive area	5

6.2.7 Table 6.4 details the severity criteria applied to the property loss/damage related consequences of each hazard.

Table 6.4 Severity Criteria: Operational Impact	**Level**
Insignificant or no damage to vessel / equipment	1
Minor or superficial damage to vessel / equipment	2
Moderate damage to vessel / equipment requiring immediate repairs	3
Major damage to vessel / equipment and detention	4
Very serious damage to vessel or equipment possible criminal proceedings	5

6.2.8 Table 6.5 details the severity criteria applied to negative media attention/coverage consequences of each hazard.

Table 6.5 Severity Criteria: Media Attention	**Level**
No Coverage	1
Local coverage	2
Regional coverage	3

National coverage	4
International coverage	5

6.3 Risk matrix

6.3.1 The risk matrix in Table 6.6 was used to provide a risk score, combining severity of a particular consequence with the likelihood (probability) of the consequence occurring.

Table 6.6 Risk Assessment Matrix

Likelihood	Rare	**1**	**2**	**3**	**4**	**5**
	Unlikely	**2**	**4**	**6**	**8**	**10**
	Possible	**3**	**6**	**9**	**12**	**15**
	Likely	**4**	**8**	**12**	**16**	**20**
	Almost certain	**5**	**10**	**15**	**20**	**25**
	Severity	Level 1	Level 2	Level 3	Level 4	Level 5

6.3.2 The risk score in Table 6.7 indicates the magnitude and acceptability of the risk in accordance with the ALARP principle. The PLA method applies this to both individual and average risk.

Table 6.7 Risk Classification

Score	Classification	Definition
1 to 2	**Slight**	No action is required.
3 to 4	**Minor**	No additional controls are required, monitoring is required to ensure no changes in circumstances.
5 to 9	**Moderate**	Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.
10 to 14	**High**	Efforts should be made to reduce risk to ALARP level. Job can only be performed after authorisation from Harbour Master and after further

		additional controls required under the circumstances.
15 to 25	**Extreme**	Intolerable risk. Job is not authorised.

6.4 Hazard identification

6.4.1 A hazard can be defined as 'the potential for an adverse consequence', and may be associated with a situation that could cause harm to people, damage to the environment, an operational impact or negative media attention.

6.4.2 In order to facilitate a comprehensive overview of potential maritime hazards, various river users and operators were consulted throughout the risk assessment process, including:

a. Thames Clippers;

b. Cory Environmental Limited;

c. City Cruises;

d. Livett's Launches;

e. Bennett's Barges;

f. London Duck Tours;

g. Metropolitan Police Marine Policing Unit;

h. Royal National Lifeboat Institute (RNLI).

6.4.3 The project also made several site visits to HR Wallingford's physical model during the risk assessment process. This provided Captain David Phillips (at the time, PLA Harbour Master (Upper)), freight (Cory Environmental) and commercial (Thames Clippers) operators with the opportunity to understand the impact of the proposed developments on the river flow patterns and to visualise the scale of the temporary and permanent work at various locations. However, the site at Albert Embankment Foreshore was not included in this physical model.

6.5 Mitigation strategy

6.5.1 Throughout the assessment process, it was evident that potential hazards presented by the project would require mitigation measures throughout the project lifecycle.

6.5.2 The following section will identify and detail the navigational issues and proposed mitigation measures.

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7 Navigational issues and mitigation measures

7.1 General

7.1.1 It is acknowledged that mitigation measures may themselves introduce further hazards that also require mitigation. Where appropriate, these have been considered.

7.1.2 Mitigation measures were developed with an emphasis on measures that are within the project's control (e.g. design of in-river structures).

7.1.3 For the purpose of this assessment, mitigation measures (risk control options) were classified as three types;

a. Design: measures that can be implemented by the project at the design stage.

b. Physical: measures that the project can implement during the construction and operational phases.

c. Operational: measures that the project can implement in conjunction with the PLA at all stages of the project.

7.1.4 Of course, some proposed mitigation measures would be beyond the project's control, such as emergency plans, operating procedures and NtMs.

7.2 Interaction with London Duck Tours vessels

7.2.1 The London Duck Tours company operates several Second World War amphibious vehicles. They launch and recover their vessels from the slip way (Lacks Dock) adjacent to Vauxhall Cross which is situated between two proposed project work sites.

7.2.2 The tours Depart from Chicheley Street (near the London Eye), pass through various areas of London (Big Ben, Houses of Parliament, Trafalgar Square etc) and then enter the Thames River at a slipway in Vauxhall. The water borne leg of the tour heads downstream approximately as far as the London Eye before returning to exit the river at the same slipway in Vauxhall.

7.2.3 It is understood that London Duck Tours conducted in excess of 7.000 individual tours in 2011. The company estimates that this figure could rise by as much as 20% in 2012.

7.2.4 Three navigational safety issues have been identified with the proposed works at Albert Embankment Foreshore associated with the operations of London Duck Tours.

a. When entering the water from Lack's Dock, the temporary and permanent works could obstruct the Duck master's view of the traffic on the river and may lead to a collision between a Duck and a vessel transiting the area.

b. It is reported that Duck vessels sometimes lose propulsion and could therefore drift onto project's permanent structures.

c. The shape and location of the temporary and permanent works site could lead to a change in river flow. When the Ducks enter the water the flow of the river could move them beam on towards Vauxhall Bridge. If this occurred the potential for a river incident would be increased as a result of the Ducks having limited power, limited manoeuvrability and a low freeboard.

7.2.5 During consultation with London Duck Tours owners, it was highlighted that lines of sight would be greatly reduced with the temporary cofferdams in place. Once the Ducks are at the bottom of the slipway they are committed to entering the river and they have very little option other than to continue on their journey.

Figure 7.1 London Duck Tours entering the River Thames at Lacks Dock

7.2.6 The current operating procedure for London Duck Tours masters entering the river at Lacks Dock is to use Thames Automatic Identification System (AIS) to check for any other vessels in the vicinity and to look for other vessels that would not be identified on AIS such as rowers.

7.2.7 In the event of an incident, such as equipment defect or stalled engine, the London Duck Tours vessel drops an anchor. It takes approximately 35-50m of anchor chain before the vessel comes to a stop after the anchor

takes hold in the river bed (there is no control of playing out the anchor cable).

Actions required

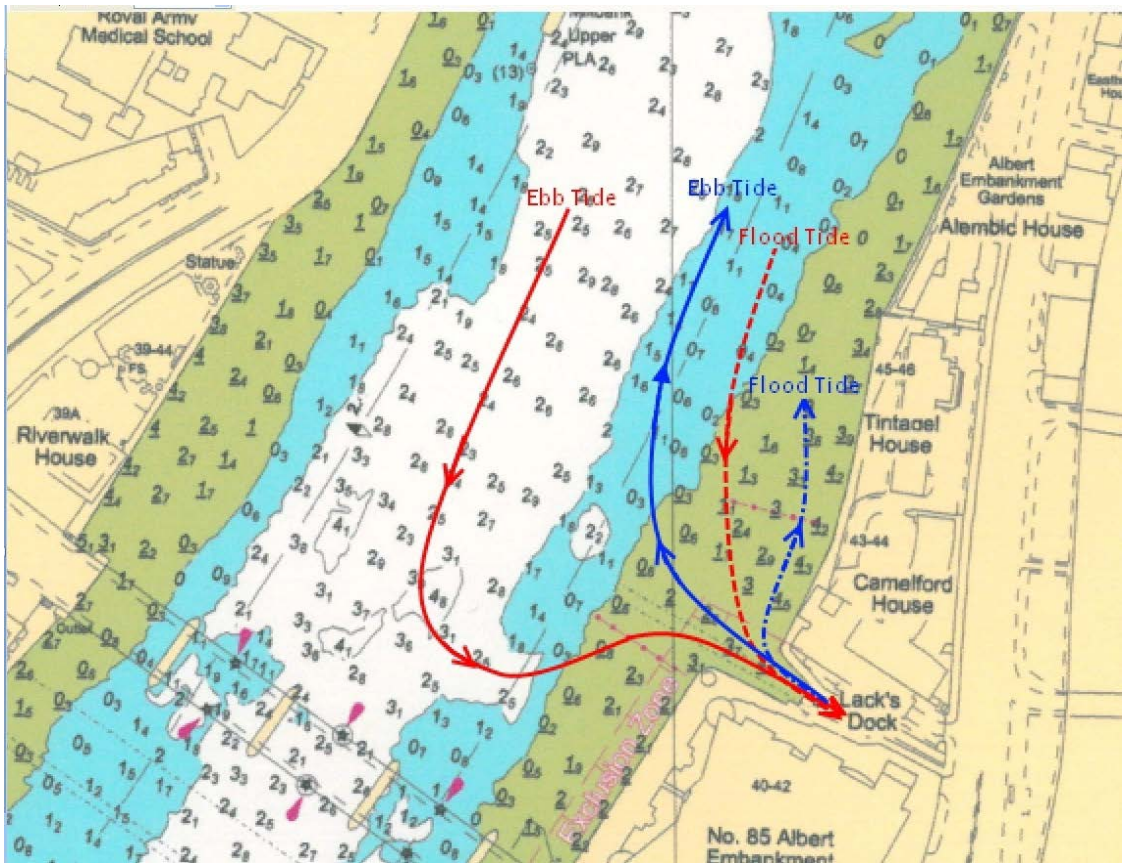
7.2.8 A number of actions, specific to these issues, have been commenced or completed in order to assist the project to provide a robust and evidence-based assessment to the PLA. These actions include:

a. Analyse and observe current London Duck Tour operations, including entry and exit of the river at the Albert Embankment slipway;

b. Undertake consultation with the owner/operator of London Duck Tours, informing them of the proposed extent of the work at this site and the proposed in-river structures. Determine perceived level of interaction between the two operations and likely issues arising from the project's works at the site;

c. Review of HR Wallingford's Fluvial Modelling undertaken at Albert Embankment Foreshore (Appendix B).

Figure 7.2 Routes of London Duck Tours vessels



Mitigation of issues: Design

7.2.9 Designing the project has been an iterative process, influenced by the ongoing navigational risk assessment process. Measures to eliminate or reduce navigational hazards identified in early risk assessments were embedded into the design of the temporary and permanent works to

eliminate or reduce navigational hazards. This assessment therefore assesses the residual risk assuming the effective implementation of these measures. The embedded measures include:

a. The in-river footprint of the temporary and permanent works site has been minimised so that intrusion into the river is kept as small as reasonably practical while incorporating the necessary works and is set back from the authorised channel. This reduces the extent that works sites extend into the river and therefore reduces the likely impact on existing river users.

b. A small change has been made to the shape of the permanent shaft structure, subsequent to phase two consultation, to round off the corner of the permanent structure, improving sight lines for users of Lack's Dock.

c. Piles have been provided around the terraced interception structure to prevent users of Lack's Dock drifting onto the partly submerged structure and capsizing in the event of engine failure

d. Constraints have been placed on the working areas within the river, as identified on the Zones of Foreshore Working drawing to minimise the activity required in close proximity to the authorised channel

e. The design of the temporary and permanent structures includes the provision of ladders, safety grab chains and other lifesaving equipment around the work sites to aid emergency egress from the river, in accordance with the PLA's guidance document 'Review of Lifesaving Provisions Along the River Thames'.

7.2.10 The following sections set out proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

7.2.11 London Duck vessels are fitted with Thames AIS offering the vessel master visibility of what is occurring on the river;

7.2.12 London Duck vessels are fitted with Very High Frequency (VHF) communications system which allows contact with Thames Vessel Traffic Service (VTS) and other vessels in the area;

7.2.13 Provision of a temporary 'watchman's hut' for use by London Duck Tours during the construction phases of the project. There are a number of operational and responsibility issues associated with providing such a facility. Operating policy and procedures would need to be written, taking into account overall lines of responsibility and stakeholder operating requirements.

7.2.14 Consideration should be given to providing such a facility, the issue of responsibility in the event of an incident would need to be investigated, with final responsibility of vessel movements and therefore safety falling on the vessel master.

7.2.15 The temporary watchman's hut would provide shelter, Thames AIS display equipment and communication equipment for a dedicated river lookout. The lookout would be in communication with the project marine co-ordination staff:

a. Thames Barrier Navigation Centre (TBNC);

b. London Duck Tour vessels;

c. London Duck Tour control centre;

d. Other vessels in vicinity of the site, including Thames Tunnel barges.

7.2.16 The lookout would be provided by London Duck Tours. It is assumed that the lookout would be on watch for periods when London Duck Tours are in operation, typically from 09:15 to one hour before sunset.

7.2.17 A boat-based lookout could be provided as an alternative to the watchman's hut. The boat should have towing capability. This could be the same as the safety boat below.

7.2.18 A safety boat, with towing capability, should be available at the site to rescue a DUKW that has lost propulsion.

7.2.19 Control of project vehicle movements across the foreshore between the northern and southern sites to avoid conflict with London Duck Tours movements, which can be at least 80 movements a day in peak season. Control measures could include provision of traffic signals to prioritise movements and avoid conflict, as well as measures to reduce the number of project movements across the foreshore such as pumping concrete to the site and moving materials outside of the operational hours of London Duck Tours.

Mitigation of issues: River operations

7.2.20 Liaison and dialogue between the project and London Duck Tours operator with early notification of any large scale plant movement that is likely to have an impact on London Duck Tours operations.

7.2.21 Emergency response exercises and training.

7.3 Interaction with other existing river traffic

7.3.1 The Albert Embankment Foreshore site is close to:

a. Lacks Dock - used by London Duck Tours;

b. St George Wharf - used by Thames Clippers;

c. Millbank Millennium Pier - used by Thames Clippers and numerous pleasure boat operators;

d. Various in-river mooring facilities.

7.3.2 Freight movements include Cory Environmental waste transfer service and barge operators delivering aggregates to sites further up river.

Figure 7.3 Cory tug & barge in transit

7.3.3 The project is proposing to use barges to transfer excavated material and imported fill by river from this site during the construction phases A to C.

7.3.4 Project barges working at this site and the associated interaction between existing river users, either in transit past the site or operating at the nearby piers has been identified as a potential navigational hazard.

Figure 7.4 Thames Clippers transiting through Vauxhall Bridge

Actions required

7.3.5 A number of actions, specific to the issues, have been commenced or completed in order to assist the project to provide a robust and evidence-based assessment to the PLA. These actions include:

a. collate AIS data to allow detailed assessment and site specific drawings to be produced and overlaid on navigational charts, showing the extent of the interaction.

b. identify typical river traffic that uses this section of the river and its typical frequency

c. analyse passenger vessel movements through this section of the river.

d. record and observe recreational river traffic in the areas - typical vessels under 13.7m in length that are directed to navigate outside of the authorised channel.

Mitigation of issues: Design

7.3.6 The following measures are embedded in the designs and this assessment therefore only assesses the residual risk assuming the effective implementation of these measures:

a. The in-river footprint of the temporary and permanent works site has been minimised so that intrusion into the river is kept as small as possible while incorporating the necessary works and is set back from the authorised channel. This reduces the extent that the construction work sites extend into the river and therefore reduces the likely impact on existing river users.

b. Constraints have been placed on the working areas within the river, as identified on the Zones of Foreshore Working drawing to minimise the activity required in close proximity to the authorised channel.

c. Barge size has been optimised in order to minimise the number of barge movements to/from the site.

7.3.7 The following sections set out the proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. assessment and understanding of operating procedures to ensure minimum disruption/interaction with existing users

b. meeting with Cory Environmental and London Duck Tours to get their views and input into interaction issues and possible working relationships at this site

c. permanent closure of Arch No5 with appropriate ‘arch closed’ signs and lights.

Mitigation of issues: River operations

a. Notice to Mariners - informing operators & river users of planned operations in area, highlighting times when project barges are likely to be servicing the site.

b. Berthing Co-ordination Manager to liaise and be in communication with all operators in the local area and be on hand to deal with potential areas of concern or conflict.

7.4 Intrusion into the river

7.4.1 There would be two separate working areas at Albert Embankment Foreshore location, which are summarised below:

Northern working area

7.4.2 The furthermost boundary of the LLAU is approximately 25m beyond the authorised channel.

7.4.3 The temporary cofferdam is approximately 28m from the authorised channel.

7.4.4 The permanent structure is greater than 60m from the authorised channel.

7.4.5 During construction of the cofferdam, a jack-up barge servicing piling operations would be located no closer than 10m to the authorised channel, as shown on the Zones of Foreshore Working drawing (Appendix A). The area of the LLAU that is closer to the authorised channel (or located within the authorised channel) allows for the possible placement of scour protection to the temporary cofferdam. The placement of scour protection would be a short-term operation and is therefore excluded from this assessment. The Contractor would be required to prepare and agree detailed navigational risk assessments before commencing these works.

Southern working area

7.4.6 The boundary of the LLAU is approximately 10m from the authorised channel along most sections.

7.4.7 The temporary cofferdam is approximately 27m from the authorised channel.

7.4.8 The permanent structure is greater than 30m from the authorised channel.

7.4.9 The southern working area encompasses the whole of Vauxhall Bridge arch No 5. During construction, a jack-up barge servicing piling operations may encroach into arch No4 and approximately 10m from the authorised channel.

7.4.10 Freight traffic transits past the Albert Embankment Foreshore site and would normally use the centre arch (arch No3) of Vauxhall Bridge.

7.4.11 Non freight vessels are encouraged to navigate outside of the authorised channel, where it is safe to do so[3].

7.4.12 During construction phases A, B and C, it is assessed that the intrusion into the river and proximity to the authorised channel at this location presents a hazard to existing navigation, most notably to vessels under 13.7m in length overall proceeding downstream.

7.4.13 The probability of an incident occurring reduces when plant is removed from the river, for example once the temporary cofferdams have been constructed, and when barges are not berthed alongside the work site. Therefore, the probability of incident occurring at this site is assessed as being greater during phase A and phase C than during phase B.

Actions required

7.4.14 A number of actions, specific to the issues, have been commenced or completed in order to assist the project to provide a robust and evidence-based assessment to the PLA. These actions include:

a. analyse passenger vessel movements through this section of the river

b. record and observe leisure / recreational river traffic in the areas - typical vessels under 13.7m that are directed to navigate outside of the authorised channel

Mitigation of issues: Design

7.4.15 The following measures are embedded in the designs and this assessment therefore only assesses the residual risk assuming the effective implementation of these measures:

a. The in-river footprint of the temporary and permanent works site has been minimised so that intrusion into the river is kept as small as reasonably practical while incorporating the necessary works and is set back from the authorised channel. This reduces the extent that works sites extend into the river and therefore reducing the likely impact on existing river users.

b. Constraints have been placed on the working areas within the river, as identified on the Zones of Foreshore Working drawing to minimise the activity required in close proximity to the authorised channel

7.4.16 The following sections set out the proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. assessment and understanding of operating procedures to ensure minimum disruption/interaction with existing users

[3] PLA General Direction for Navigation in the Port of London 2011 - No 36 states the requirement for use of the authorised channel.

b. meeting with Cory Environmental and London Duck Tours to get their views and input into interaction issues and possible working relationships at this site

Mitigation of issues: River operations

a. Notice to Mariners - informing operators & river users of planned operations in area, highlighting times when jack-up barges or other obstructions are planned to be located close to the authorised channel.

7.5 Arch closures: Vauxhall Bridge

7.5.1 The LLAU extends into arch No4. During construction and removal of the temporary cofferdam (phases A and C), jack-up barges may obstruct part of Arch No4. At these time, Arch No4 may need to be closed to navigation

7.5.2 As a result, if there is a need to close arch No3, (either planned or for an emergency situation, but not necessarily associated with the project), there could be an adverse impact on vessel traffic.

7.5.3 Vauxhall Bridge has five arches and Arches No2, No3 and No4 are designated as working arches in the PLA's *Mariners Guidance to Bridges on the Tidal Thames*.

a. Arch No2 should normally be used by smaller inbound traffic to leave Arch No3 clear for the larger and reporting vessels.

b. Arch No3 should be used by larger and reporting vessels travelling both inbound and outbound. Smaller vessels should only traverse arch No3 if it is clear to do so and does not impede the progress of larger and reporting vessels. There are special signal lights located above Arch No3.

c. Arch No4 should normally be used by smaller outbound traffic if the tide allows.

7.5.4 Arch No1 and 5 are occasionally used by small, self-propelled vessels.

Figure 7.5 Vauxhall Bridge - Proceeding upstream

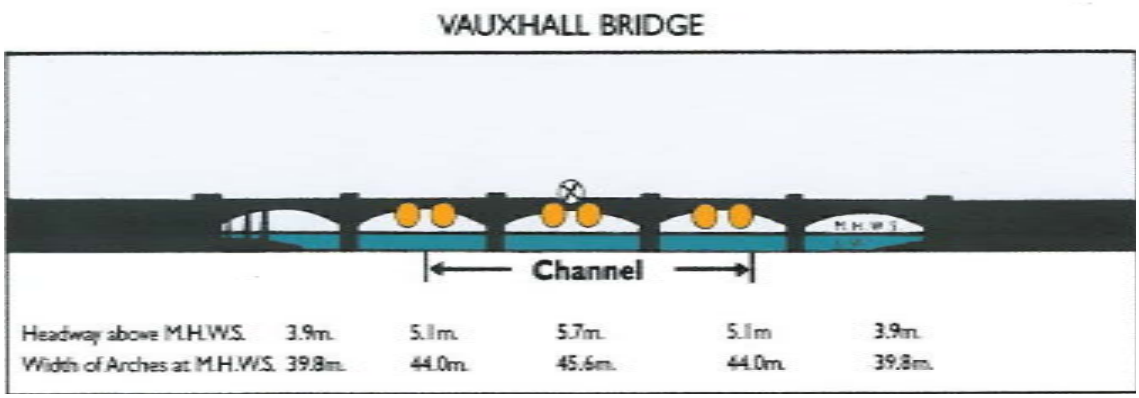
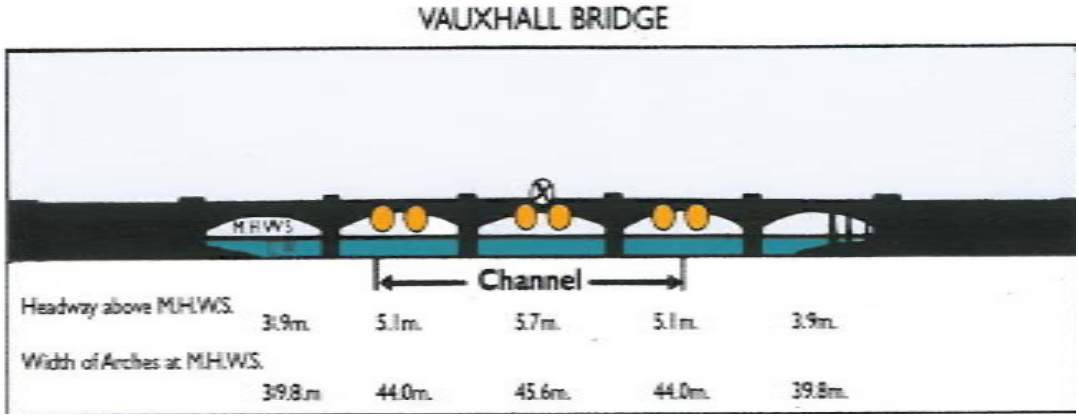


Figure 7.6 Vauxhall Bridge - Proceeding downstream



Actions required

7.5.5 A number of actions, specific to the issues, have been commenced or completed in order to assist the project to provide a robust and evidence-based assessment to the PLA. These actions include:

a. consult with the PLA, Transport for London and Bridge owners in order to establish schedule for planned closure of arch No3

b. conduct analysis of vessel movements through Vauxhall Bridge to ascertain extent to which the project works would impact an arch closure

Mitigation of issues: Design

7.5.6 The following measures are embedded in the designs and this assessment therefore only assesses the residual risk assuming the effective implementation of these measures:

a. Planned closure of arch No3 should not take place during the construction or removal of the temporary cofferdam (Phase A and C). General bridge inspections are carried out every 2 years, but do not require closure of the arch. Principal bridge inspections are carried out every six years. Principal bridge inspections will be conducted immediately prior to project work commencing.

7.5.7 The following sections set out the proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. provision of arch closure lights and signs once arch No5 is occupied by the southern temporary and permanent structure.

Mitigation of issues: River operations

a. Notice to Mariners informing river users of the planned closures and the lights/markings to expect.

b. The project would remove plant and equipment from arch No4 to allow navigation through the arch in the event of an unplanned closure of arch No3.

c. Harbour service launch to control navigation through the bridge in the event of a single arch being open to reporting vessels.

7.5.8 Previous notices to mariners have been issued for this type of situation stating 'When two navigable arches are closed to navigation, local traffic control would be established from a Port of London Authority Harbour Services Launch operating in the area. Vessels wishing to pass through the remaining open navigable arch of Blackfriars Road and Railway Bridges or operating between London and Waterloo Bridges are to call "Thames Patrol" on VHF.

7.6 Increase in river flow

7.6.1 The shape, location and size of the temporary cofferdam and permanent structure in the river at the Albert Embankment Foreshore site could lead to an increase in-river flow that may have an adverse impact on existing river users, most notably the London Duck Tour vessels.

7.6.2 HR Wallingford carried out fluvial modelling of the proposed structures in the river at Albert Embankment Foreshore.

7.6.3 Analysis of the work carried out by HR Wallingford identified that the introduction of the proposed temporary and permanent structures at this site would have a minimal effect on existing river users. The changes in flow were predicted to be low and the majority of vessels using this area would be likely to be unaffected.

7.6.4 Analysis of the fluvial modelling results established the following:

a. The greatest change in maximum flow for the temporary works across a given cross section in the Albert Embankment Foreshore area is approximately 0.4 knots, which is associated with a peak flood spring tide with a 65m^3/s river flow in line with the temporary works.

b. The greatest change in maximum flow for the permanent works across a given cross section in the Albert Embankment Foreshore area is approximately 0.2 knots, which is associated with a peak flood spring tide with strong river flow (800m^3/s) in line with Vauxhall Bridge.

7.6.5 Further analysis of the fluvial modelling results is provided in Appendix B, including a tabulation of the changes in maximum flow for the available tidal and fluvial conditions.

7.6.6 The greatest change in peak flows of 0.4 knots would occur in the centre of the authorised channel in the flood tide, and therefore should not affect navigation of London Duck Tours vessels, which navigate outside of the authorised channel on a flood tide (as illustrated on Figure 7.2). Further, although this scenario results in the greatest change in peak flow, the peak flow in this scenario is still less than the peak flow for other scenarios.

7.6.7 The London Duck Tours vessels are likely to experience a change in flow of no more than 0.1 to 0.2 knots, and will experience a reduction in flow in close proximity to Lack's Dock, based on analysis of their operating routes and the fluvial modelling results.

Actions required

7.6.8 One action, specific to the issues, was completed in order to assist the project to provide a robust and evidence-based assessment to the PLA as follows:

a. Inform the PLA of reports produced covering the extent of the increases in flow (see Appendix B).

Mitigation of issues: Design

7.6.9 The following measures are embedded in the designs and this assessment therefore only assesses the residual risk assuming the effective implementation of these measures:

a. Computational modelling of in-river structures and analysis to determine likely increases/decreases in flow and vessel types most likely to be affected by changes.

b. The in-river footprint of the temporary and permanent works site has been minimised so that intrusion into the river is kept as small as reasonably practical while incorporating the necessary works, which minimises the change in flow around the structures.

c. The corners of the temporary cofferdams have been rounded to reduce fluvial impacts and scour.

d. The design of the temporary and permanent structures includes the provision of ladders, safety grab chains and other lifesaving equipment around the work sites to aid emergency egress from the river, in accordance with the PLA's guidance document 'Review of Lifesaving Provisions Along the River Thames'.

7.6.10 The following sections set out proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

7.6.11 None identified.

Mitigation of issues: River operations

7.6.12 None identified.

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8 General navigational hazards

8.1.1 In addition to the 'navigation issues' considered within this report, navigational hazards associated with day-to-day river operations were also identified. These hazards relate to the interaction of the project-related marine traffic with existing river users.

8.1.2 'Worst Credible' consequences and the probability of the consequences were considered in the assessment. As a result, in some cases the Worst Credible score was lower than the 'Most Likely' score. This is explained by the probability that a 'moderate injury', for example, is higher than the probability of a 'single fatality'.

8.1.3 Full hazard details are contained in Annex A through to Annex I.

8.2 Project phases A to D: Most likely

Table 8.1 Most likely risk scores

				Score			
Hazard Id	**Hazard title**	**Hazard description**	**Phase**	**People**	**Environment**	**Operational**	**Media**
1	Emergency arch closure - arch No3 or 4	There may be an emergency requirement to close No3 or 4.	A	8	4	6	6
			B	8	4	6	6
			C	8	4	6	6
			D	8	4	6	6
2	Planned arch closure - arch No3 or 4	There may be a requirement to close No 3 or 4 arch for maintenance.	A	8	4	6	6
			B	8	4	6	6
			C	8	4	6	6
			D	N/A	N/A	N/A	N/A
3	Planned and permanent arch closure – arch No5	During construction/use/decons truction of the temporary cofferdam, the project proposes to close arch No5 to all navigation. The project proposes to close the arch as it would be occupied by the permanent structure.	A	N/A	N/A	N/A	N/A
			B	N/A	N/A	N/A	N/A
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
4	Increase in flow	Changes to the hydrodynamics of the river may affect passing	A	9	6	6	
			B	9	6	6	9
			C	9	6	6	9

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
		vessels, particularly through the arches of Vauxhall Bridge.	D	9	6	6	9
5	Contact - High Speed Passenger Vessel with worksite	A High Speed Passenger Vessel comes into contact with the project's temporary or permanent worksite at Albert Embankment Foreshore.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
6	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with temporary or permanent work site at Albert Embankment Foreshore.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
7	Contact - private leisure vessel with worksite	A private leisure vessel comes into contact with temporary or permanent work site at Albert Embankment Foreshore.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
8	Contact - commercial freight operator with worksite	A commercial freight operator comes into contact with temporary or permanent work site at Albert Embankment Foreshore.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
9	Contact - tug and tow with worksite	A tug and tow comes into contact with temporary or permanent worksite at Albert Embankment Foreshore.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
10	Contact - London Duck aquatic	A London Duck aquatic vehicle comes into	A	9	6	9	9
			B	9	6	9	9
			C	9	6	9	9

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	vehicle with worksite	contact with the project's temporary or permanent work site at Albert Embankment Foreshore.	D	9	6	6	6
11	Grounding - All vessels due to 'Squat Effect'	At periods of low water, vessels may be affected by the 'Squat Effect', causing them to be closer to the river bed than expected.	A	6	2	6	6
			B	6	2	6	6
			C	6	2	6	6
			D	6	2	6	6
12	Mooring breakout	A vessel involved in project activities breaks free from moorings	A	6	4	6	4
			B	6	4	6	4
			C	6	4	6	4
			D	N/A	N/A	N/A	N/A
13	Collision - London Duck aquatic vehicle collides with another vessel	A London Duck aquatic vehicle collides with another non project vessel due to effects of the works	A	12	9	9	12
			B	12	9	9	12
			C	12	9	9	12
			D	12	9	9	12
14	Collision - High Speed Passenger Vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Albert Embankment	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8
			D	N/A	N/A	N/A	N/A
15	Collision - Class V passenger vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a Class V passenger vessel in the vicinity of Albert Embankment.	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8
			D	N/A	N/A	N/A	N/A
16	Collision - private	A vessel conducting	A	9	6	9	9

				Score			
Hazard Id	**Hazard title**	**Hazard description**	**Phase**	**People**	**Environment**	**Operational**	**Media**
	leisure vessel (construction/deconstruction)	project construction/deconstruction activities collides with a private leisure vessel in the vicinity of Albert Embankment.	B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
17	Collision - commercial freight operator (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a commercial freight operator in the vicinity of Albert Embankment.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	9	6	9
			D	N/A	N/A	N/A	N/A
18	Collision - tug and tow (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collide with a tug and tow in the vicinity of Albert Embankment.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	9	6	9
			D	N/A	N/A	N/A	N/A
19	Collision - London Duck aquatic vehicle (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a London Duck aquatic vehicle in the vicinity of Albert Embankment.	A	9	6	9	9
			B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
20	Contact with Vauxhall Bridge (construction/deconstruction)	A vessel conducting project construction/deconstruction activities makes contact with Vauxhall Bridge, including arches, abutments and any associated bridge superstructure.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	3	6	6
			D	N/A	N/A	N/A	N/A
21	Collision - High Speed Passenger	A vessel conducting project delivery/material	A	N/A	N/A	N/A	N/A
			B	6	4	6	8

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	Vessel (delivery/material removal)	removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Albert Embankment	C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
22	Collision - High Speed Passenger Vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a Class V passenger vessel in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
23	Collision - private leisure vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a private leisure vessel in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	9	6	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
24	Collision - commercial freight operator (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a commercial freight operator in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	6	9	6	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
25	Collision - tug and tow (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a tug and tow in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	6	9	6	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
26	Collision - London Duck aquatic vehicle (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a London Duck aquatic vehicle in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	9	6	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
27	Contact with	A vessel conducting	A	N/A	N/A	N/A	N/A

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	Vauxhall Bridge (delivery/material removal)	project delivery/material removal activities makes contact with Vauxhall Bridge, including arches, abutments and any associated bridge superstructure.	B	6	3	6	6
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

8.3 Project phases A to D: Worst credible

Table 8.2 Worst credible risk scores

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
1	Emergency arch closure - arch No3 or 4	There may be an emergency requirement to close arch No 3 or 4.	A	5	3	4	4
			B	5	3	4	4
			C	5	3	4	4
			D	5	3	4	4
2	Planned arch closure - arch No3 or 4	There may be a requirement to close arch No3 or 4 for maintenance.	A	5	3	4	4
			B	5	3	4	4
			C	5	3	4	4
			D	N/A	N/A	N/A	N/A
3	Planned and permanent arch closure – archNo 5	During construction/use/deconstruction of the temporary cofferdam, it is proposed that arch No5 is closed to all navigation. The arch will be occupied by the permanent structure and subsequently closed.	A	N/A	N/A	N/A	N/A
			B	N/A	N/A	N/A	N/A
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
4	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels, particularly through the arches of Vauxhall Bridge.	A	12	9	9	12
			B	12	9	9	12
			C	12	9	9	12
			D	12	9	9	12

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
5	Contact - High Speed Passenger Vessel with worksite	A High Speed Passenger Vessel comes into contact with temporary or permanent work site at Albert Embankment Foreshore.	A	10	6	8	10
			B	10	6	8	10
			C	10	6	8	10
			D	10	6	8	10
6	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with temporary or permanent work site at Albert Embankment Foreshore.	A	10	6	8	10
			B	10	6	8	10
			C	10	6	8	10
			D	10	6	8	10
7	Contact - private leisure vessel with worksite	A private leisure vessel comes into contact with temporary or permanent worksite at Albert Embankment Foreshore.	A	10	6	8	8
			B	10	6	8	8
			C	10	6	8	8
			D	10	6	8	8
8	Contact - commercial freight operator with worksite	A commercial freight operator comes into contact with temporary or permanent worksite at Albert Embankment Foreshore.	A	8	6	8	6
			B	8	6	8	6
			C	8	6	8	6
			D	8	6	8	6
9	Contact - tug and tow with worksite	A tug and tow comes into contact with temporary or permanent worksite at Albert Embankment Foreshore.	A	8	6	8	6
			B	8	6	8	6
			C	8	6	8	6
			D	8	6	8	6
10	Contact - London Duck aquatic vehicle with worksite	A London Duck aquatic vehicle comes into contact with temporary or permanent worksite at Albert Embankment Foreshore.	A	12	9	12	12
			B	12	9	12	12
			C	12	9	12	12
			D	12	9	9	9
11	Grounding - All vessels due to 'Squat Effect'	At periods of low water, vessels may be affected by the 'Squat Effect', causing them to be closer to the river bed than expected.	A	8	4	8	8
			B	8	4	8	8
			C	8	4	8	8
			D	8	4	8	8
12	Mooring breakout	A vessel involved in project activities breaks free from	A	8	6	8	8
			B	8	6	8	6

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
		moorings	C	8	6	8	6
			D	N/A	N/A	N/A	N/A
13	Collision - London Duck aquatic vehicle collides with another vessel	A London Duck aquatic vehicle collides with another non project vessel due to effects of the Tideway works	A	10	8	8	10
			B	10	8	8	10
			C	10	8	8	10
			D	10	8	8	10
14	Collision - High Speed Passenger Vessel (construction/deconstruction)	A vessel conducting construction/deconstruction activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Albert Embankment	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8
			D	N/A	N/A	N/A	N/A
15	Collision - Class V passenger vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a Class V passenger vessel in the vicinity of Albert Embankment.	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	8	4	6	8
			D	N/A	N/A	N/A	N/A
16	Collision - private leisure vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a private leisure vessel in the vicinity of Albert Embankment.	A	8	6	8	8
			B	N/A	N/A	N/A	N/A
			C	8	6	8	8
			D	N/A	N/A	N/A	N/A
17	Collision - commercial freight operator (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a commercial freight operator in the vicinity of Albert Embankment.	A	9	12	9	9
			B	N/A	N/A	N/A	N/A
			C	9	12	6	6
			D	N/A	N/A	N/A	N/A
18	Collision - tug and tow (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collide with a tug and tow in the vicinity of Albert Embankment.	A	9	12	9	9
			B	N/A	N/A	N/A	N/A
			C	9	12	9	9
			D	N/A	N/A	N/A	N/A
19	Collision - London Duck aquatic vehicle	A vessel conducting project construction/deconstruction activities collides with a	A	12	9	12	12
			B	N/A	N/A	N/A	N/A
			C	12	9	12	12

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	(construction/deconstruction)	London Duck aquatic vehicle in the vicinity of Albert Embankment.	D	N/A	N/A	N/A	N/A
20	Contact with Vauxhall Bridge (construction/deconstruction)	A vessel conducting project construction/deconstruction activities makes contact with Vauxhall Bridge, including arches, abutments and any associated bridge superstructure.	A	9	6	9	9
			B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
21	Collision - High Speed Passenger Vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Albert Embankment	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
22	Collision - Class V passenger vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a Class V passenger vessel in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
23	Collision - private leisure vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a private leisure vessel in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	8	6	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
24	Collision - commercial freight operator (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a commercial freight operator in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	9	12	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
25	Collision - tug and tow (delivery/material removal)	A vessel conducting project delivery/material removal activities collide with a tug and tow in the vicinity of Albert Embankment.	A	N/A	N/A	N/A	N/A
			B	9	12	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
26	Collision -	A vessel conducting project	A	N/A	N/A	N/A	N/A

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	London Duck aquatic vehicle (delivery/material removal)	delivery/material removal activities collides with a London Duck aquatic vehicle in the vicinity of Albert Embankment.	B	12	9	12	12
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
27	Contact with Vauxhall Bridge (delivery/material removal)	A vessel conducting project delivery/material removal activities makes contact with Vauxhall Bridge, including arches, abutments and any associated bridge superstructure.	A	N/A	N/A	N/A	N/A
			B	9	6	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

9 Mitigation measures

9.1 Existing mitigation

9.1.1 Existing safeguards (measures that manage the risk) in the form of control measures and relevant PLA guidance, are set out in Table 9.1 together with any additional controls deemed desirable or necessary to reduce risk to a level that is ALARP. The risk is assessed taking account of the impact of these various safeguards and controls.

Table 9.1 Existing safeguards

• Boat Masters License	• Vessel Master Experience
• MCA - MGN 199 (M) Dangers of Interaction	• Permanent/Temporary Notice to Mariners
• Aids to Navigation	• Passage Planning
• Safe Systems of Work	• Tug Operator Procedures
• Contractors Risk Assessment	• BML Local Knowledge Endorsement
• River Bylaws	• General Directions
• VTS Qualification	• VHF Communications
• Bridge Special Signal Lights	• Ship Towage Code of Practice
• VTS Navigational Broadcast	• Emergency Plans and Procedures
• Thames AIS	• Oil Spill Contingency Plan
• PLA Bridge Guide	• Maintenance / Inspection Routines
• Admiralty Charts	• COLREGs
• Tide Gauges	• Qualified Crew
• Tide Tables	• Barge Operators daily check lists
• Accurate Tidal Information	• High Speed Craft Code

9.1.2 The above list is not exhaustive but was used to highlight the measures that are most relevant to project operations.

9.2 Proposed mitigation

9.2.1 The proposed risk reduction/mitigation measures were divided into three categories: design, physical and river operations. This is to provide the PLA with assurance that the measures proposed throughout this assessment, and in all project preliminary risk assessments have regard to the project's responsibility to reduce risk rather than focussing on local authorities' and existing river users' responsibilities.

9.3 Design

9.3.1 The following measures are embedded in the designs. This navigational risk assessment therefore assesses the residual risk on the basis that these measures are in place.

a. The in-river footprint of the temporary and permanent works site was minimised so that intrusion into the river is kept as small as possible (while incorporating the necessary works) and is set back from the authorised channel. This reduces the extent that works sites would extend into the river and therefore reduces the likely impact on existing river users.

b. Design of the eastern site was changed to improve sight lines for London Ducks entering the river. The outer face of the structure was reduced and stream lined.

c. Piles were provided around the terraced interception structure to prevent users of Lack's Dock drifting onto the partly submerged structure and capsizing in the event of engine failure.

d. Constraints were placed on the working areas within the river, as identified on the Zones of Foreshore Working drawing to minimise the activity required in close proximity to the authorised channel.

e. The design of the temporary and permanent structures includes the provision of ladders, safety grab chains and other lifesaving equipment around the work sites to aid emergency egress from the river, in accordance with the PLA's guidance document 'Review of Lifesaving Provisions Along the River Thames'.

f. Planned 6 yearly inspection/maintenance works on the bridge would be carried out immediately prior to the project works so that planned closure of Vauxhall Bridge arch No3 would not need to take place during the works.

g. Barge size was optimised in order to minimise the number of barge movements to/from the site.

h. Computational modelling of in-river structures and analysis was carried out to determine likely increases/decreases in flow and vessel types most likely to be affected by changes.

9.3.2 The following sections identify proposed mitigation to address the residual risks.

9.4 Physical

9.4.1 The following measures have been or would be undertaken:

a. Assessment and understanding of operating procedures to ensure minimum disruption/interaction with existing users at this site

b. Meetings with Cory Environmental and London Duck Tours to get their views and input into interaction issues and possible working relationships at this site

c. Provision of a temporary 'watchman's hut' during the construction phases of the project. There are a number of operational and responsibility issues associated with providing such a facility. Operating policy and procedures would require to be written, taking into account overall lines of responsibility and stakeholder operating requirements. The temporary watchman's hut would provide shelter, Thames AIS display equipment and communication equipment for a dedicated river lookout. The lookout would be in communication with TBNC and other river users on VHF and the project marine co-ordinator

d. A boat-based lookout could be provided as an alternative to the watchman's hut. The boat should have towing capability. This could be the same as the safety boat below.

e. A safety boat, with towing capability, should be available at the site to rescue a DUKW that has lost propulsion.

f. Fendering, ladders, safety grab chains and associated lifesaving equipment to be included in the design of the temporary and permanent works structure in accordance with the PLA's guidance document *Review of Lifesaving Provisions Along the River Thames*.

g. Provision of arch closure lights and signs prior to the occupation of arch No5 by the southern temporary cofferdam and permanent structure.

9.5 River Operations

9.5.1 The following measures would be undertaken:

a. Scheduling of barge movements / passage planning and publication of planned operations

b. Berthing Co-ordination Manager to liaise and be in communication with all operators in the local area and to be on hand to deal with potential areas of concern / conflict

c. Notices to Mariners informing operators and river users of planned operations in area, highlighting times when project barges are likely to be servicing the site and when jack-up barges or other plant is planned to be in the river.

d. Emergency response training and exercises

e. Project to remove plant and equipment from arch No4 to allow navigation through the arch in the event of an unplanned closure of arch No3.

f. Harbour service launch to control navigation through the bridge in the event of a single arch being open to reporting vessels.

Table 9.2 Mitigation measures within the project's control

Procedural	Informational	Qualifications / Personnel	Guidance / Publications	Site Specific
Safe Systems of Work	Sound Warnings	Berth Master (term to be defined)	Temporary Notice to Mariners	Grab Chains
Contractors Risk Assessment	Light Warnings	Qualifications / Competence of on-site personnel	Permanent Notice to Mariners	Fendering
Site Working Practices	Anemometer at site			Impact Protection - Temporary Works
Scheduling of barge movements to assist with existing river events				Impact Protection - Permanent Works
				New Tide Gauges / Markers

10 Conclusion

10.1 Assessment

10.1.1 This *Navigation Issues and Preliminary Risk Assessment* has assessed the potential impact of the proposed works at Albert Embankment Foreshore on existing river users.

10.1.2 The project's approach to this assessment comprised stakeholder engagement, analysis of Automatic Identification System (AIS) data, observation of current river operations including a desktop review of hazards and development of potential mitigation measures.

10.1.3 The issues have been presented to the PLA during a number of hazard review meetings.

10.1.4 The risk assessment criteria, assessment matrix, terminology and risk classification were provided by the PLA. This assessment follows the Formal Safety Assessment (FSA) methodology including;

a. stakeholder consultation
b. identification of hazards
c. hazard analysis.

10.2 Stakeholder engagement

10.2.1 A number of issues were identified throughout the risk assessment process for this site including:

a. interaction with London Duck Tours operations at Lacks Dock
b. interaction with other existing river users
c. intrusion into river - proximity to authorised channel
d. bridge arch closures
e. changes in flow resulting from the temporary and permanent in-river structures.

10.3 Risk analysis

10.3.1 Hazards at various stage of the project were assessed and scored using the risk matrix and scorecard provided by the PLA in terms of 'Most Likely' and 'Worst Credible' scenarios.

10.3.2 Annexes A to I provide full details of the hazards identified and their overall scores. The analysis is summarised below in Table 10.1 and Table 10.2:

Table 10.1 Risk summary: Most likely

Most Likely	Phase A	Phase B	Phase C	Phase D
Extreme: Intolerable risk. Job is not authorised	0	0	0	0
High: Efforts should be made to reduce risk to ALARP level. Job can only be performed after authorisation from Harbour Master and after further additional controls required under the circumstances	2	2	2	5
Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer	53	61	58	31
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances	9	13	13	4
Slight: No action is required	0	0	0	0

Table 10.2 Risk summary: Worst credible

Worst Credible	Phase A	Phase B	Phase C	Phase D
Extreme: Intolerable risk. Job is not authorised	0	0	0	0
High: Efforts should be made to reduce risk to ALARP level. Job can only be performed after authorisation from Harbour Master and after further additional controls required under the circumstances	17	17	17	10
Moderate: Efforts should be made to reduce risk to ALARP. Job can be performed under direct supervision of Senior Officer	50	50	50	25
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances	9	9	9	1
Slight: No action is required	0	0	0	0

10.3.3 Most of the hazards (within the Most Likely assessment) fell within the ‘moderate risk’ category, requiring efforts to be made to reduce the risk to ALARP level.

10.3.4 For ‘Worst Credible’ scenarios, the majority of hazards fell within the ‘moderate risk’ category with a number falling in the ‘high risk’ category, indicating that the work could only be performed after authorisation from the Harbour Master.

10.4 Overall

10.4.1 The Albert Embankment Foreshore would be split into two working areas, bisected by Lacks Dock, a slipway regularly used by the London Duck Tour sightseeing company to launch and recover their amphibious vehicles.

10.4.2 The interaction and impact on London Duck Tour operations were highlighted as the major navigational hazard associated with this site.

10.4.3 The navigational issues have been summarised below:

a. Interaction with existing river users including freight, passenger and recreational vessels

b. Interaction with London Duck Tours operations at Lacks Dock: During consultation with the operators of London Duck Tours, a number of navigational and operational issues were identified. The project continues to consult with the owners to ensure that construction works and operations do not cause an adverse impact on their service and that their concerns are addressed adequately

c. Intrusion into river and proximity to authorised channel: the LLAU reaches up to 25m into the authorised channel, this intrusion into the river is likely to have an impact on smaller craft (those under 13.7m in length overall) proceeding upstream past this site.

d. Bridge arch closures: emergency or planned closure of arch No3 (whilst arch No4 is closed during construction activities) has been assessed as a navigational hazard

e. Changes in flow resulting from the temporary and permanent in-river structures.

10.4.4 This report provides an independent, evidence-based assessment of current river operations and the likely impact that project operations would have on existing river users in the vicinity of Albert Embankment Foreshore.

The overall responsibility for safety on the River Thames lies with the PLA which needs to determine whether the issues and hazards detailed set out in this report present a ‘tolerable’ navigational risk.

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11 Recommendations

11.1 General

11.1.1 The project recommends implementing the mitigation measures presented in Section 7. Additionally, the below should be given consideration.

11.1.2 **Temporary watchman's hut**: Consideration should be given to providing such a temporary facility, the issue of responsibility in the event of an incident would need to be investigated, with final responsibility of vessel movements and therefore safety falling on the vessel master. There are a number of operational and responsibility issues associated with providing such a facility. Operating policy and procedures would require to be written, taking into account overall lines of responsibility and stakeholder operating requirements.

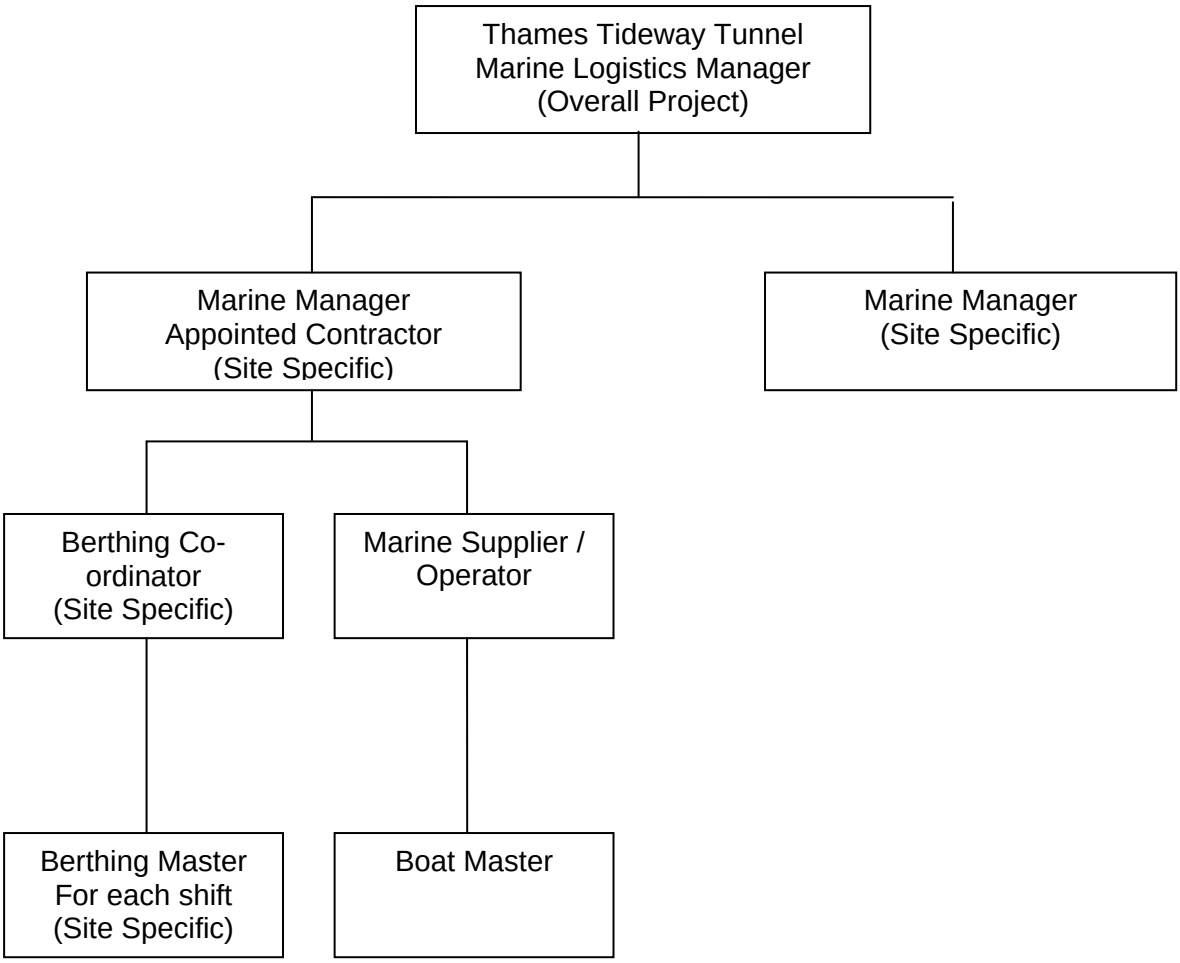
11.1.3 **Construction methodology**: Further consideration should be given to construction logistics to minimise or avoid interaction between construction vehicles at the bottom of Lack's Dock and London Duck Tours vessels, including measures such as pumping concrete and out of hour movements of materials between the two sites.

11.1.4 **Marine Logistics Manager:** Network Rail's major works at Blackfriars Bridge were highlighted as an example of how the river can be used for large scale civil engineering projects over an extended time period. Dedicated marine logistic managers and experienced marine staff are employed on this project to ensure that project and navigational safety requirements are met. The project recommends taking lessons learnt and best working practices from similar projects and implementing them for this project.

11.1.5 **Continued Communication**: The project should continue to maintain communication and liaison with the owners of London Duck Tours.

11.1.6 **Berthing Co-ordinator:** The project recommends appointing a Berthing Co-ordinator to communicate with all commercial operators in order to facilitate safe berthing and departures from berths in close proximity to project operations. The co-ordinator would co-ordinate departures so that all freight operators, including project barges, could depart on time without adversely impacting on navigation on the tidal Thames.

Figure 11.1 Potential marine logistics hierarchy



Overall safety on the river is the PLA's responsibility: the Thames Barrier Navigation Centre assists the PLA by managing and directing traffic from Crayfordness to Teddington Lock.

Abbreviations

AIS	Automatic Identification System
ALARP	As low as reasonably practicable
CSO	Combined sewer overflow
LLAU	Limits of land to be acquired or used
NtM	Notice to Mariners
PLA	Port of London Authority

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Appendices

List of appendices in order

Appendix A: Project drawings

Appendix B: HR Wallingford analysis

Appendix C: Freight tracks and AIS analysis

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.03**

Albert Embankment Foreshore

Appendix A

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

Hard copy available in

Box **57** Folder **A**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix A: Project Drawings

Drawing title	Phase
Construction phases - Site set-up	Phase A
Construction phases - Shaft construction and tunnelling	Phase B
Construction phases - Construction of other structures	Phase C
Construction phases - Site demobilisation	
Permanent works layout Sheet 1 of 2	Phase D
Permanent works layout Sheet 2 of 2	Phase D
River foreshore zones of working	

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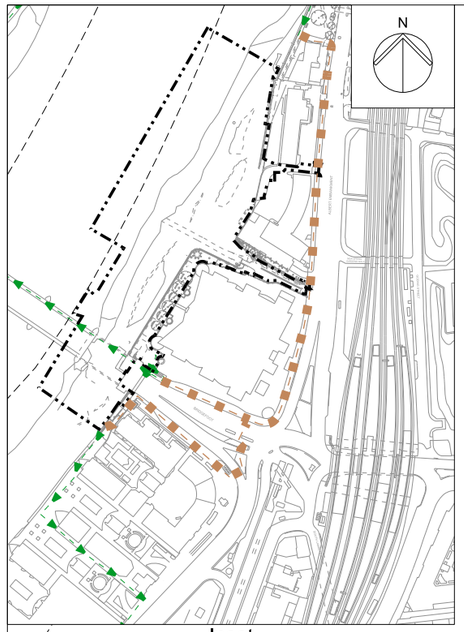


Inset
Thames Path diversion
Scale 1:2500 at A1
Scale 1:5000 at A3

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principle construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Existing flood defence levels to be maintained at all times
6. Option A refers to construction access from Lack's Dock. Elements that are applicable to Option A only, and not to Option B are annotated accordingly. Option B refers to construction access between Camelford House and Tintagel House. Elements that are applicable to Option B only, and not to Option A are annotated accordingly. All other elements apply, regardless of which Option is selected.

Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

100m 0 100m
Scale 1:2500 at A1
1:5000 if reproduced at A3

10m 0 40m
Scale 1:500 at A1
1:1000 if reproduced at A3

ILLUSTRATIVE

Location
Albert Embankment Foreshore
London Borough of Lambeth

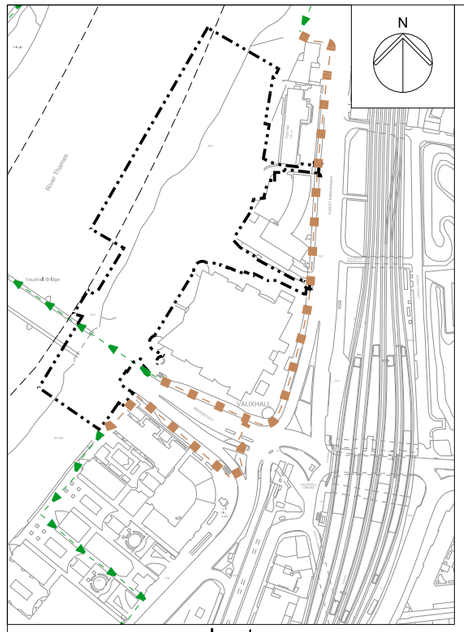
Document Information
Application for Development Consent

Construction phases - phase 1
Site set-up
Book of plans - section 17

DCO-PP-15X-ALBEF-170030
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



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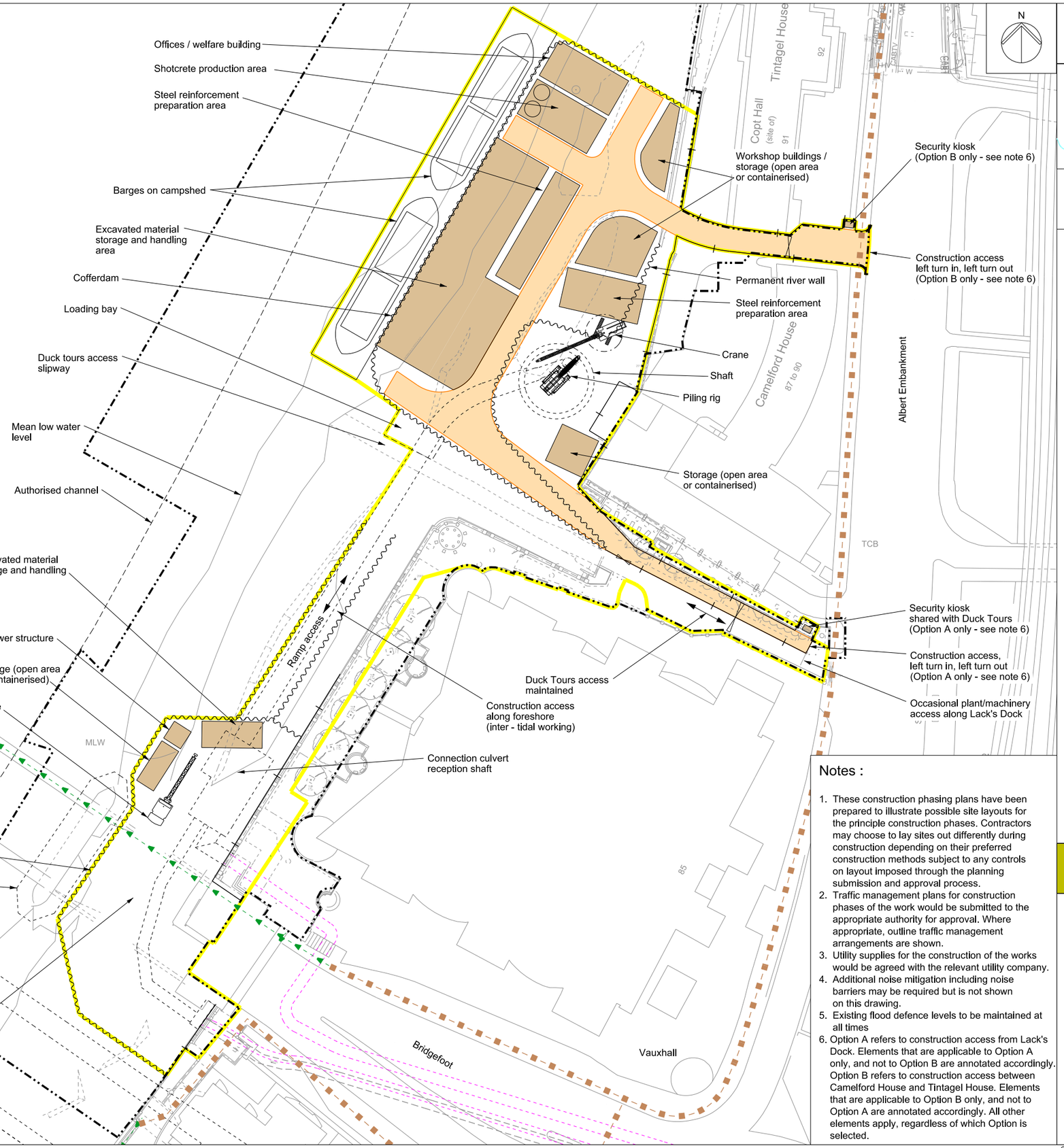
Scale 1:5000 at A3



Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principle construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Existing flood defence levels to be maintained at all times
6. Option A refers to construction access from Lack's Dock. Elements that are applicable to Option A only, and not to Option B are annotated accordingly. Option B refers to construction access between Camelford House and Tintagel House. Elements that are applicable to Option B only, and not to Option A are annotated accordingly. All other elements apply, regardless of which Option is selected.

Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

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Scale 1:2500 at A1
1:5000 if reproduced at A3

10m 0 40m
Scale 1:500 at A1
1:1000 if reproduced at A3

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Location
Albert Embankment Foreshore
London Borough of Lambeth

Document Information
Application for Development Consent

Construction phases - phase 2
Shaft construction and tunnelling
Book of plans - section 17

DCO-PP-15X-ALBEF-170031
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Thames Tideway Tunnel
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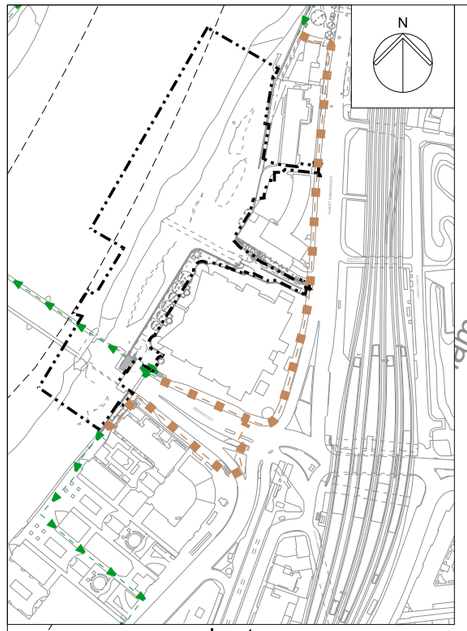
Thames Water



Inset
Thames Path diversion
Scale 1:2500 at A1
Scale 1:5000 at A3

Main tunnel
Offices / welfare building
Cofferdam
Barges on campshed
Crane
Loading bay
Duck tours access slipway
Mean low water level
Authorised channel
Site power structure
Crane
Storage (open area or containerised)
Ramp access
Concrete delivery (tidal) or construct pump line from main shaft
Interception and valve chamber
Cofferdam
Bridge piers
London Underground Victoria Line tunnels
Bridge omitted for clarity
Main tunnel
Permanent river wall with terracing
Vauxhall Bridge
MLW
Bridgefoot
Vauxhall
Albert Embankment
Copt Hall (site of)
Workshop buildings / storage (open area or containerised)
Security kiosk (Option B only - see note 6)
Construction access left turn in, left turn out (Option B only - see note 6)
Permanent river wall
Storage (open area or containerised)
Crane
Connection tunnel
Shaft
Duck Tours access maintained
Security kiosk shared with Duck Tours (Option A only - see note 6)
Construction access, left turn in, left turn out (Option A only - see note 6)
Occasional plant/machinery access along Lack's Dock

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principle construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Existing flood defence levels to be maintained at all times
6. Option A refers to construction access from Lack's Dock. Elements that are applicable to Option A only, and not to Option B are annotated accordingly. Option B refers to construction access between Camelford House and Tintagel House. Elements that are applicable to Option B only, and not to Option A are annotated accordingly. All other elements apply, regardless of which Option is selected.

Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

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Scale 1:2500 at A1
1:5000 if reproduced at A3

10m 0 40m
Scale 1:500 at A1
1:1000 if reproduced at A3

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Location
Albert Embankment Foreshore
London Borough of Lambeth

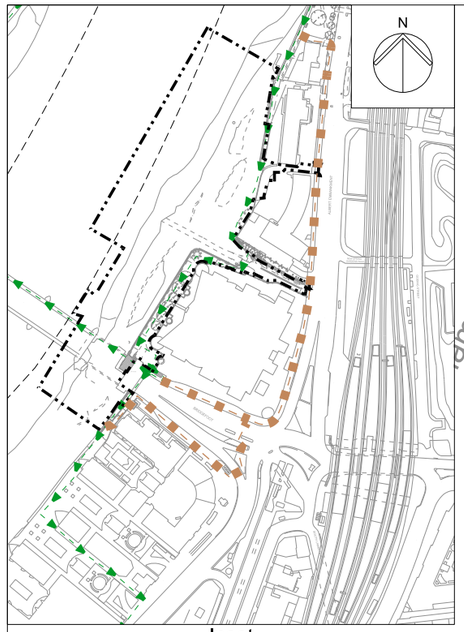
Document Information
Application for Development Consent

Construction phases - phase 3
Construction of other structures
Book of plans - section 17

DCO-PP-15X-ALBEF-170032
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



Inset
Thames Path diversion
Scale 1:2500 at A1
Scale 1:5000 at A3

Cofferdam sheet piles and infill removed and foreshore reinstated
Campshed removed and foreshore reinstated
Scour protection constructed prior to foreshore reinstatement
Mean low water level
Authorised channel
Outfall apron constructed prior to foreshore reinstatement
Vauxhall Bridge
Ramp access removed and foreshore reinstated
Scour protection constructed prior to foreshore reinstatement
Cofferdam sheet piles and infill removed and foreshore reinstated
Thames Path reinstated
Hoarding removed
Permanent foreshore structure
Bridge piers
London Underground Victoria Line tunnels
Bridge omitted for clarity
Scour protection constructed prior to foreshore reinstatement
Bridgefoot
Vauxhall
Access / haul route removed and site reinstated (Option B only - see note 1)
Walls reinstated (Option B only - see note 1)
Security kiosk removed (Option B only - see note 1)
Footway reinstated (Option B only - see note 1)
Permanent foreshore structure
Hoarding removed
Thames path reinstated
Ramp to underground car park reinstated (Option B only - see note 1)
Access / haul route removed and site reinstated (Option A only - see note 1)
Security kiosk removed (Option A only - see note 1)
Footway reinstated (Option A only - see note 1)
Walls reinstated (Option A only - see note 1)
Security kiosk and barrier replaced (Option A only - see note 1)
Albert Embankment
Tintagel House
Copt Hall (site of)
Camelford House
Shelter
MLW
SL

Notes:

1. Option A refers to construction access from Lack's Dock. Elements that are applicable to Option A only, and not to Option B are annotated accordingly. Option B refers to construction access between Camelford House and Tintagel House. Elements that are applicable to Option B only, and not to Option A are annotated accordingly. All other elements apply, regardless of which Option is selected.

Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Provision of permanent permissive right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

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1:5000 if reproduced at A3

10m 0 40m
Scale 1:500 at A1
1:1000 if reproduced at A3

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Location
Albert Embankment Foreshore
London Borough of Lambeth

Document Information
Application for Development Consent
Construction phases - phase 4
Site demobilisation
Book of plans - section 17
DCO-PP-15X-ALBEF-170033
January 2013

Thames Tideway Tunnel
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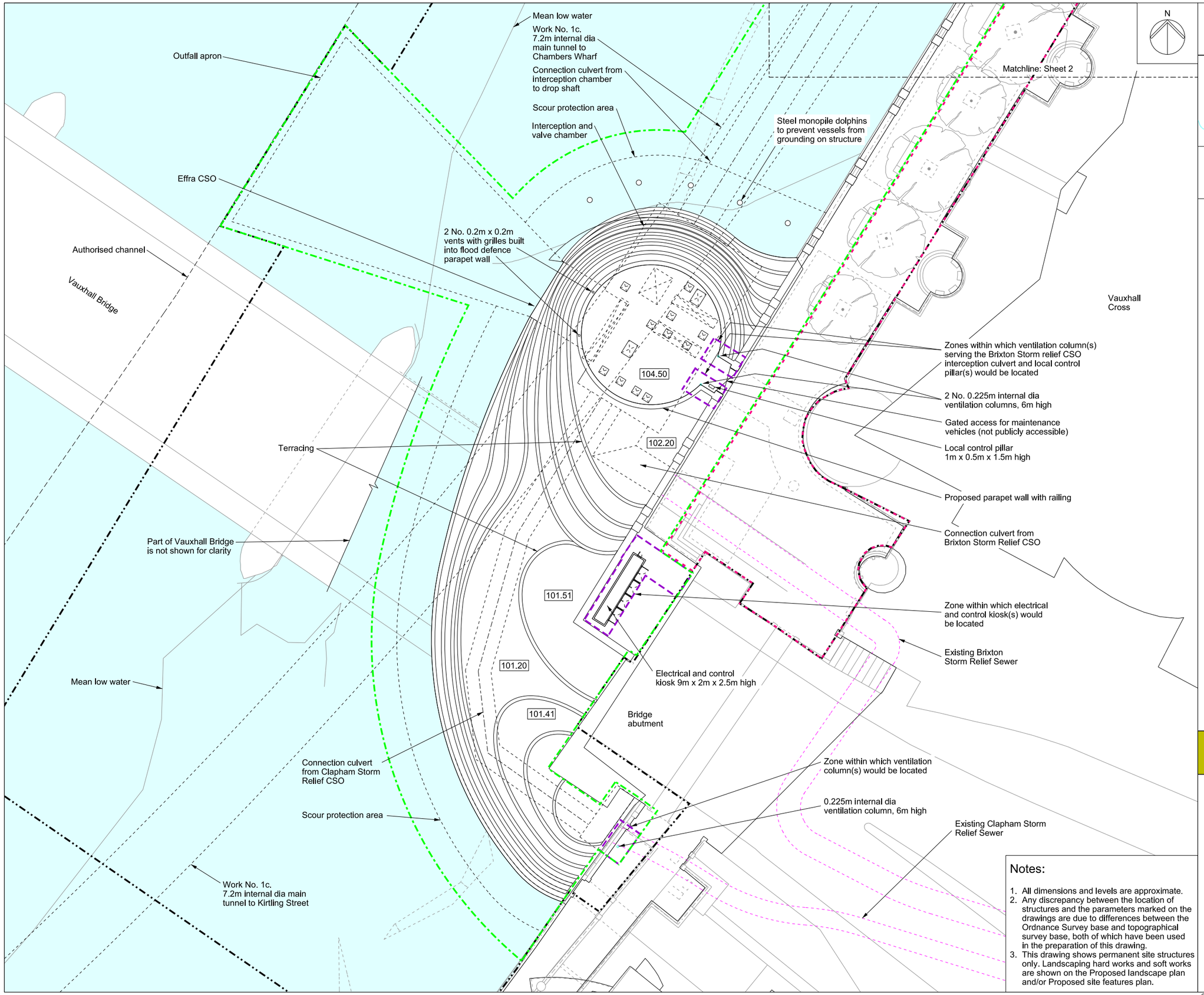
Thames Water



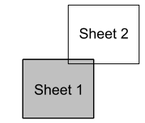
Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Existing sewers
- Proposed access cover
- 104.50 — Proposed level (shown in metres above tunnel datum)
- Zone within which all permanent site structures would be located
- Zone within which the shaft would be located
- Zone within which permanent above ground structures would be located
- Limits of permanent access

Sheet Layout:



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ILLUSTRATIVE

Location
Albert Embankment Foreshore
London Borough of Lambeth

Document Information
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Permanent works layout
Sheet 1 of 2
Book of plans - section 17

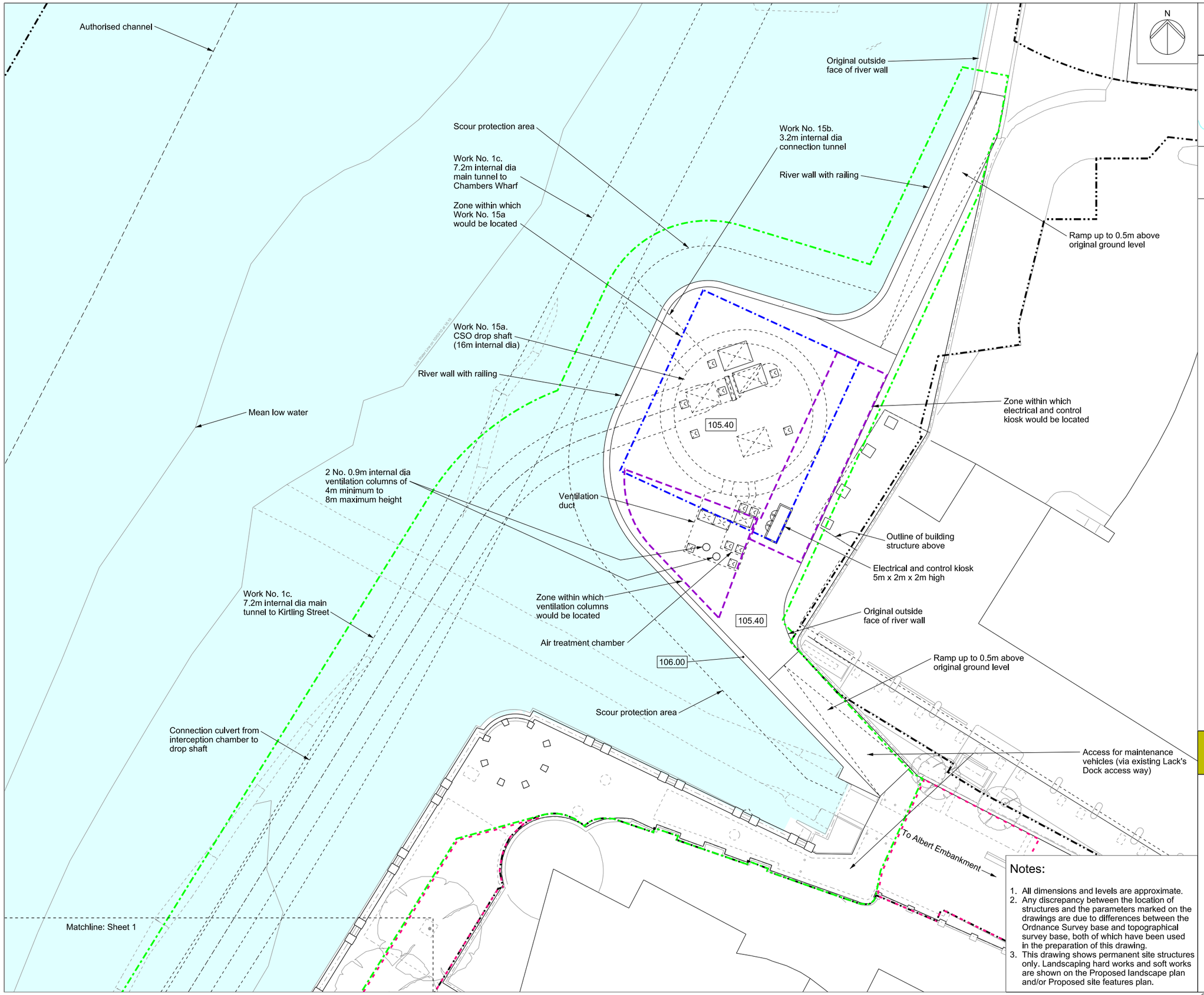
DCO-PP-15X-ALBEF-170010
January 2013

Notes:

1. All dimensions and levels are approximate.
2. Any discrepancy between the location of structures and the parameters marked on the drawings are due to differences between the Ordnance Survey base and topographical survey base, both of which have been used in the preparation of this drawing.
3. This drawing shows permanent site structures only. Landscaping hard works and soft works are shown on the Proposed landscape plan and/or Proposed site features plan.

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



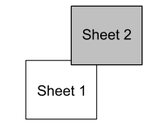
Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Proposed access cover
- 104.50 — Proposed level (shown in metres above tunnel datum)
- Zone within which all permanent site structures would be located
- Zone within which the shaft would be located
- Zone within which permanent above ground structures would be located
- Limits of permanent access

Sheet Layout:



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Location

Albert Embankment Foreshore
London Borough of Lambeth

Document Information

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Permanent works layout
Sheet 2 of 2
Book of plans - section 17

DCO-PP-15X-ALBEF-170011
January 2013

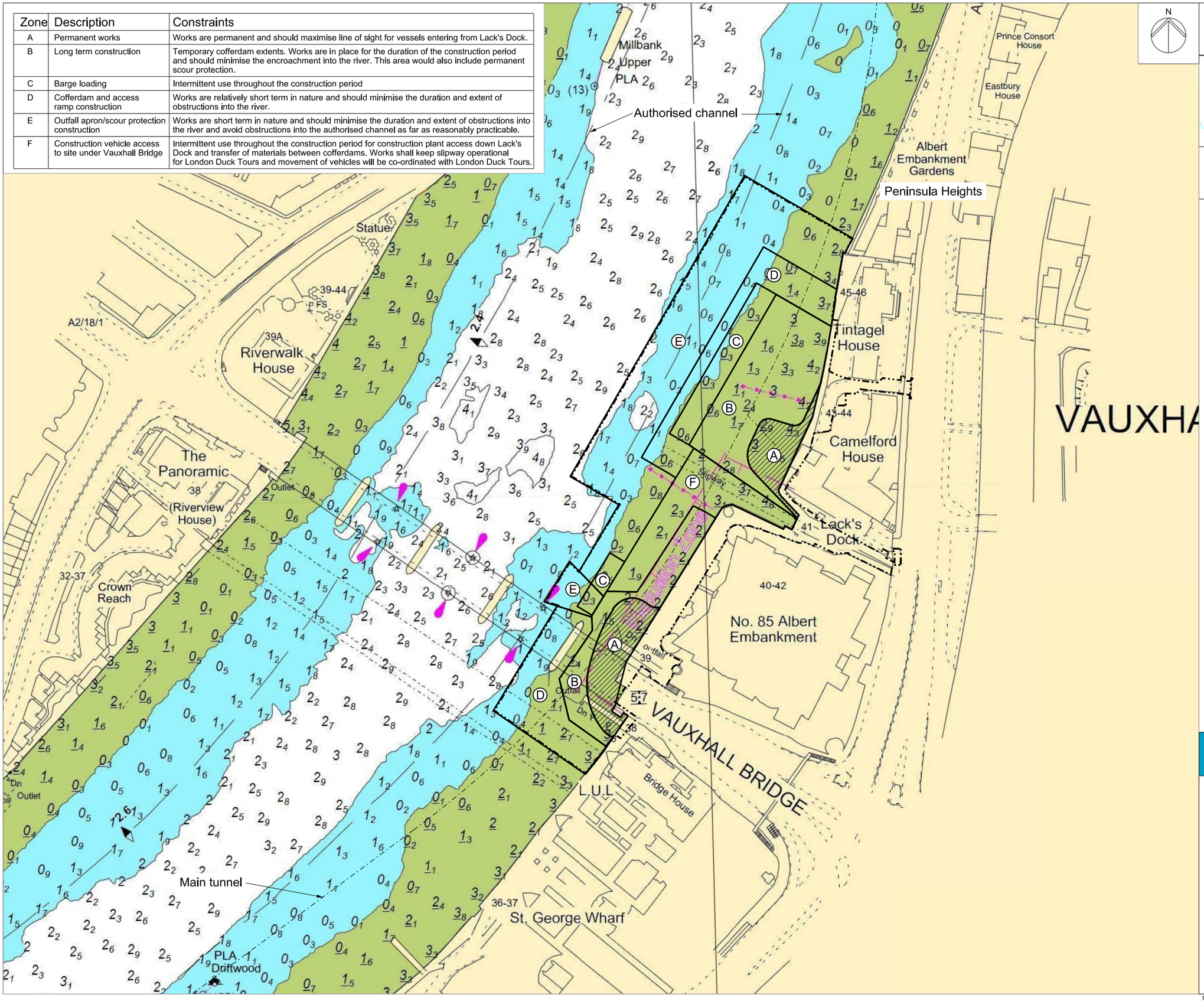
Notes:

1. All dimensions and levels are approximate.
2. Any discrepancy between the location of structures and the parameters marked on the drawings are due to differences between the Ordnance Survey base and topographical survey base, both of which have been used in the preparation of this drawing.
3. This drawing shows permanent site structures only. Landscaping hard works and soft works are shown on the Proposed landscape plan and/or Proposed site features plan.

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water

Zone	Description	Constraints
A	Permanent works	Works are permanent and should maximise line of sight for vessels entering from Lack's Dock.
B	Long term construction	Temporary cofferdam extents. Works are in place for the duration of the construction period and should minimise the encroachment into the river. This area would also include permanent scour protection.
C	Barge loading	Intermittent use throughout the construction period
D	Cofferdam and access ramp construction	Works are relatively short term in nature and should minimise the duration and extent of obstructions into the river.
E	Outfall apron/scour protection construction	Works are short term in nature and should minimise the duration and extent of obstructions into the river and avoid obstructions into the authorised channel as far as reasonably practicable.
F	Construction vehicle access to site under Vauxhall Bridge	Intermittent use throughout the construction period for construction plant access down Lack's Dock and transfer of materials between cofferdams. Works shall keep slipway operational for London Duck Tours and movement of vehicles will be co-ordinated with London Duck Tours.



Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

Limits of land to be acquired or used (LLAU)

Notes:

1. All levels are in metres and relate to chart datum.
2. Background information shown on this drawing is taken from:

   River Thames - Nine Elms Reach

   Port of London Authority Hydrographic Service

   H.O. Ref. No....113-315-030....Date....23/12/2010

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1:2000 if reproduced at A3

FOR INFORMATION

Location

Albert Embankment Foreshore
London Borough of Lambeth

Document Information

Application for Development Consent

River foreshore zones of working

DCO-PP-15X-ALBEF-170036
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.03**

Albert Embankment Foreshore

Appendix B

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

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Box **57** Folder **A**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix B: HR Wallingford analysis

HR Wallingford studies

B.1.1 In January 2009 HR Wallingford were commissioned by the Thames Tideway Tunnel Delivery Team to undertake detailed fluvial modelling and simulations of conditions at proposed sites for the interception of selected Combined Sewer Overflows (CSOs) in the proposed Thames Tideway Tunnel project.

B.1.2 As part of a Navigational Risk Assessment for the Albert Embankment Foreshore Site the results of HR Wallingford's modelling and simulations were analysed. This was conducted to provide an evidence based approach on the potential impact that proposed in river structures may have on the flow of the river and subsequently on vessels in transit past the site.

B.1.3 The following flow scenarios were modelled by HR Wallingford:

a. Large Flood Tide - a typical spring tide range with 65m^3/s flow at Teddington (65m^3/s being the annual mean freshwater flow)

b. Extreme Ebb Tide - a typical spring tide range with 800m^3/s flow at Teddington (800m^3/s was measured in the winter of 1894 and is considered to represent an approximately 1 in 100 year flow)

c. Spring tide range enhanced by passage of surge and 65m^3/s flow at Teddington.

B.1.4 Typical tidal conditions used comprised a series of spring tides of ranging from 5.06m to 5.86m at Southend-on-Sea.

B.1.5 HR Wallingford's study simulations of high current conditions were required for combinations of extreme tides and fluvial flows for which the Thames Barrier would **NOT** be closed.

B.2 Results

HR Wallingford analysis

B.2.1 By adding a pair of lines crossing the river (one in line with the northern development and one in line with Vauxhall Bridge) it was possible to analyse the changes in flow rate along these lines. Images were produced to represent each of the current flow diagrams for the Wallingford report and these have been included in the sections below.

B.2.2 Current patterns would be affected by the proposed developments, however analysis shows that significant changes to current patterns would typically be in close proximity (within a few meters) to either the bridge arches or the development itself.

B.2.3 In areas further from the arches or the development, changes to the flow would typically be a slight increase, with very little to no change to direction of flow.

B.2.4 Considering the change in maximum flow, for the temporary works, the greatest change in maximum flow under the bridge (across a given cross section) would be approximately 0.4 knots. This would be associated with a peak ebb spring tide with river flow of 65m^3/s.

B.2.5 Considering the change in maximum flow, for the permanent works, the greatest change in maximum flow under Vauxhall Bridge (across a given cross section) would be approximately 0.2 knots, this would be associated with a peak flood spring tide with 65m^3/s river flow. In line with the widest part of the development, this increase would remain at approximately 0.2 knots.

B.2.6 The change in maximum flow under Vauxhall Bridge would be less than 0.4 knots for both the temporary and permanent works. Although the changes in flow could be considered small, it is recommended that, notices to mariners should be issued warning of these changes.

B.2.7 The changes in maximum flows are tabulated below for the temporary works.

Table B.1 Temporary Works

Reference	Flow Conditions	Change in maximum flow in line with development	Change in maximum flow in line with Vauxhall Bridge
Fig B.1	Peak Ebb currents - Spring tide, 65m^3/s river flow	0.1 knots	0.1 knots
Fig B.2	Peak Flood currents - spring tide, 65 m^3/s river flow	0.4 knots	0.2 knots
Fig B.3	Peak Ebb currents - spring tide, 800 m^3/s river flow	0 knots	0 knots
Fig B.4	Peak Flood currents - spring tide, 800 m^3/s river flow	0 knots	0.2 knots
Fig B.5	Peak Ebb currents - large flood tide rise with 65m^3/s river flow	0.1 knots	0.2 knots
Fig B.6	Peak Flood currents - large flood tide rise with 65m^3/s river flow	0.2 knots	0.1 knots

B.2.8 The changes in maximum flows are tabulated below for the permanent works.

Table B.2 Permanent Works

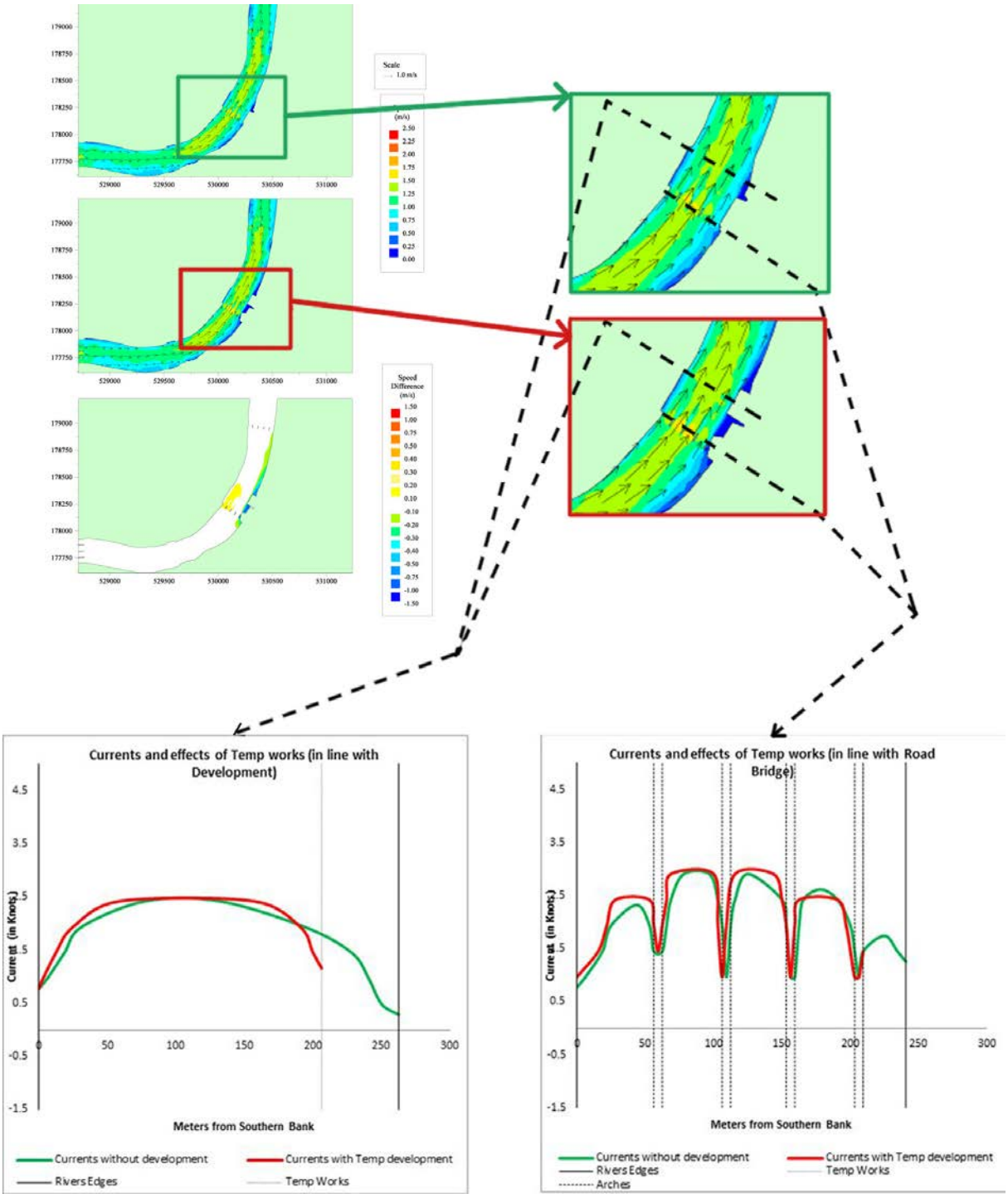
Reference	Flow Conditions	Change in maximum flow in line with development	Change in maximum flow in line with Vauxhall Bridge
Fig B.7	Peak Ebb currents - Spring tide, 65m^3/s river flow	0.1 knots	0.1 knots
Fig B.8	Peak Flood currents - spring tide, 65 m^3/s river flow	0 knots	0.2 knots
Fig B.9	Peak Ebb currents - spring tide, 800 m^3/s river flow	0.1 knots	0.1 knots
Fig B.10	Peak Flood currents - spring tide, 800 m^3/s river flow	0 knots	0.2 knots
Fig B.11	Peak Ebb currents - large flood tide rise with 65m^3/s river flow	0 knots	0.2 knots
Fig B.12	Peak Flood currents - large flood tide rise with 65m^3/s river flow	0 knots	0.2 knots

B.2.9 Temporary Works - Peak Ebb currents - Spring tide, 65m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.3 knots. The increase in maximum flow would be 0.1 knots.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.2 knots. The increase in maximum flow would be 0.1 knots.

Figure B.1 Temporary Works – Peak Ebb currents – Spring tide, 65m^3/s river flow

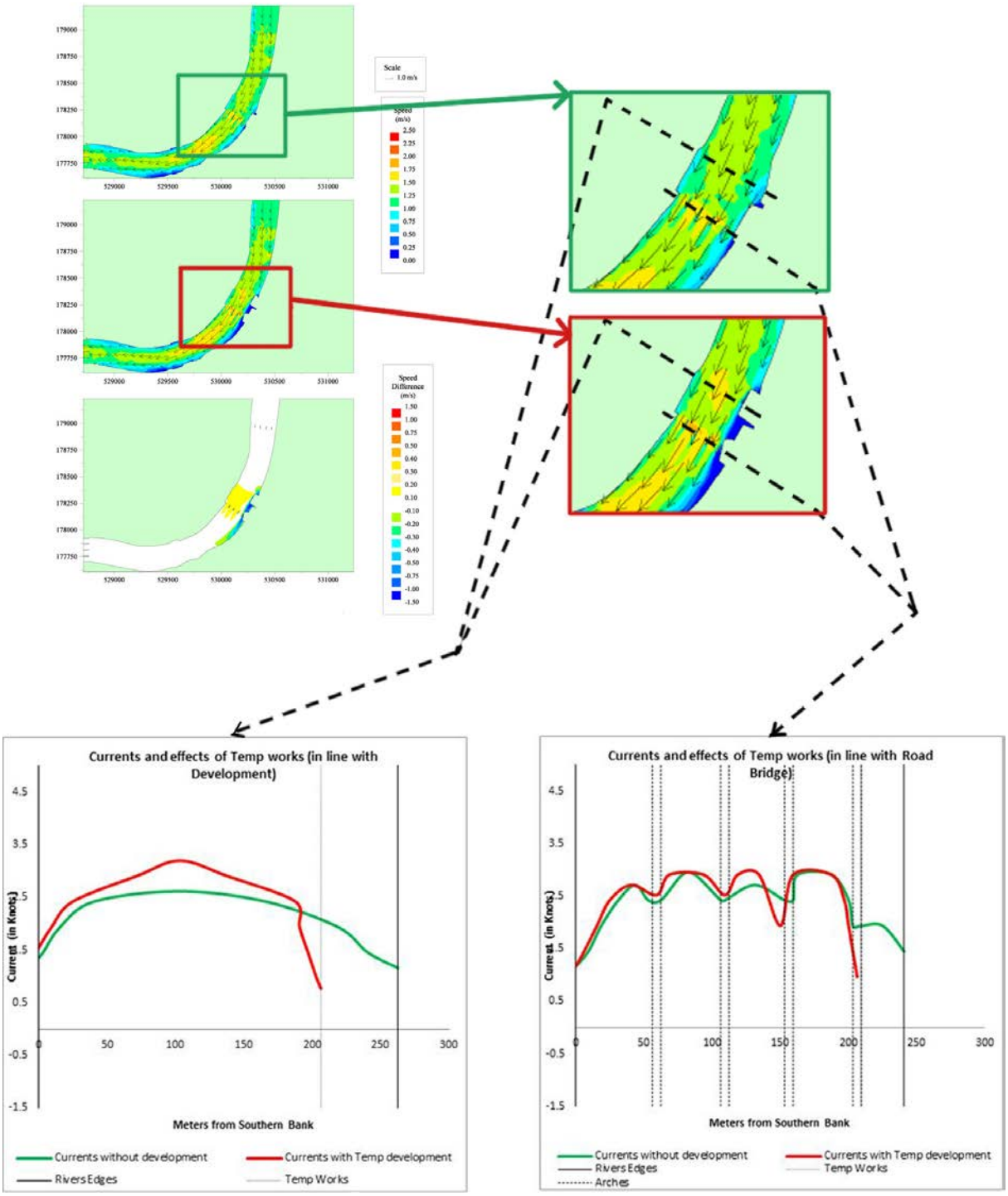


B.2.10 Temporary Works – Peak Flood currents – spring tide, 65 m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.4 knots. The increase in maximum flow would be 0.4 knots.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.2 knots.

Figure B.2 Temporary Works - Peak Flood currents - spring tide, 65 m^3/s river flow

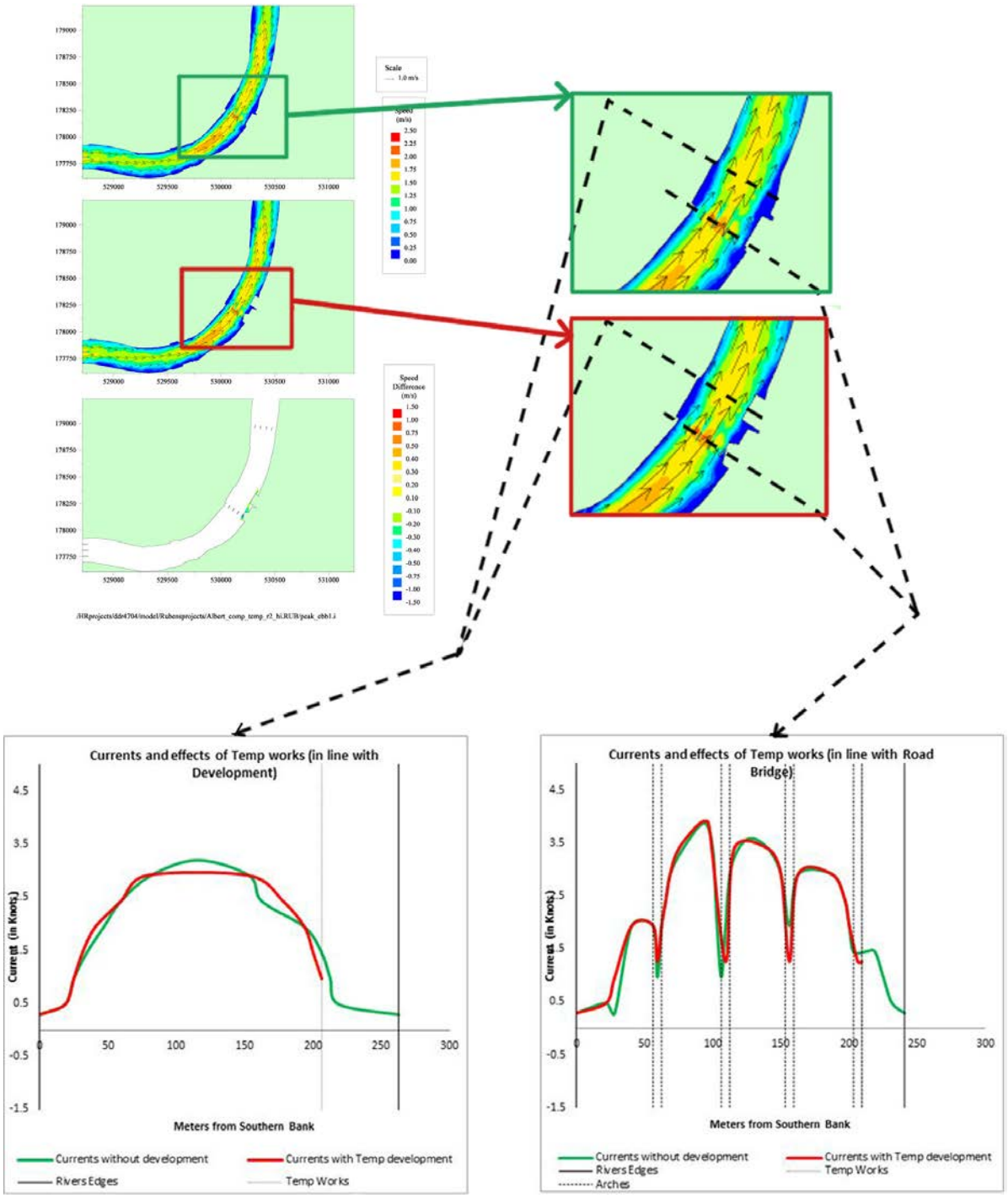


B.2.11 Temporary Works - Peak Ebb currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.4 knots. There would be no increase in maximum flow.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.2 knots. There would be no increase in maximum flow.

Figure B.3 Temporary Works - Peak Ebb currents - spring tide, 800 m^3/s river flow.

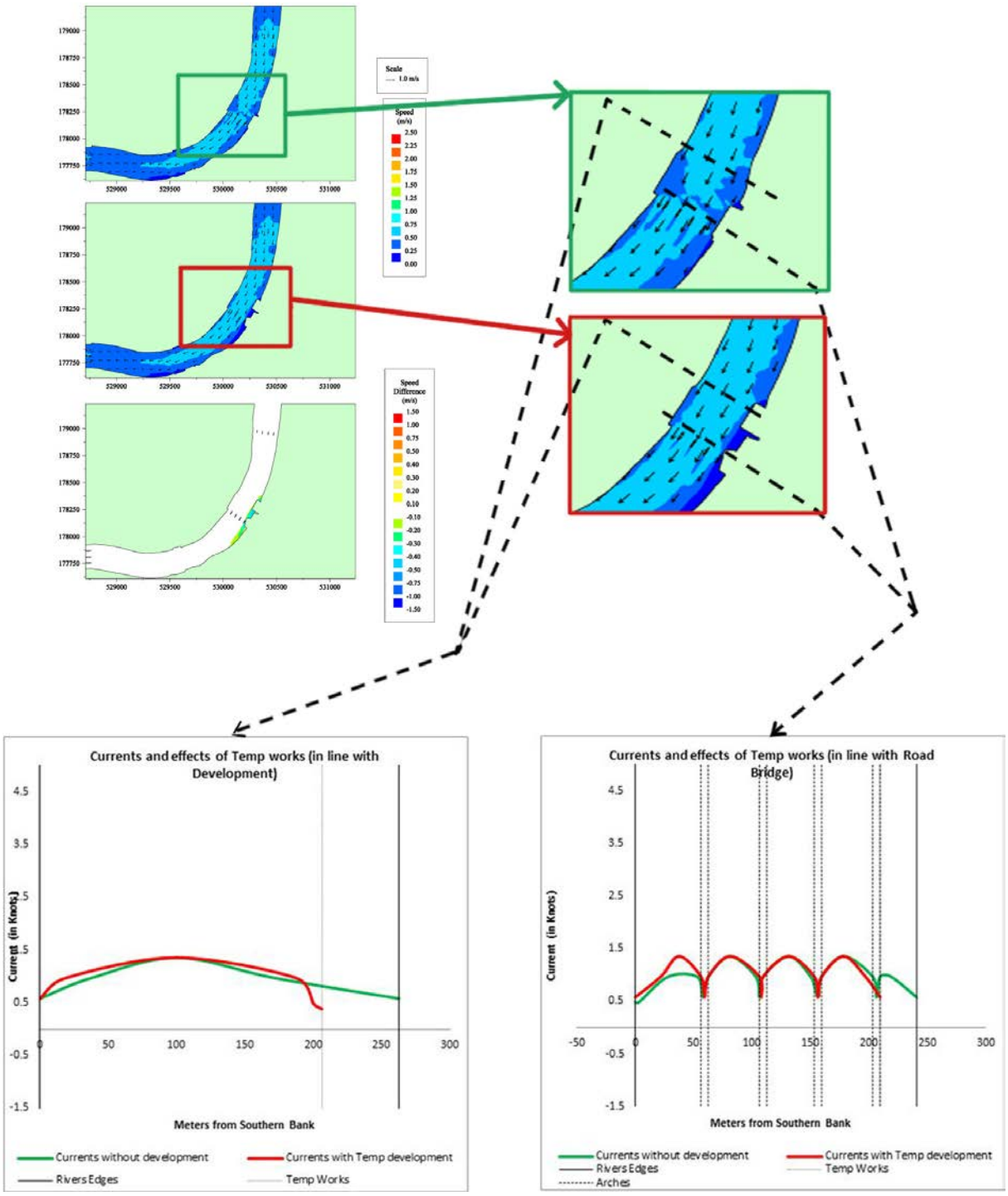


B.2.12 Temporary Works - Peak Flood currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.1 knots. There would be no increase in maximum flow.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.2 knots.

Figure B.4 Temporary Works - Peak Flood currents - spring tide, 800 m^3/s river flow.

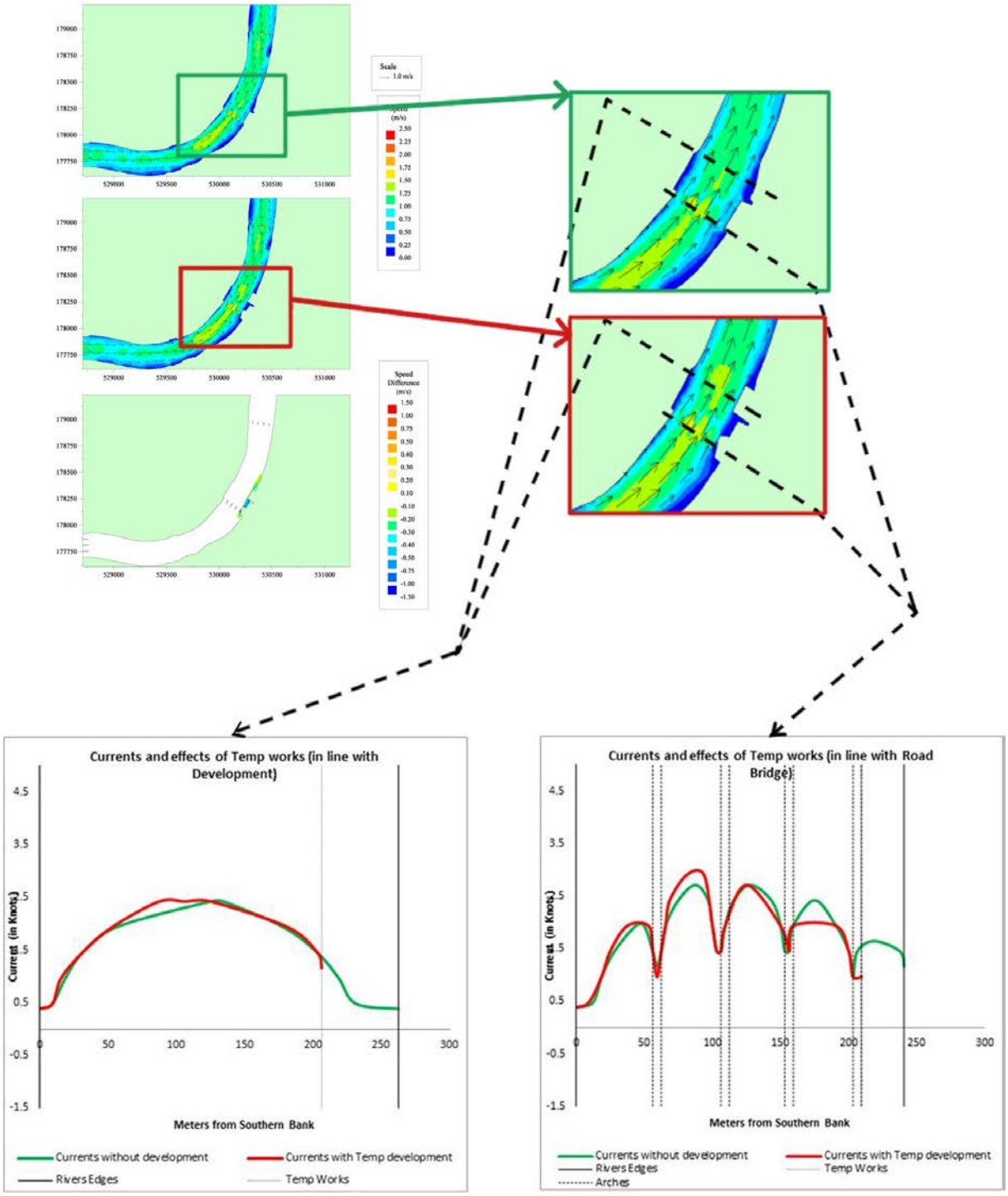


B.2.13 Temporary Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.3 knots. The increase in maximum flow would be 0.1 knots.

b. There would be no increase in average flow (in line with Vauxhall Bridge). The increase in maximum flow would be 0.2 knots.

Figure B.5 Temporary Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow.

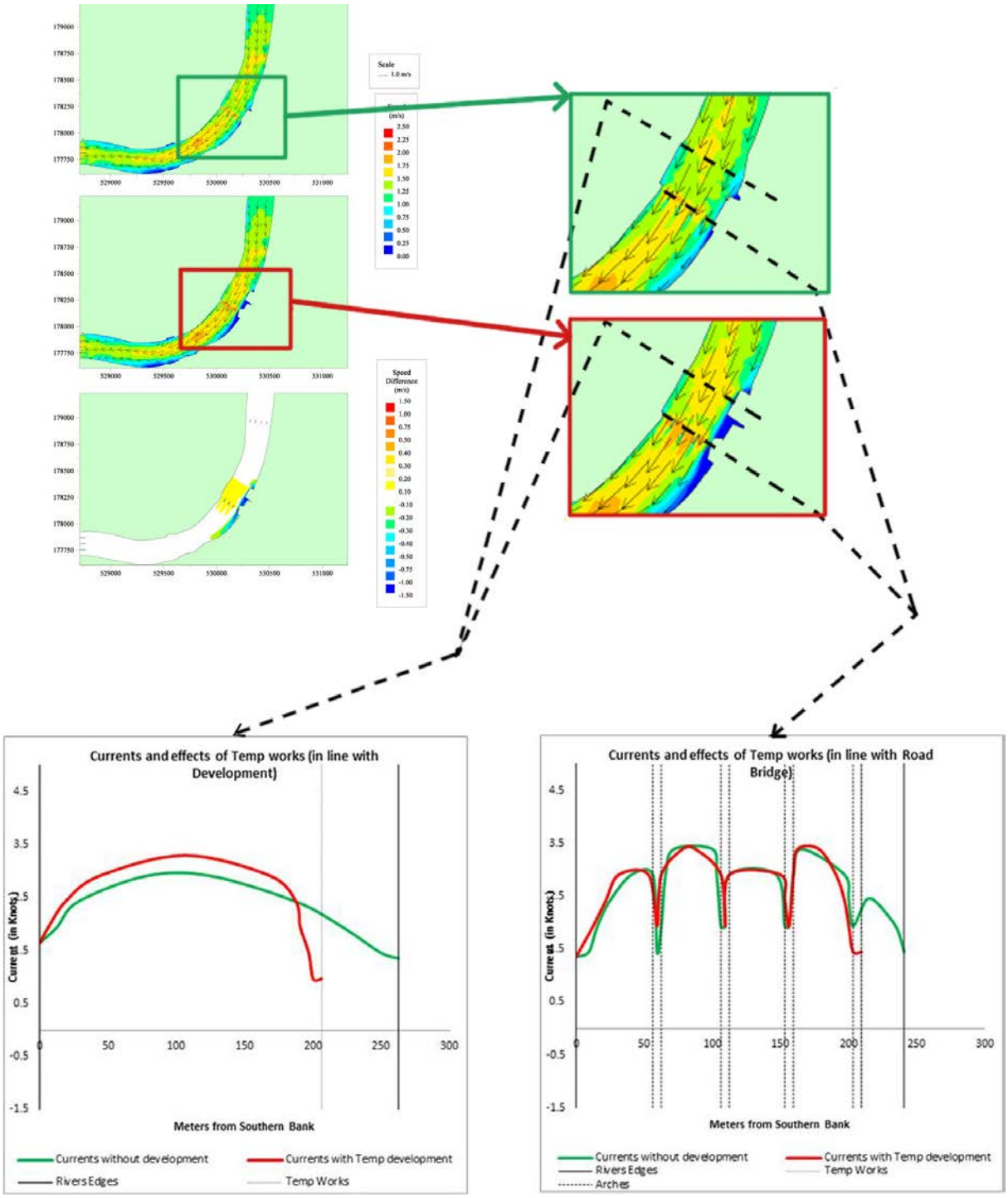


B.2.14 Temporary Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.4 knots. The increase in maximum flow would be 0.2 knots.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.1 knots.

Figure B.6 Temporary Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow.

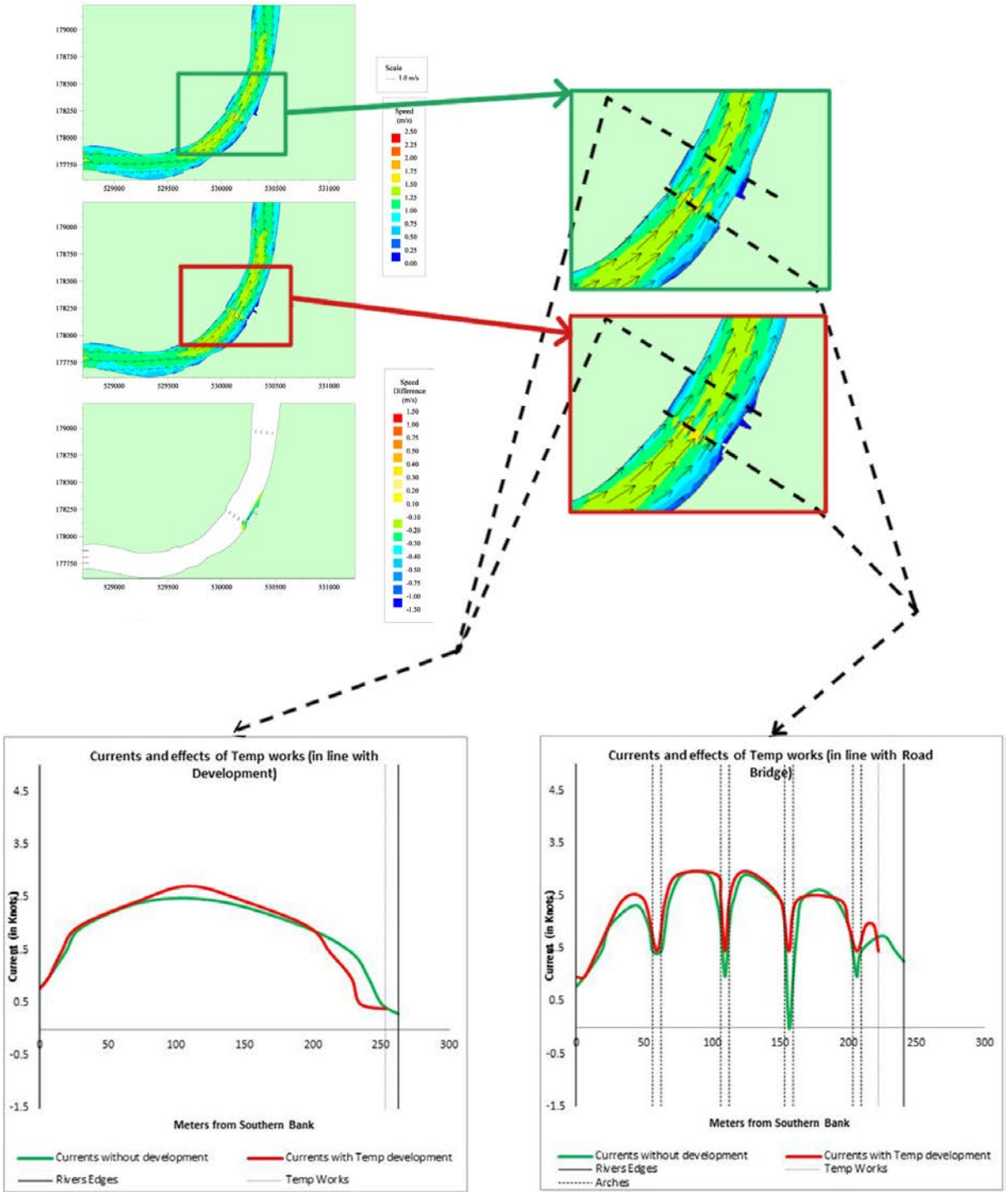


B.2.15 Permanent Works - Peak Ebb currents - Spring tide, 65m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.1 knots. The increase in maximum flow would be 0.1 knots.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.2 knots. The increase in maximum flow would be 0.1 knots.

Figure B.7 Permanent Works - Peak Ebb currents - Spring tide, 65m^3/s river flow.

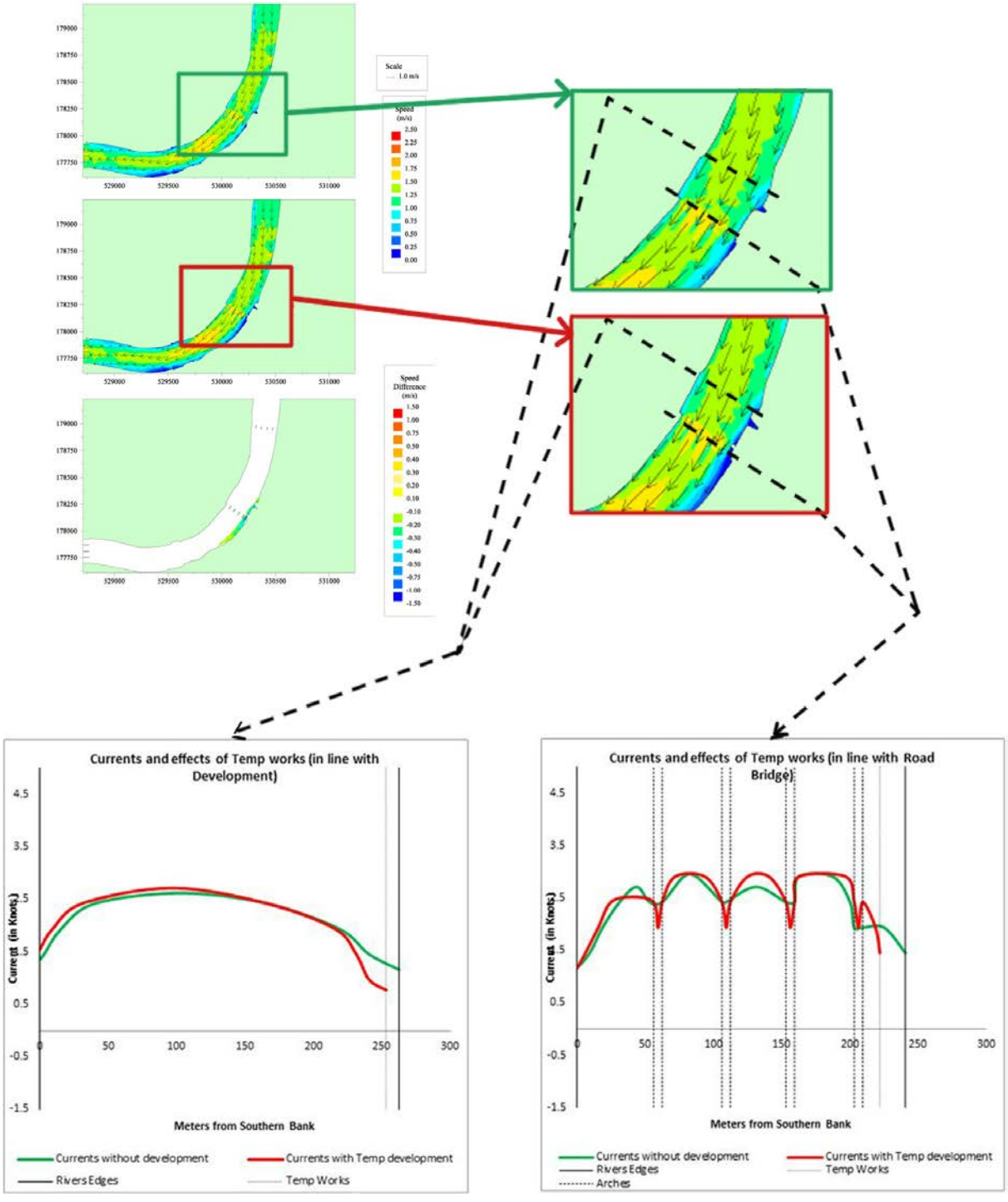


B.2.16 Permanent Works - Peak Flood currents - spring tide, 65 m^3/s river flow:

a. There would be no increase in average or maximum flow (in line with development).

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.2 knots.

Figure B.8 Permanent Works - Peak Flood currents - spring tide, 65 m^3/s river flow.

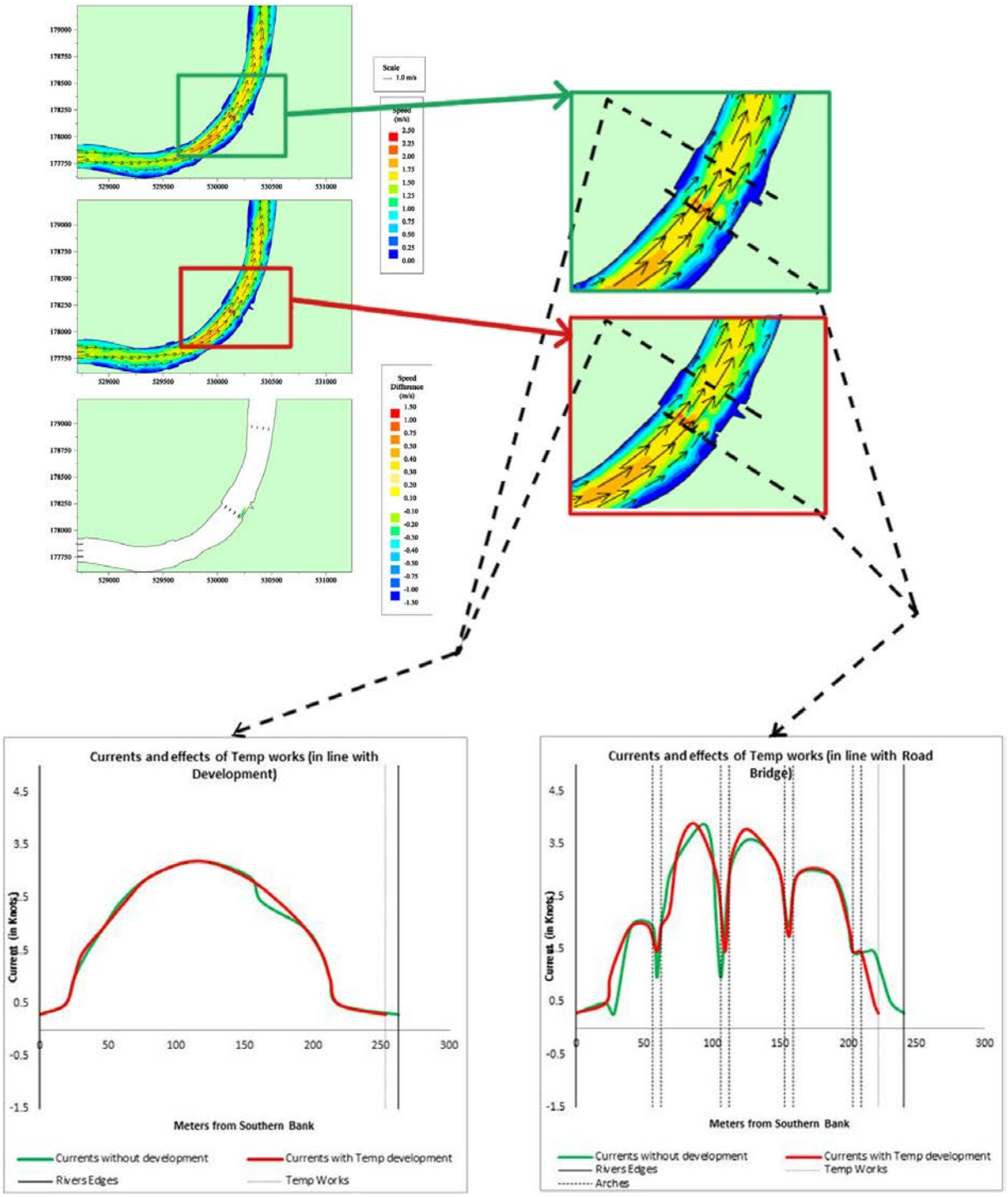


B.2.17 Permanent Works - Peak Ebb currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with development) would be approximately 0.1 knots. The increase in maximum flow would be 0.1 knots.

b. The average increase in flow (in line with Vauxhall Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.1 knots.

Figure B.9 Permanent Works - Peak Ebb currents - spring tide, 800 m^3/s river flow.

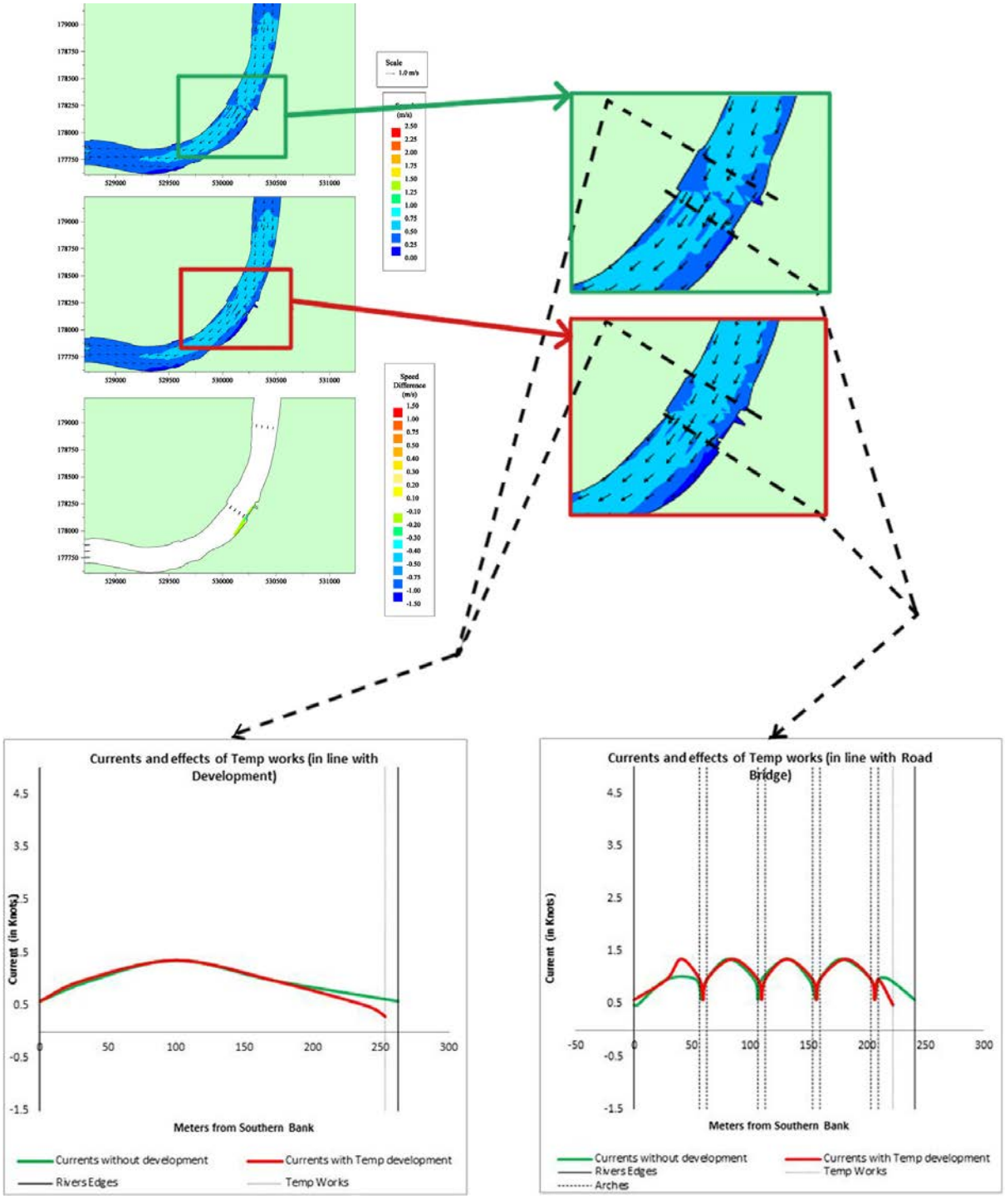


B.2.18 Permanent Works - Peak Flood currents - spring tide, 800 m^3/s river flow:

a. There would be no increase in average or maximum flow (in line with development).

b. The average increase in flow (in line with Vauxhall Bridge) would beapproximately 0.1 knots. The increasein maximum flow would be0.2 knots.

Figure B.10 Permanent Works - Peak Flood currents - spring tide, 800 m^3/s river flow.

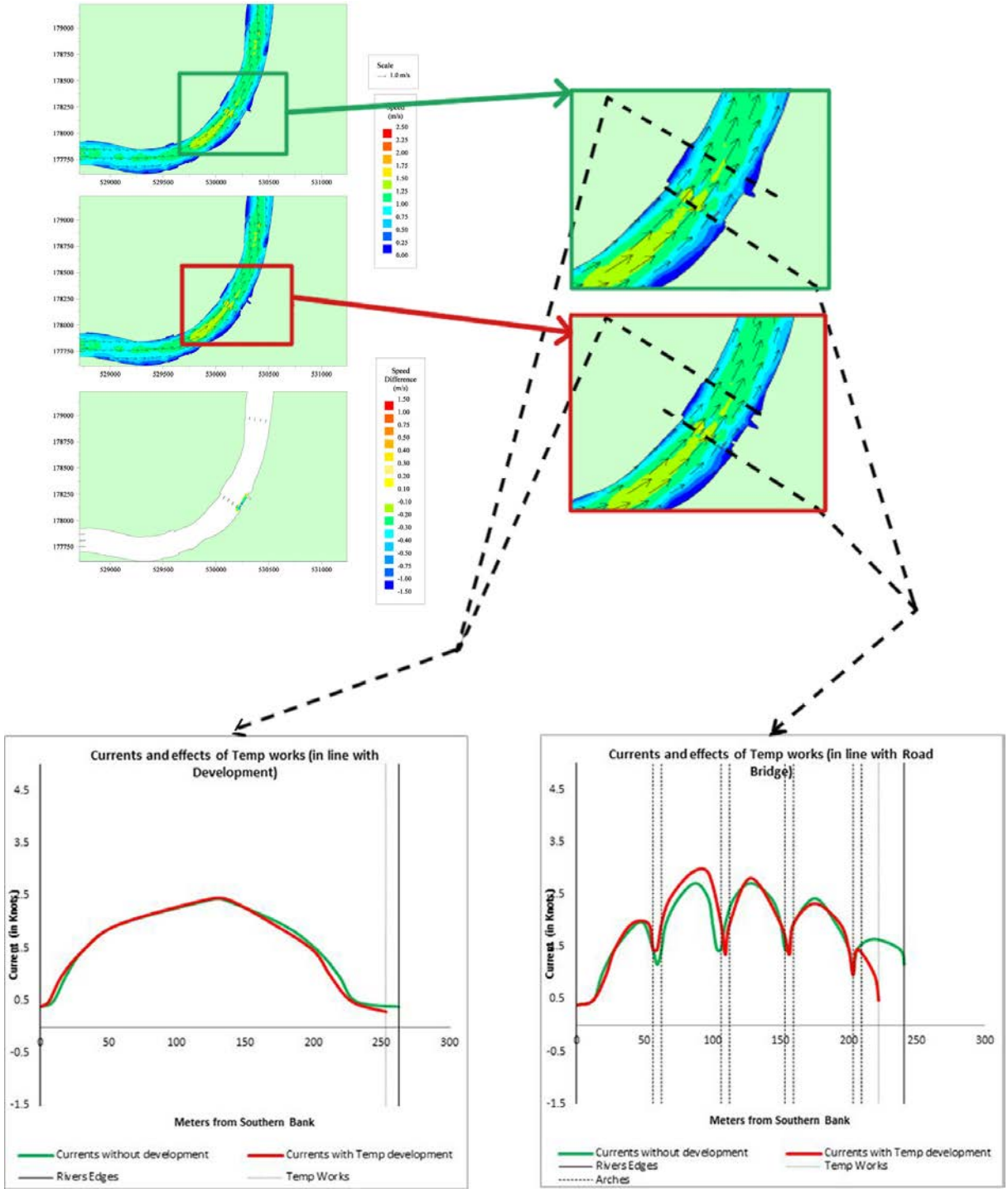


B.2.19 Permanent Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow:

a. There would be no increase in average or maximum flow (in line with development).

b. The average increase in flow (in line with Vauxhall Bridge) would beapproximately 0.1 knots. The increasein maximum flow would be0.2 knots.

Figure B.11 Permanent Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow.

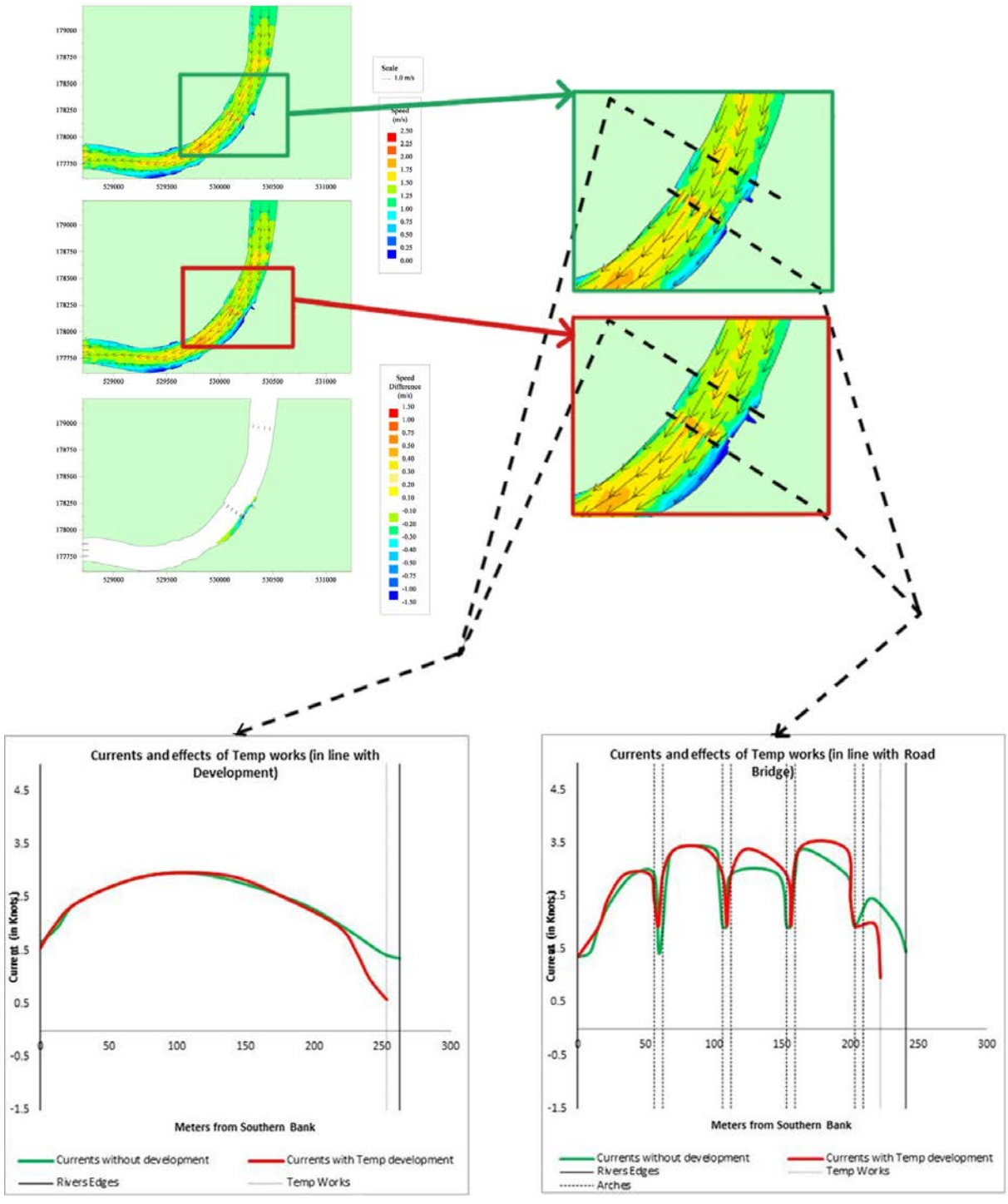


B.2.20 Permanent Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow:

a. There would be no increase in average or maximum flow (in line with development).

b. The average increase in flow (in line with Vauxhall Bridge) is approximately 0.2 knots. The increasein maximum flow is 0.2 knots.

Figure B.12 Permanent Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow.



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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.03**

Albert Embankment Foreshore

Appendix C

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

Hard copy available in

Box **57** Folder **A**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix C: Freight tracks and AIS analysis

C.1 Introduction

C.1.1 The project is proposing to use the foreshore of the River Thames adjacent to Albert Embankment Foreshore for construction and accommodation of permanent structures required to operate the main tunnel. The site would be used to connect the existing local CSOs, known as the Clapham Storm Relief CSO and Brixton Storm Relief CSO to the main tunnel.

C.1.2 There would be two separate construction sites, the northern one is the larger of the two and would have vehicle access, and the southern site is smaller and would not have direct regular vehicle access from the highway. There would be a requirement to transfer material and plant from the northern site to the southern one and it is proposed that this would be done during low tides using the exposed foreshore.

C.1.3 The permanent structure at the southern site would extend from the foreshore (outside of No 85 Albert Embankment) into the river by approximately 25m and thus during construction and on completion of the works, Vauxhall Bridge arch No 5 would not be available for navigation.

C.1.4 Arch No5 is not designated as a working arch and the available water depth, combined with the exclusion zone around No. 85 Albert Embankment results in this arch being rarely used by any vessel.

C.1.5 A review of AIS track information of inbound freight movements through arch No3 was undertaken. The track data was captured in November 2011 and provided by Cory Environmental Ltd. An AIS transponder was sited on the starboard rear quarter of the rearmost rank of barges, enabling analysis of vessel track data for the entire duration of the journey.

C.2 Summary of results

C.2.1 The majority of freight movements, including Cory Environmental Ltd, can be expected to be in the study area between 3 hours before and 1 hour before high water. This provides Cory with a sufficient operating window to be able to deliver the empty barges and remove full barges from facilities upriver at Cringle Dock and Wandsworth Riverside Waste Facility.

C.2.2 Cory Environmental Limited, one of a number of freight operators operating within the study area, state on their current passage plan that tugs are required to depart Cringle Dock 1 hour before HW on the spring tides and 30 minutes before HW on the neap tides in order to clear the bridges in the Central Pool area of London.

C.2.3 Arch No3 of Vauxhall Bridge has the Special Signal Light situated above it and is generally used by all larger, Reporting Vessels, proceeding up stream and down stream. Observations and AIS track analysis at this site confirms this.

Inbound Traffic

C.2.4 Vessels transiting past the site, heading up river, currently use arch No3 of Vauxhall Bridge.

C.2.5 Smaller vessels are currently able to use arch No4. During construction activities, the proximity to the authorised channel of the temporary cofferdam and associated moored barges, may result in smaller vessels having to navigate within the authorised channel and use arch No3.

Outbound Traffic

C.2.6 Vessels proceeding downstream also use arch No2. The Special Signal Light situated above the centre arch provides indication of Reporting Vessels in the area.

C.2.7 The proposed closure of arch No5 during construction activities and with the permanent structure in place is not thought to impact on outbound traffic. The majority of small craft are currently able to use arch No2 when proceeding downstream and provided that arch No3 is clear, this could be used as well.

C.2.8 During temporary works construction (Phase A) and while the temporary works would be being removed (Phase C), it is assumed that arch No5 would be closed to all traffic. However due to arch No5 not being used for navigation, and there being no planned maintenance to arches 3 or 4 during these phases it is assessed that the project wouldn't pose major problems for current river traffic.

Other Main River Users

C.2.9 London Duck Tours represents a significant user in the Albert Embankment Foreshore area. 'Splash down' for the London Duck vessels occurs at Lacks Dock, which is situated in the middle of the development area, between the two works structures.

C.2.10 Cory Environmental represent one of the most significant tug and barge operators passing through the area.

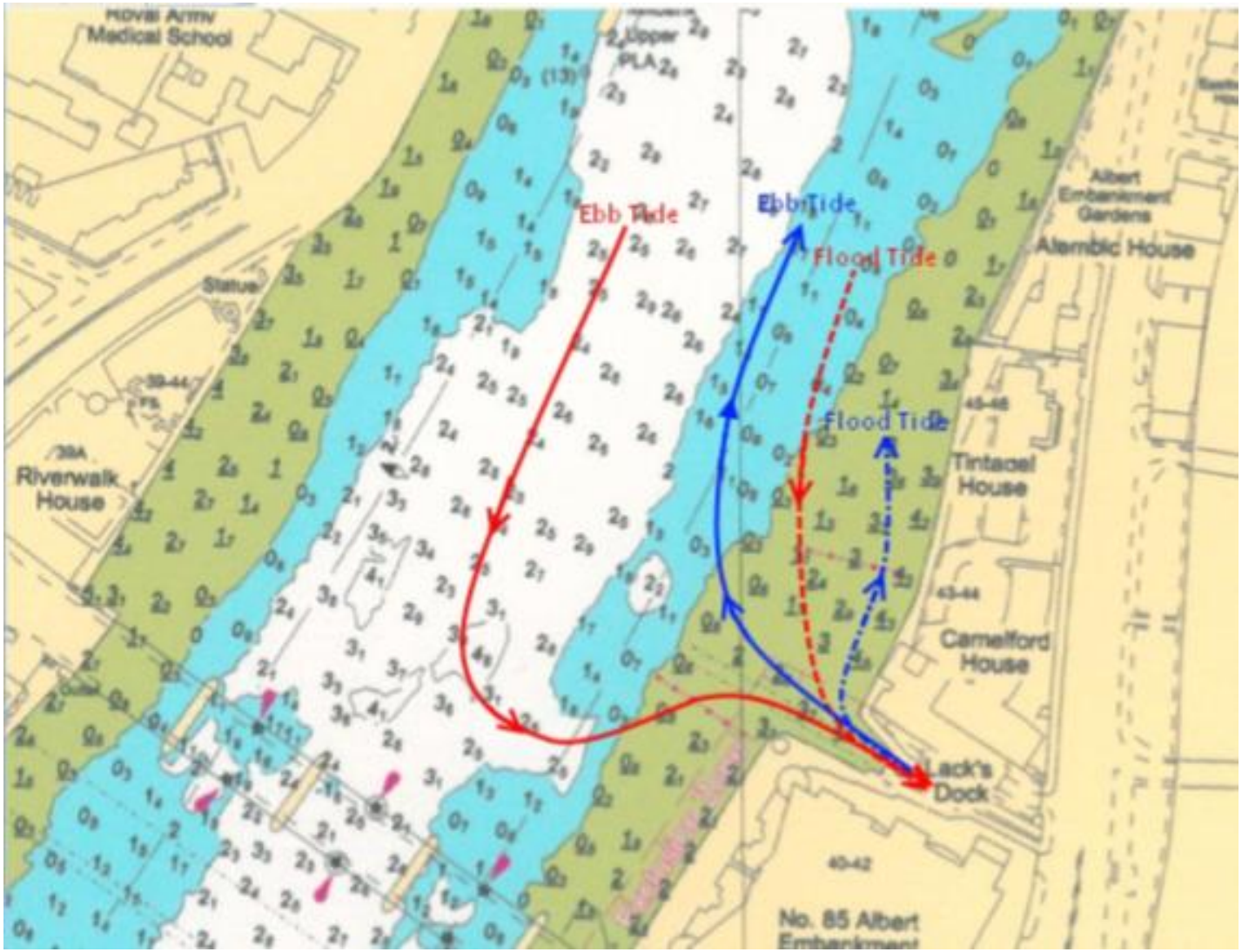
C.2.11 To reflect their respective importance, impacts and routing for these two operators have been analysed separately in the following sections.

C.3 London Duck Tours

C.3.1 Figure C.1 below displays a sample of entry routes taken by the London Ducks using the Lacks Dock slip way. Current operating procedures are for the vessel to use the appropriate route depending on tide levels, following the slipway until the duck is fully floated and then turning to head downstream.

C.3.2 Throughout construction activities and whilst the temporary cofferdam would be in place, the London Duck Tour vessels would need to stay on the slipway for longer than they currently do in order to be far enough off of the river bank to turn, without making contact with the temporary structure.

Figure C.1 Additional London Dock Tour Routes

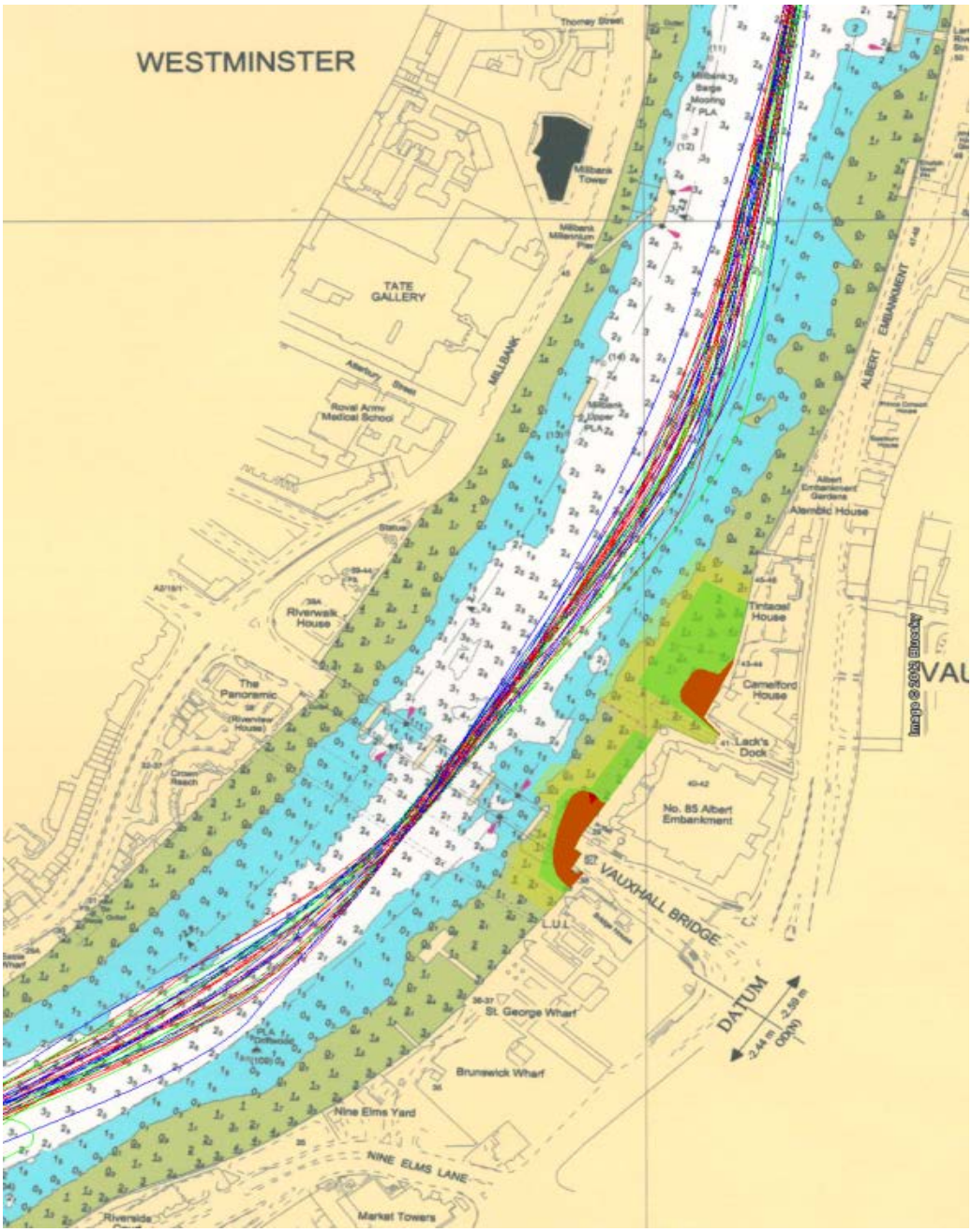


C.4 Cory Environmental

Cory Tug & Tow Upstream GPS tracks

C.4.1 Cory environmental supplied the project with a set of GPS data showing the movements of their tugs and barges. The data covered 14 days in November 2011, a total of 35 tug movements. This data was analysed and visualised to inform various sections of this report. Included below in Figure C.2 is a GIS output of all tracks overlaid over a chart of the the Albert Embankment area.

Figure C.2 GPS Tracks of Cory tugs and barges



C.4.2 By individually investigating each of the tracks supplied it was possible to speculate on the potential impacts of the various phases of development.

C.4.3 For each track supplied, an image was created displaying a wide ‘bar’ type line. This line represented the path taken by the tug in question, with the width being representative of the width of a tug towing at least two barges (side by side). However due to the similarities between the vast majority of these lines, only five have been included in this report. These five (highlighted yellow in Table C.1 below) represent a good cross section of possible routes taken by Cory Environmental.

Cory GPS summary

C.4.4 Table C.1 has the following headings:

a. Date – Date the GPS data was collected
b. Colour – colour system assigned by Cory tugs to enable identification of individual tugs
c. Tug – The name of the tug in question
d. Head Rank Port – The name of the barge being towed in the port position
e. Head Rank stb’d - the name of the barge being towed in the starboard position
f. Second rank – the name of the barge being towed in the rear position (where applicable)
g. Time entering chart area – approximate time at which the tug entered the displayed chart area
h. Wind Direction - Approximate Wind Direction
i. Wind Speed - Wind speed in m/s
j. High tide – time at which high tide was (taken from the PLA 2011 tide times booklet)
k. Tidal height – projected height of tide at Tower Bridge (taken from the PLA 2011 tide times booklet)
l. Notes/Comments – any pertinent notes or comments on this specific track data
m. Figure – reference in this document for the image of the GPS tracks.

Table C.1 Cory AIS Data

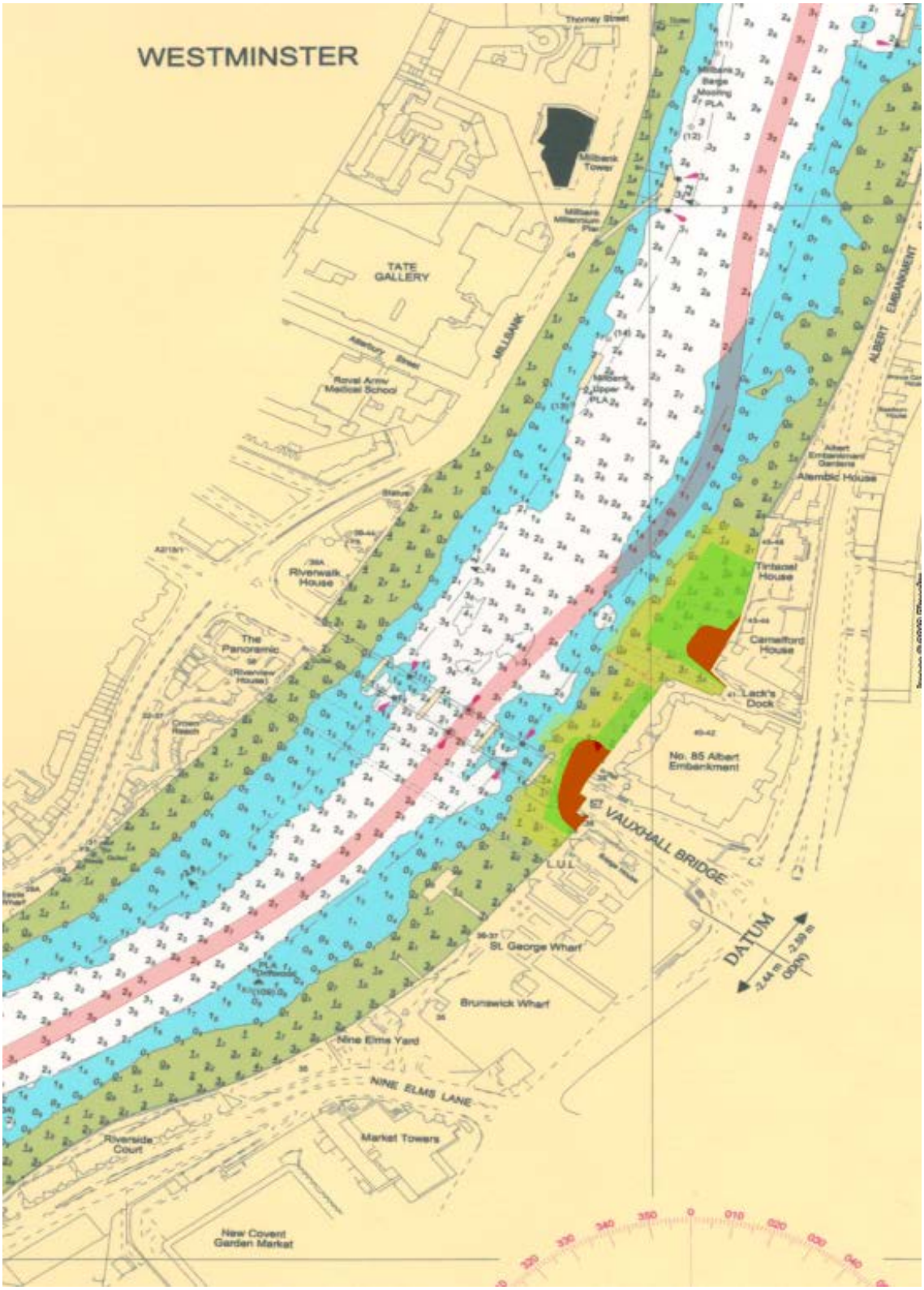
Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Time entering chart area	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Notes / Comments	Figure
07/11/11	Red	Resource	Cringle	Cringle		07:58	NE	3	11:21	6.2		
07/11/11	Blue	Reclaim	Cringle	Cringle	Walbrook		NE	3	11:21	6.2	No data for this area	
07/11/11	Green	Recovery	Cringle	Wangas		07:32	NE	3	11:21	6.2		
08/11/11	Red	Reclaim	Cringle	Cringle	Cringle	09:15	SE	9	12:10	6.5		Figure C.3
08/11/11	Blue	Regain	Cringle	Cringle		08:55	SE	8	12:10	6.5		
08/11/11	Green	Resource	Cringle	Cringle	Wangas	08:49	SE	8	12:10	6.5		
09/11/11	Red	Resource	Cringle	Walbrook		10:26	SE	3	12:51	6.7		
09/11/11	Blue	Recovery	Cringle	Wangas	Wangas	10:07	SE	3	12:51	6.7		
09/11/11	Green	Redoubt	Cringle	Cringle	Wangas	10:15	SE	5	12:51	6.7		Figure C.4
10/11/11	Red	Resource	Cringle	Cringle	Wangas	10:14	E	3	13:27	6.8		
10/11/11	Blue	Regain	Cringle	Cringle	Wangas	09:55	E	4	13:27	6.8		
11/11/11	Red	Reclaim	Cringle	Cringle	Wangas	11:23	E	4	14:00	6.9		
11/11/11	Blue	Recovery	Walbrook	Cringle		11:54	SE	4	14:00	6.9		
11/11/11	Green	Resource	Cringle	Cringle	Wangas	11:07	SE	4	14:00	6.9		
14/11/11	Red	Resource	Wangas	Cringle		12:27	E	4	15:39	6.9		
14/11/11	Blue	Recovery	Walbrook	Cringle		12:37	E	4	15:39	6.9		Figure C.5
14/11/11	Green	Regain	Wangas	Cringle		12:41	E	4	15:39	6.9		
15/11/11	Green	Reclaim	Cringle	Cringle			NE	4	16:16	6.8	No data for this area	
16/11/11	Red	Redoubt	Walbrook	Cringle		14:56	SE	3	16:55	6.7		

16/11/11	Blue	Reclaim	Cringle	Cringle	Cringle	13:27	E	3	16:55	6.7		
16/11/11	Green	Recovery	Cringle	Wangas	Cringle		E	3	16:55	6.7	No data for this area	
17/11/11	Red	Redoubt	Cringle	Cringle	Cringle	14:58	SW	5	17:40	6.6		
17/11/11	Blue	Reclaim	Wangas	Wangas		14:38	SW	5	17:40	6.6		
18/11/11	Red	Regain	Cringle	Wangas	Cringle	14:12	S	5	18:33	6.4		Figure C.6
18/11/11	Blue	Recovery	Cringle	Cringle		15:38	S	4	18:33	6.4		
22/11/11	Red	Regain	Wangas	Wangas		07:19	E	2	10:34	6.5		
22/11/11	Blue	Recovery	Cringle	Cringle	Cringle	07:23	E	2	10:34	6.5		
22/11/11	Green	Reclaim	Cringle	Cringle		07:30	E	2	10:34	6.5		
23/11/11	Red	Reclaim	Wangas	Wangas		09:16	SW	2	11:35	6.8		
23/11/11	Blue	Redoubt	Cringle	Walbrook		09:21	SW	2	11:35	6.8		Figure C.7
23/11/11	Green	Regain	Transponder on tug			09:18	SW	2	11:35	6.8		
24/11/11	Red	Resource	Wangas	Wangas		09:41	SW	4	12:31	7.1		
24/11/11	Blue	Reclaim	Cringle	Cringle	Cringle	09:43	SW	4	12:31	7.1		
24/11/11	Green	Recovery	Cringle	Cringle	Cringle	09:28	SW	4	12:31	7.1		
25/11/11	Red	Resource	Walbrook	Cringle		11:50	W	10	13:22	7.2		
25/11/11	Blue	Recovery	Wangas	Wangas		11:38	W	10	13:22	7.2		
25/11/11	Green	Redoubt	Cringle	Cringle	Cringle	11:34	W	10	13:22	7.2		

Cory Individual Tracks

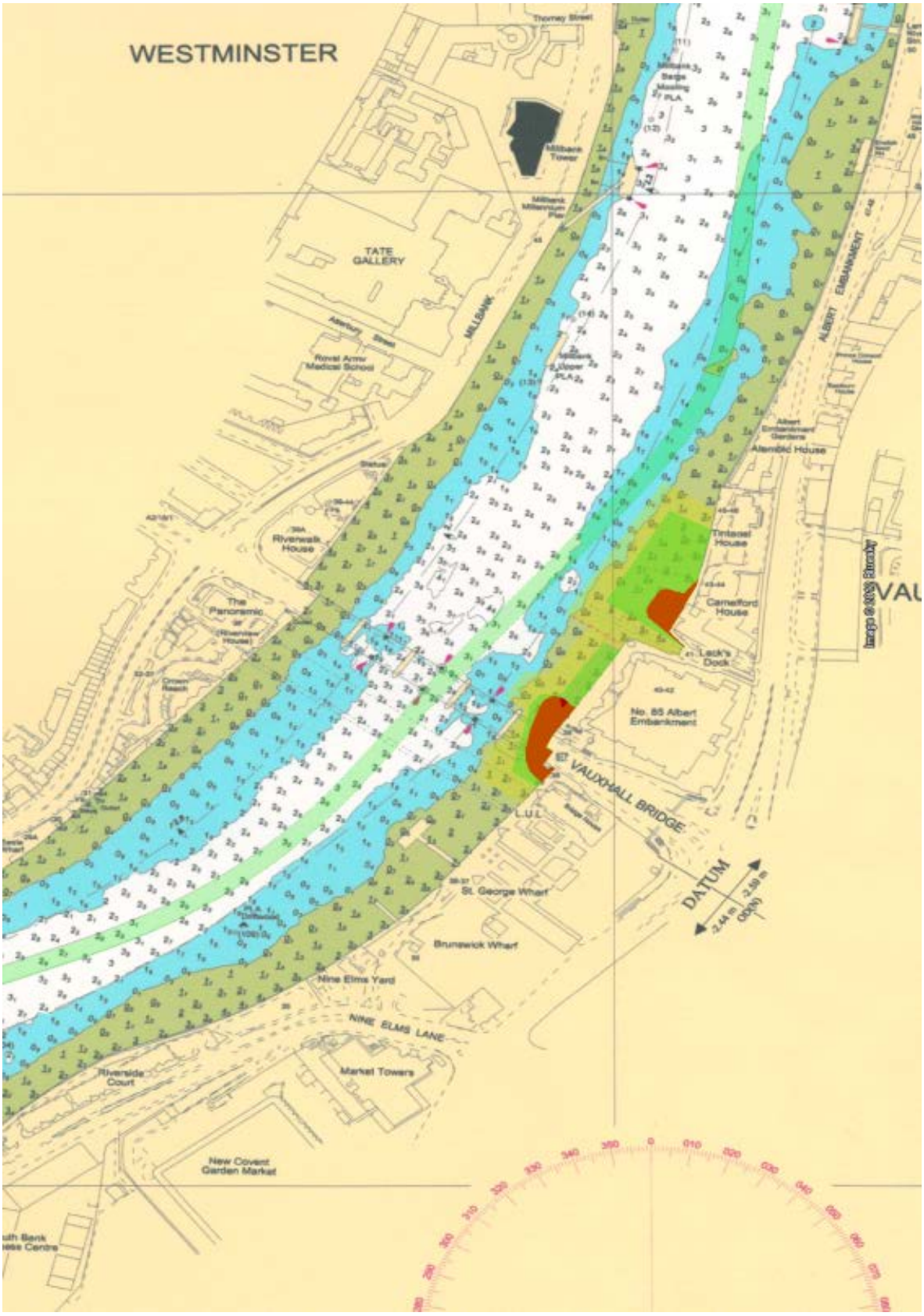
C.4.5 08/11/2011 - Red Track image

Figure C.3 Cory Track 08/11/2011



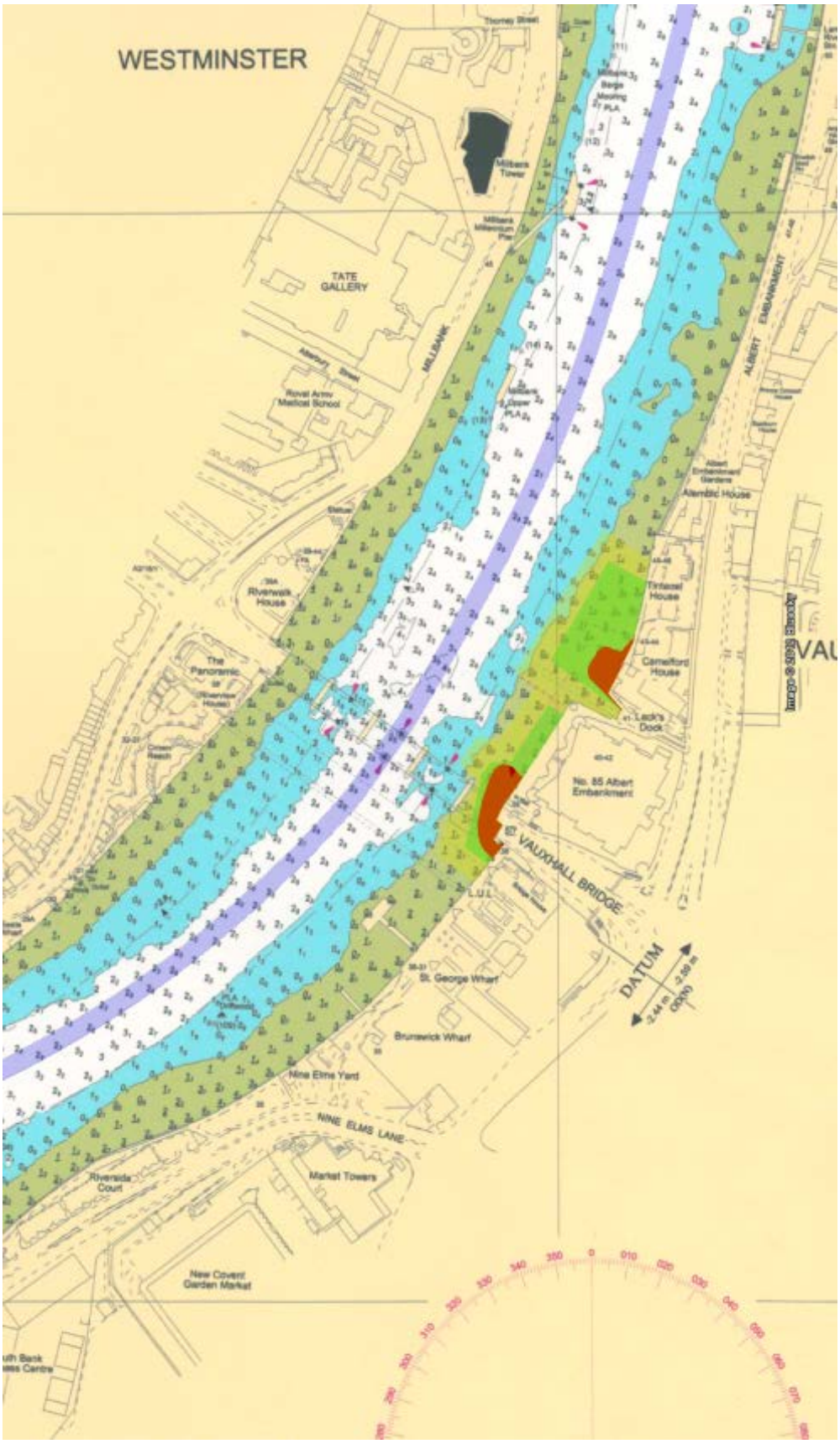
C.4.6 09/11/2011 - Green Track image

Figure C.4 Cory Track 09/11/2011



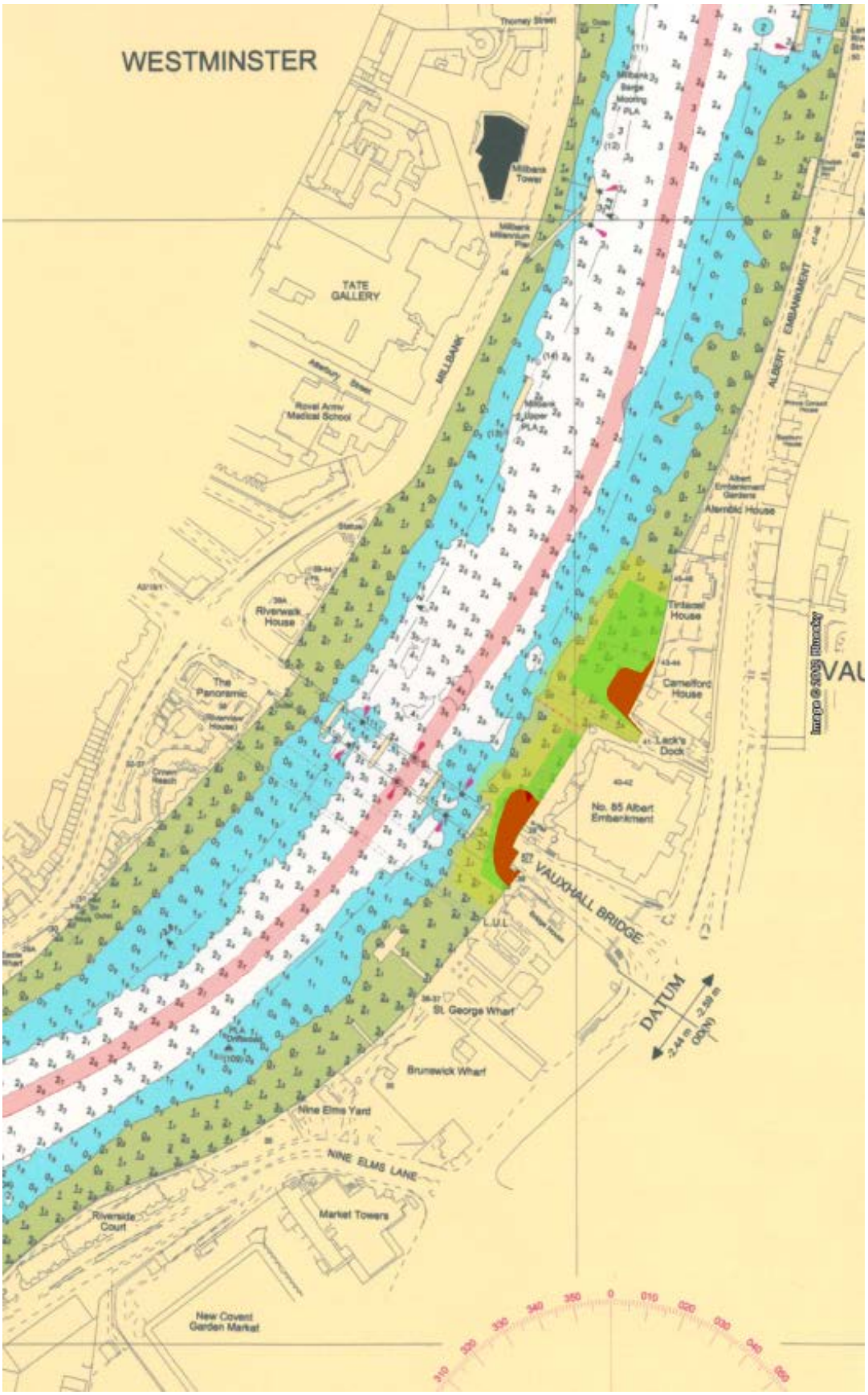
C.4.7 14/11/2011 - Blue Track image

Figure C.5 Cory Track 14/11/2011



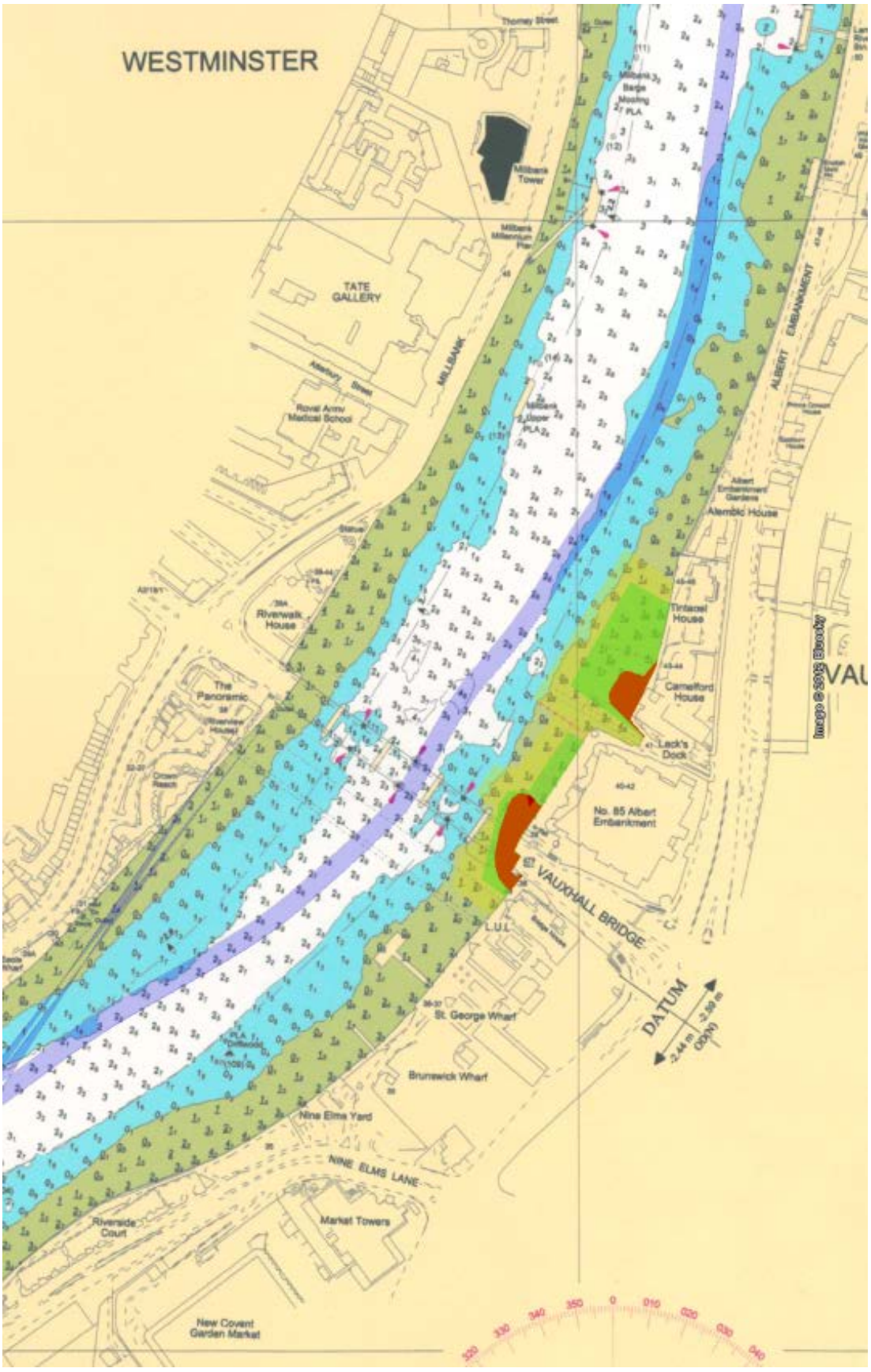
C.4.8 18/11/2011 - Red Track image

Figure C.6 Cory Track 18/11/2011



C.4.9 23/11/2011 - Blue Track image

Figure C.7 Cory Track 23/11/2011



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