Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.11**

King Edward Memorial Park Foreshore

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

Hard copy available in

Box **57** Folder **B**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Navigational Issues and Preliminary Risk Assessment: King Edward Memorial Park Foreshore

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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 King Edward Memorial Park Foreshore (KEMP) as part of the Thames Tideway Tunnel 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 the 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 (including delivery of materials by barge)

b. Phase B: construction of drop shaft/culvert/connections (including removal of excavated materials by barge)

c. Phase C: removal of cofferdam (including removal of materials by barge)

d. Phase D: permanent works site.

1.2 Issues to be addressed

1.2.1 Part of the proposed site lies within the foreshore of the River Thames, with the remainder of the site located within the south western corner of King Edward Memorial Park. The site is in close proximity to the entrance to Shadwell Basin and the Shadwell Basin Outdoor Activity Centre and Sailing Club.

1.2.2 The issues identified at this site are:

a. proximity to the authorised channel

b. relocation of PLA moorings

c. impact on the facilities and users of Shadwell Basin Outdoor Activity Centre and Sailing Club

d. interaction with existing river users

   i commercial operators

   ii leisure users

e. wash

f. change in river flow.

1.3 Proximity to the authorised channel

1.3.1 During the consultation and design for planning phase of the project, the overall footprint of the temporary works area was minimised. As a result the Limits of land to be acquired or used (LLAU) would be no closer than 30m from the authorised channel. On completion of site restoration, the permanent structure would be more than 70m from the authorised channel.

1.4 Relocation of PLA Stone Stairs Barge Tier mooring

1.4.1 PLA chart 319 shows Stone Stairs Barge Tier mooring located just to the east of the temporary works. This mooring would require relocation during the temporary works.

1.4.2 It is proposed that the moorings would be reinstated as part of the completion of the permanent structure.

1.5 Impact on facilities and users of Shadwell Basin Outdoor Activity Centre and Sailing Club

1.5.1 The location of Shadwell Basin Outdoor Activity Centre (SBOAC) would result in possible interaction between users of the activity centre and vessels servicing the site. In addition, concerns have been raised, regarding the temporary and permanent works structures exacerbating the effect of wash from passing vessels, at certain states of the tide.

1.5.2 It is understood that SBOAC and the Sailing Club generally welcome the proposed project, as they understand it would improve the quality of the water, which is a benefit to them and the community however, they are concerned about the impact of the proposed works on their operations.

1.5.3 SBOAC and Sailing Club have been extremely cooperative during the consultation phase, providing project engineers with an understanding and overview of their operations and procedures. It is proposed to continue to work with SBOAC to develop a safe window of operation that takes into account these specific conditions and concerns.

1.6 Interaction with other existing river users

1.6.1 The KEMP site is located downstream of Tower Bridge and away from the busiest section of the river.

1.6.2 The proposed works would introduce additional freight movements and consequently these would need to be coordinated with other users.

1.7 Wash

1.7.1 Thames Clippers are passing the site at speed and could cause barge break outs of moored project vessels if not sufficiently secured.

1.8 Change in river flow

1.8.1 Fluvial modelling shows that the baseline flow is low in the vicinity of the site and there would be a small decrease in flow in the vicinity of the works.

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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 KEMP 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

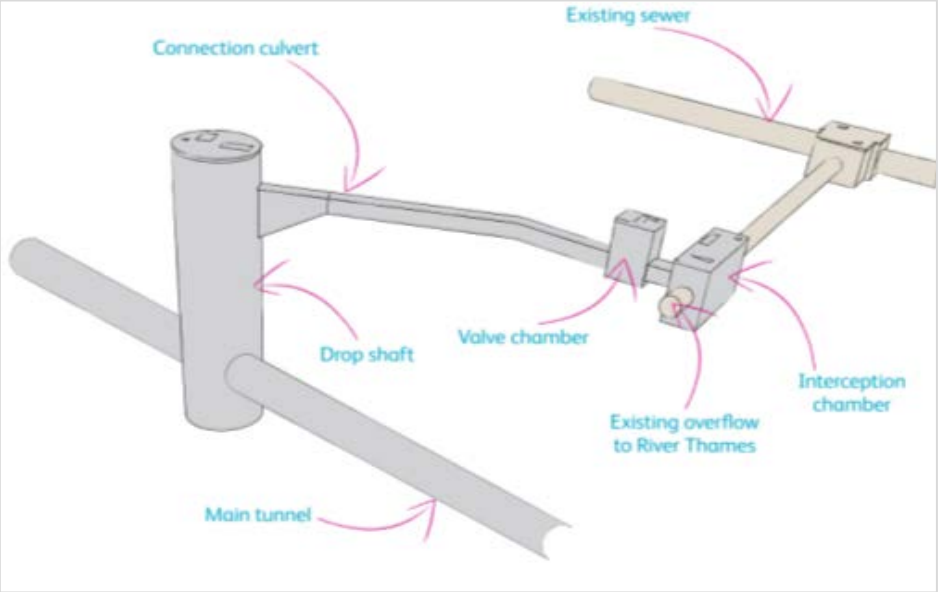
c. control of two CSOs by locally modifying the sewerage system requiring two system modification sites

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 KEMP CSO site would be required to intercept the North East 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 KEMP site would accommodate:

a. an online CSO drop shaft – 20m internal diameter, approximately 60m deep
b. a connection to the North East Storm Relief CSO outfall
c. connection culverts and valve chambers
d. air management structures
e. a new section of river wall

2.2.6 A cofferdam would be constructed, which would include the following areas to enable construction of the permanent in-river structure:

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

2.3 Limits of land to be acquired or used

2.3.1 The proposed draft limits of land to be acquired or used (LLAU) for the site extends approximately 65m from the river wall into the river. The LLAU does not encroach into the authorised channel, remaining at least 30m from it.

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

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

2.3.4 Appendix A details the various design, construction and site layout drawings, including 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: construction of cofferdam (including delivery of materials by barge)

b. Phase B: construction of drop shaft/culvert/connections (including removal of excavated materials by barge)

c. Phase C: removal of cofferdam (including removal of materials by barge)

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 cofferdam would be constructed by installing a sheet piled wall. It is currently envisaged that the cofferdam would be designed as a twin walled cofferdam 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 The temporary structure would extend approximately 50m into the river from the foreshore and is at least 50m away from the authorised channel at all points.

2.7 Phase B: Drop shaft, culvert and connections construction

2.7.1 The CSO drop shaft would be constructed by diaphragm wall construction techniques and have a cast in-situ secondary lining.

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.

2.8 Phase C: Cofferdam removal

2.8.1 On completion of the CSO drop shaft and connection chambers, the permanent river wall would be constructed. The area between the cofferdam and permanent river wall would be excavated.

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

2.8.3 Only once the permanent river wall is in place would the cofferdam on the riverside be removed in order to maintain flood protection. The cofferdam piled wall 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 anticipated in the event of failure of the outer flap valves on the permanent river walls.

2.9.2 The permanent structure would extend approximately 33m into the river and beat least approximately 70m away from the authorised channel.

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 to construction activities at the KEMP site and to assess how the proposed phases of the project would likely impact on existing river users.

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. Observations and analysis of Automatic Identification Systems (AIS) data were also undertaken in order to provide a comprehensive understanding of the operations specific to the KEMP site.

3.1.4 In order to consider the navigation impact on the wider river community, the scope of this assessment comprised an area covering approximately 500 meters either side of the site. 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 the Shadwell Basin Outdoor Activity Centre and Sailing Club, and the effects of project activities on them 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 KEMP site is located within the Lower Pool to Limehouse Reach section of the River Thames and is included in PLA Chart No 319.

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).

3.3 The authorised channel

3.3.1 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.

3.3.2 The authorised channel in the KEMP area varies between 90m and 100m wide.

3.3.3 The document *General Directions for Navigation in the Port of London 2011* 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 13.7 metres or 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 13.7 metres 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".*

3.4 Tide set

3.4.1 During consultation for this and other sites associated with the project, the project determined that the 'tide set' in this area of the River Thames should be taken into consideration when assessing navigational hazards.

3.4.2 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.

3.4.3 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.

3.4.4 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.

3.4.5 The tide set in and around King Edward Memorial Park is assessed as 'moderate to the North' on both the flood and ebb tides.

3.5 Local recreational river users

Tower Hamlets Canoe Club

3.5.1 The Tower Hamlets Canoe Club is a canoe and kayaking club located in central London at Shadwell Basin which operates its adult section from the Shadwell Basin Outdoor Activity Centre.

3.5.2 The club has evening activities every Tuesday throughout the year where both experienced and non experienced members practice.

Shadwell Basin Outdoor Activity Centre

3.5.3 The Activity Centre is located on the river and is reliant on using the Shadwell Dock Stairs for river access/egress.

3.5.4 The proposed project works may affect the launch conditions and restrict operations, but mitigation measures including fendering, grab chains and booms have been identified which should, subject to a more detailed study, allow the Centre to operate most of the time. If this is not deemed acceptable, then providing a temporary launch area should be considered.

3.5.5 Access to the river is via three launch sites, highlighted in the following Figure 3.1. Site (A) is upstream and to the west of the lock entrance and is made up largely of a sand and shingle beach area. It is primarily for access by powered craft to collect activity participants with access by vertical ladder only. Another area (C) further upstream is a publicly accessible beach featuring a slipway used by canoeists and kayakers and utilised almost throughout the whole tide cycle, however it is not suitable for dinghies as there is no access for launching trolleys or boat trailers.

3.5.6 The slipway (B) which extends into the river from Shadwell Dock Stairs (to the east and downstream of the main site), is the main route used to launch sailing dinghies and a small tender used to row to the Centre's launch and safety boat moorings.

Figure 3.1 Launch sites for Shadwell Basin Outdoor Activity Centre

3.6 General existing vessel movements

3.6.1 The majority of freight movements can be expected to pass through the study area around three hours before high water, providing them with a sufficient operating window to traverse the remainder of their journey to areas such as Cringle Dock or further upriver.

3.6.2 The following Figure 3.2 shows inbound Cory barge movements in this area. Transponders were fitted on the starboard stern quarter of the outer barge, in a two barge train, and the starboard stern quarter of the rear barge of a three barge train. The tracks therefore represent the closest point that barges would get to the foreshore on the northern bank of the river. Additional freight track analysis is contained within Appendix B.

3.6.3 The River Thames is used by commuter and tourists as a means of sightseeing. With commuter traffic being stable over the seasons, tourist traffic levels are seasonal with the greatest traffic occurring in the summer months. In Central London sightseeing vessels tend to run throughout the day, with lunchtime/afternoon sightseeing cruises being most popular. These tours concentrate on the main landmarks in the central pool area of London and as such, the majority of sightseeing tours tend not to operate within the study area of this report. A number of sightseeing tour operators do transit past the proposed site, heading down river, past the O2 Arena and on towards Greenwich. These vessels are expected to be travelling within the Authorised Channel when transiting this area, both on upriver and downriver journies.

3.6.4 Complete River Boats operate a regular river taxi service between Embankment Pier and Woolwich Arsenal. The service runs every 20 minutes during peak periods and would be expected to pass the worksite around 90 times a day during weekdays (approximately 45 times in each direction).

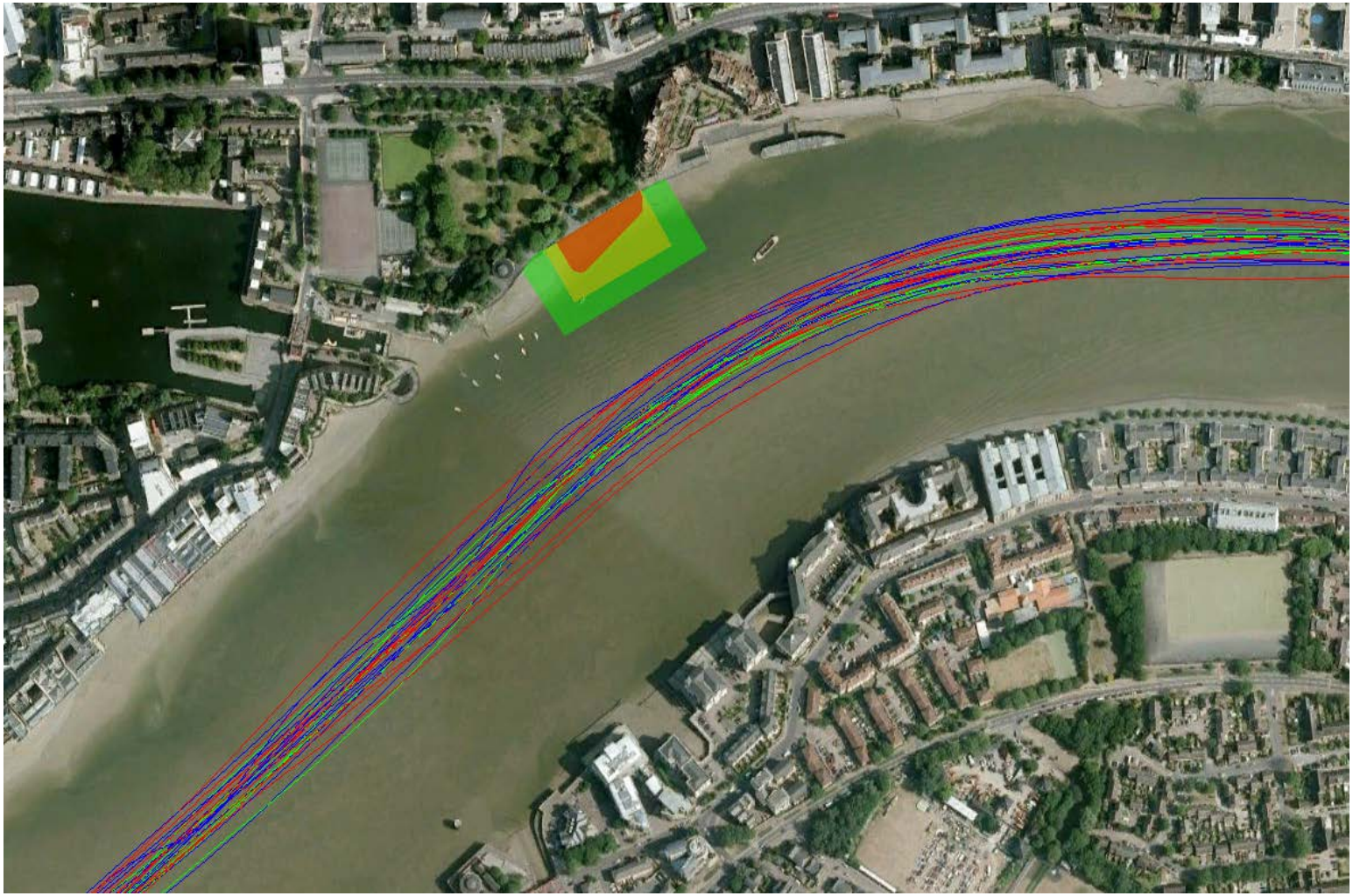
3.6.5 Thames River Service offer a river cruise that would be expected to pass King Edward Memorial Park up to 30 times a day and City Cruises offer a cruise that would be expected to pass up to 25 times a day in addition to regular services by Thames Clipper.

3.6.6 Charter vessels have an element of seasonality with the summer months seeing a higher level of passenger numbers and therefore vessels on the river. There is also some increase in charter boat numbers around the Christmas party season.

3.6.7 In 2012, three cruise ships used the Tower Bridge Upper (TBU) mooring at HMS Belfast. These were Silver Cloud from 10 to 12 June 2012, a Super Yacht from 25 July to 13 August 2012 and Hanseatic from 18 to 19 September 2012. Ships are limited to a length of 158m and the ruling depth is 5.8m.

3.6.8 Cruise ships usually swing at Hanover Hole (upriver from KEMP on the south side of the river) and are towed backwards through Tower Bridge to moor at HMS Belfast.

Figure 3.2 GPS tracks of Cory traffic in the vicinity of King Edward Memorial Park Foreshor



4 Summary of navigational issues

4.1 Proximity to authorised channel

4.1.1 The design has been minimised so that the temporary works jack-up barges are more than 30 metres from the authorised channel. The temporary cofferdam would be a minimum of 50m from the authorised channel. The permanent structure would be more than 70m from the Authorised Channel.

4.1.2 At these distances from the authorised channel, no impact on passing vessels is anticipated.

4.2 Relocation of PLA Stone Stairs Barge Tier mooring

4.2.1 PLA chart 319 shows Stone Stairs Barge Tier mooring located just to the east of the temporary works. This mooring would require relocation during the temporary works.

4.2.2 The footprint of the permanent structure extends only 33m from the foreshore and would not affect users of these moorings. It is proposed that the moorings are reinstated as part of the completion of the permanent structure.

4.3 Impact on facilities and users of Shadwell Basin Outdoor Activity Centre and Sailing Club

4.3.1 The site is close to:

a. Shadwell Basin, which is used by small recreational craft.

4.3.2 The location of Shadwell Basin Outdoor Activity Centre may result in interaction between users of the activity centre and vessels servicing the site. In addition, the activity centre has expressed the concern that the temporary cofferdam and the permanent structure may exacerbate the effect of wash from passing vessels at certain states of the tide.

4.3.3 The permanent and temporary structures would be designed so as not to endanger recreational river users. Further, timber fenders would be installed beneath the proposed permanent cantilever to prevent craft becoming fouled or from going underneath the structures, or eliminate the overhang.

4.4 Interaction with existing river traffic

4.4.1 The site is passed by commuter traffic, tugs and tows and the occasional cruise ship gaining access to the moorings at HMS Belfast. Leisure traffic also passes the site to access the moorings at St Katherine's Haven, to sightsee further up river and in some cases to access the non-tidal Thames and the canal system.

4.4.2 The location of the site may result in interaction between existing river traffic and project vessels.

4.5 Wash

4.5.1 Thames Clippers operate a high speed service passes the site at up to 30 knots which may cause project vessels to break free from its mooring.

4.5.2 The temporary moorings for construction barges would be designed to protect the moored barges from wash/draw-off from passing high speed vessels

4.6 Change in river flow

4.6.1 The shape, location and size of the temporary cofferdam and permanent structure could lead to local increases in river flow.

4.6.2 Based on fluvial modelling work carried out by HR Wallingford, a slight increase in velocity (0.1m/s) is predicted along the opposite side of the river. This increase is small in extent and represents a small change to the baseline.

4.6.3 The results of the simulations are:

a. 1 m/s = 1.94 knots

b. 0.10 m/s = 0.194 knots

c. Maximum change recorded = 0.25 knots

5 Stakeholder consultation

5.1 Consultation meetings

5.1.1 In addition to consultation with barge operators and the operators of the main passenger services, there has been extensive consultation with the Shadwell Basin Outdoor Activity Centre (SBOAC).

5.2 Observation notes

5.2.1 At the meeting with the team from SBOAC, the main concern expressed was the potential for craft and crews to be swept down into the corner created by the new structure. This particular hazard already exists in as much as craft and crews can be swept downriver in an upright or capsized state and fetch up alongside the river wall or jetties at Free Trade Wharf.

5.2.2 Activity centre staff noted that dinghies regularly have to be recovered by a safety boat after they have drifted against the existing river wall, when the foreshore is covered by the tide, which is for a duration of approximately 3 hours either side of high water. The centre does not consider this to be a significant hazard as the dinghies are able to drift with the tide parallel to the wall.

5.2.3 Activity centre staff are concerned that the close proximity of the slipway to the temporary construction would result in dinghies becoming 'pinned' against the western end of the proposed cofferdam or trapped between a barge moored against the cofferdam.

5.2.4 The event described above could only occur on the ebb tide. At no time during the meeting did the team voice any concerns about crews etc being swept upstream, on the flood tide, and becoming trapped on the pier head of the old dock entrance, despite the fact that this is a hazard with the present launching arrangements.

5.2.5 The project's marine consultant believes that the SBOAC's concern over the effect of wash from passing vessels at this site primarily during the temporary phase reflects a genuine issue as their existing use of the Shadwell Dock Stairs is difficult and may be prevented if the conditions deteriorate.

5.2.6 The project's marine consultant believes that the centre is currently near the limit of safe operations in their use of the Shadwell Dock Stairs when craft are being launched and recovered.

5.2.7 Although there was some agreement on the type factors that were needed for the extreme conditions to arise i.e. wind over the tide, tidal height in excess of 6m, excessive traffic transiting through the area, particularly craft travelling upstream on the north side of the channel, critical water and wave conditions is a subjective issue and is open to interpretation.

5.2.8 The critical conditions described above do not occur every time that SBOAC launch onto and recover from the water. The tides are cyclical in nature and with High Water occurring approximately 40 minutes later each day. Therefore, provided that launching and recovery take place at about

the same times each day, tidal conditions and height would be different as the tide moves through its fortnightly cycle. It would be theoretically possible to create a safer tide window which reflects these ever changing conditions. Many Tidal Thames rowing clubs have established such operating procedures, which also take into account weather likely to affect their safe window.

5.2.9 The area at the western end of the proposed site has a drying height of 2 to 4 metres above chart datum. The average rise per hour during neap tides is 1.2m and 1.4m on the springs. There are slight variations on these figures which can be driven by excessive fluvial water from the upper reaches, periods of high winds in the North Sea particularly of a north westerly direction.

5.2.10 Consequently, at High Water on average neap tides, there is approximately 1.9m of water alongside the wall at the jetty sites and 3.1m on the springs. If the centre could be convinced to avoid boating an hour either side of high water on the neaps and one and a half hours either side of high water springs, their safety would be greatly increased as capsized crews would be able to stand up on the high ground. Dinghies could sustain some damage from grounding but this grounding issue is a hazard that currently exists. Providing that they boat on the flood, the craft and crews would drift upriver away from the site. The river modelling at Wallingford clearly demonstrated very little inshore flow, ebb or flood, in this area.

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.

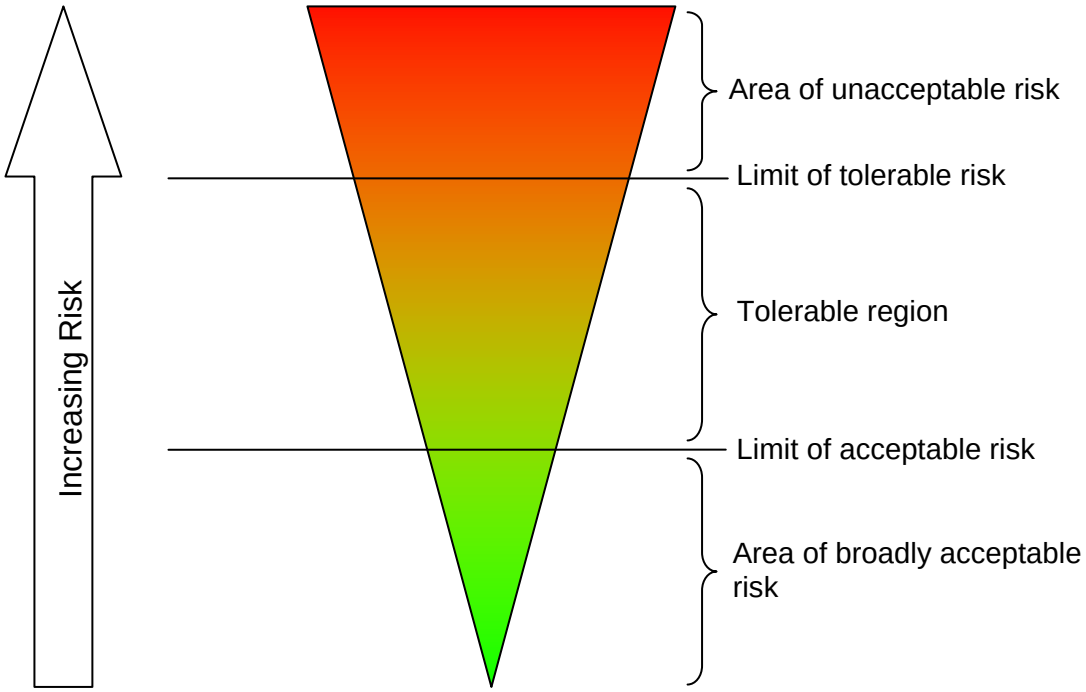
b. Risk: a relative measure of harm or loss, derived from the combination of the severity of a particular consequence together with the probability of the consequence occurring.

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 alternative risk terminology, and 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 PLAs 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.

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.

7.1.5 The proposed LLAU at this site is less than 100m from the entrance to the Shadwell Basin which is used by recreational craft.

7.1.6 Limehouse Basin is approximately 600m downstream of the proposed site.

7.1.7 During the temporary works, jack-up barges may be placed within 30m of the authorised channel.

7.2 Proximity to the authorised channel

7.2.1 The design and 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, whilst incorporating the necessary works, and is set back from the authorised channel. This would reduce the extent that the work site would extend into the river and therefore reduce the likely impact on existing river users.

7.2.2 The jack-up barges would be a minimum of 30m from the authorised channel while constructing and removing the temporary cofferdam (phase A and C). The temporary cofferdam would be a minimum of 50m from the authorised channel. The permanent structure would be more than 70m from the authorised channel.

7.2.3 At these distances from the authorised channel, no impact on passing vessels is anticipated.

7.3 Relocation of PLA Stone Stairs Barge Tier mooring

7.3.1 PLA chart 319 shows Stone Stairs Barge Tier mooring located just to the east of the temporary works. This mooring would require relocation during the temporary works.

7.3.2 The mooring would be reinstated as part of the completion of the permanent structure.

7.4 Impact on facilities and users of Shadwell Basin Outdoor Activity Centre and Sailing Club

7.4.1 The site is close to:

a. Shadwell Basin, which is used by small recreational craft

7.4.2 The location of Shadwell Basin Outdoor Activity Centre may result in interaction between users of the activity centre and vessels servicing the site. In addition, the activity centre has expressed the concern that the temporary cofferdam and the permanent structure may exacerbate the effect of wash from passing vessels at certain states of the tide.

Actions required

7.4.3 A number of actions, specific to the issue, 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. actively engage with members of activity centre and sailing club

b. analyse typical usage patterns and frequencies

c. record and observe other leisure / recreational river traffic in the area: typically vessels under 13.7m that are directed to navigate outside of the authorised channel.

Mitigation of issues: Design

7.4.4 In June 2012 a review of water-based activities in proximity to King Edward Memorial Park was undertaken. The aim of the assessment was to review the Centre's activities and to assess the potential impact on the Activity Centre and Sailing Club operations as a result of Thames Tideway Tunnel activities in this area of the tidal Thames.

7.4.5 The permanent and temporary structures would be designed so as not to endanger recreational river users.

Mitigation of issues: Physical

a. Include timber fenders beneath the proposed permanent cantilever to prevent craft becoming fouled or from going underneath the structures, or eliminate the overhang.

Mitigation of issues: River operations

a. appoint Berthing Co-ordination Manager who would liaise and be in communication with the sailing club and activity centre and be on hand to deal with potential areas of concern or conflict

b. promulgate traffic movements and schedules to the Activity Centre, Sailing Club and the PLA.

7.5 Interaction with other existing river traffic

7.5.1 Freight movements past the site include Cory Environmental Ltd's waste transfer service and barge operators delivering aggregates to sites further up river.

7.5.2 Passing traffic is mainly commuter traffic, tugs and tows and the occasional cruise ship gaining access to the moorings at HMS Belfast. Leisure traffic also passes the site to access the moorings at St Katherine's Haven, to sightsee further up river and in some cases to access the non-tidal Thames and the canal system.

Actions required

7.5.3 A number of actions, specific to the issue, 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/GPS 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 leisure / recreational river traffic in the area: typically vessels under 13.7m that are directed to navigate outside of the authorised channel

Mitigation of issues: Design

7.5.4 The design and 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. This reduces the footprint of the in-river structures and therefore reduces the likely impact on existing river users.

7.5.5 The permanent and temporary work structure, including jack-up barges, is greater than 30 metres from the authorised channel.

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

7.5.7 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 freight operators, such as Cory Environmental, to get their views and input into interaction issues and possible working relationships at this site.

Mitigation of issues: River operations

a. issue Notice to Mariners informing operators and river users of planned operations in area, highlighting times when project related river movements are likely to be servicing the site

b. appoint Berthing Co-ordination Manager who would 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.

7.6 Wash

7.6.1 Thames Clippers operate a high speed service passes the site at up to 30 knots.

Actions required

7.6.2 A number of actions, specific to the issue, 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. consider the case of potential barge break out caused by vessels passing the site at speed during the design stage of the project.

Mitigation of issues: Design

7.6.3 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 temporary moorings for construction barges would be designed to protect the moored barges from wash/draw-off from passing high speed vessels

b. 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'.

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

Mitigation of issues: Physical

a. None identified

Mitigation of issues: River operations

a. None identified

7.7 Change in river flow

7.7.1 The shape, location and size of the temporary cofferdam and permanent structure could lead to local increases in river flow.

7.7.2 Fluvial modelling work carried out by HR Wallingford has been analysed. Given the limited change in flow predicted at the site, the results of this analysis are presented within the body of this report, rather than in a separate annex.

7.7.3 A summary of the main change in flow is set out below. The following Figure 7.1 shows an image taken from the HR Wallingford Report and represents the typical flow, the flow with the temporary works, and the changes in flow in the area of the site for a large flood tide (typical spring tide range with 65m3/s flow at Teddington,65m3/s being the annual mean freshwater flow). This tidal condition is one of the worst case scenarios and thus the image shows one of the greatest potential changes to flow in the area.

7.7.4 The image shows that flow would be generally reduced in the vicinity of the site and limited to the area directly upstream and downstream of the temporary cofferdam structure. A slight increase (0.10 m/s) is predicted along the opposite side of the river. This increase is small in extent and represents a small change compared to the baseline.

7.7.5 The results of the simulations are summarised in the following tables, showing the peak through tide currents.

a. 1 m/s = 1.94 knots

b. 0.10 m/s = 0.194 knots

c. Maximum change recorded = 0.25 knots

Table 7.1 Baseline observations

Simulation		Peak speed at analysis point (knots)					
Tide	**Freshwater Flow m^3/s**	1	2	3	4	5	6
Typical Spring	65	1.98	2.24	2.16	1.79	1.11	1.05
Typical Spring	800	2.14	2.43	2.35	1.89	1.19	1.09
Large Flood	65	2.14	2.43	2.37	1.96	1.15	1.15

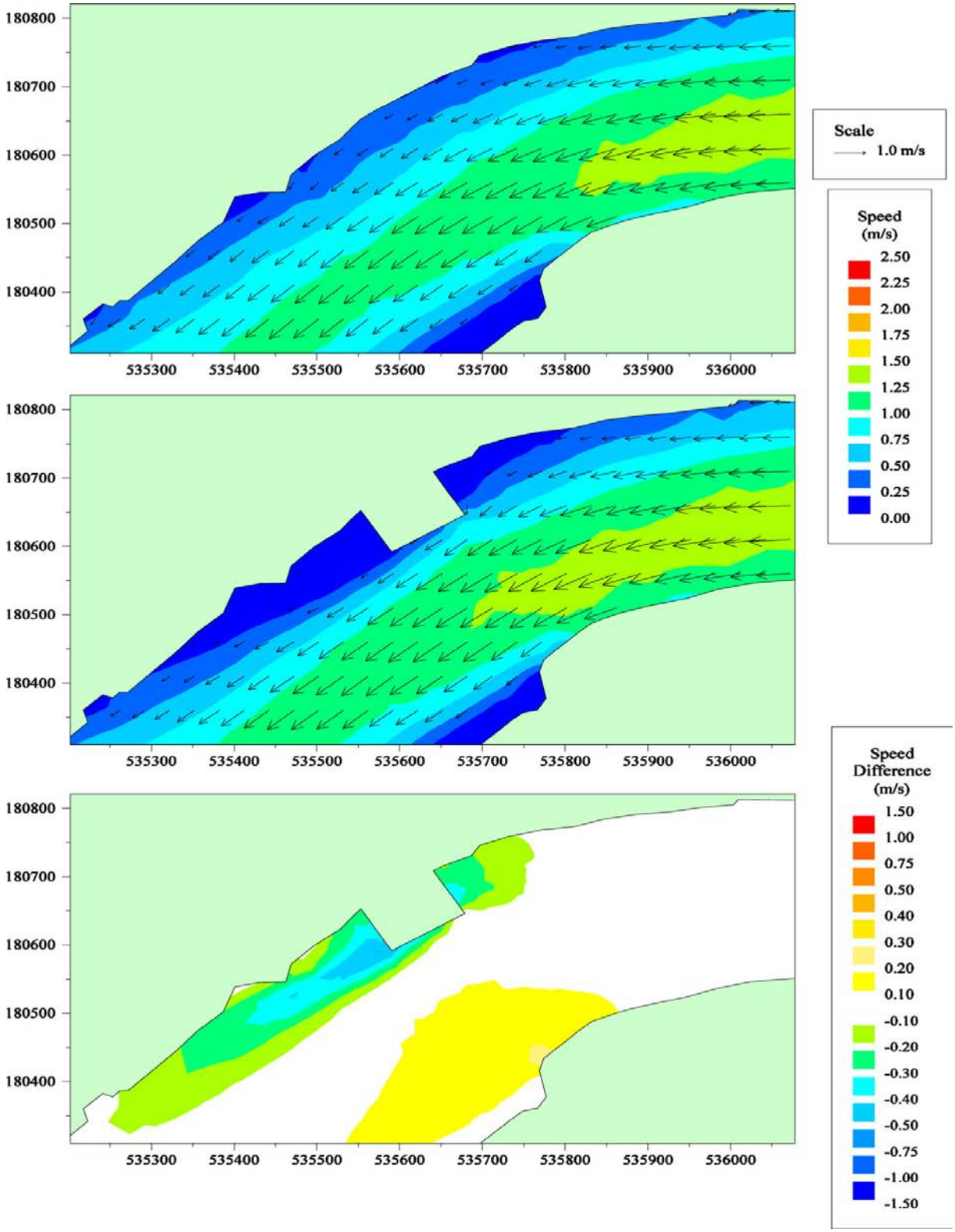
Table 7.2 Temporary work observations

Simulation		Peak speed at analysis point (knots) and change compared with the baseline					
Tide	**Freshwater Flow m^3/s**	1	2	3	4	5	6
Typical Spring	65	2.27 (+0.29)	2.45 (+0.21	2.35 (+0.19)	1.92 (-0.13)	0.66 (-0.45)	0.54 (-0.51)
Typical Spring	800	**2.39 (+0.25)**	2.64 (+0.21)	2.53 (+0.18)	1.98 (+0.09)	0.41 (-0.78)	0.56 (-0.53)
Large Flood	65	2.45 (+0.31)	2.66 (+0. 23)	2.55 (+0.18)	2.08 (+0.12)	0.72 (-0.43)	0.49 (-0.66)

Table 7.3 Permanent work observations

Simulation		Peak speed at analysis point (knots) and change compared with the baseline					
Tide	**Freshwater Flow m^3/s**	1	2	3	4	5	6
Typical Spring	65	2.02 (+0.04)	2.27 (+0.03)	2.18 (+0.02)	1.83 (-0.04)	0.99 (-0.12)	0.93 (-0.12)
Typical Spring	800	2.18 (+0.04)	2.47 (+0.04)	2.39 (+0.04)	1.91 (+0.02)	1.07 (-0.12)	0.99 (-0.10)
Large Flood	65	2.18 (+0.04)	2.47 (+0.04)	2.39 (+0.02)	1.96 (0.00)	1.07 (-0.08)	1.01 (-0.14)

Figure 7.1 Temporary works: peak flood currents - spring tide, 65m3/s river flow tide, 65m3/s river flow



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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'.

a. Full hazard details contained in Annex A through to Annex I.

8.2 Project phases A to D: Most likely

Table 8.1 Most likely hazard log summary

				Score			
Hazard Id	Hazard title	Hazard description	Phase	People	Environment	Operational	Media
1	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels.	A	6	4	4	4
			B	9	6	6	6
			C	6	4	4	4
			D	9	6	6	9
2	Contact - High Speed Passenger Vessel with worksite	A High Speed Passenger Vessel comes into contact with the project's worksite at King Edward Memorial Park.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
3	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with the project's worksite at King Edward Memorial Park.	A	6	4	6	8
			B	6	4	6	6
			C	6	4	6	8
			D	6	4	6	6
4	Contact - private	Private leisure vessels,	A	6	2	6	6

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	leisure vessel with worksite	including narrow boats, comes into contact with the project's worksite at King Edward Memorial Park.	B	9	3	9	9
			C	6	2	6	6
			D	9	6	9	9
5	Contact - commercial freight operator with worksite	Commercial freight comes into contact with the project's worksite at King Edward Memorial Park.	A	6	6	6	4
			B	6	6	6	4
			C	6	6	6	4
			D	6	6	6	6
6	Contact - tug and tow with worksite	A Tug and Tow comes into contact with the project's worksite at King Edward Memorial Park.	A	6	4	6	4
			B	6	4	6	4
			C	6	4	6	4
			D	6	4	6	6
7	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 riverbed than expected.	A	4	2	6	4
			B	4	2	6	4
			C	4	2	6	4
			D	6	2	6	6
8	Mooring breakout	A vessel involved in project activities breaks free from moorings.	A	2	2	2	2
			B	4	4	4	4
			C	2	2	2	2
			D	N/A	N/A	N/A	N/A
9	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 King Edward Memorial Park during construction/ deconstruction of the cofferdam.	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

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
10	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 King Edward Memorial Park, during construction/ deconstruction of the cofferdam.	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
11	Collision – private leisure vessel (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities collides with a private leisure vessel in the vicinity of King Edward Memorial Park, during construction/ deconstruction of the cofferdam.	A	6	4	6	6
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8
			D	N/A	N/A	N/A	N/A
12	Collision - commercial freight operator (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities collides with a commercial freight operator in the vicinity of King Edward Memorial Park, during construction/ deconstruction of the cofferdam.	A	4	6	4	6
			B	N/A	N/A	N/A	N/A
			C	4	6	4	6
			D	N/A	N/A	N/A	N/A
13	Collision - tug and tow (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities collides with a tug and tow in the vicinity of King Edward Memorial Park, during the construction/ deconstruction of the cofferdam.	A	4	6	6	4
			B	N/A	N/A	N/A	N/A
			C	4	6	6	4
			D	N/A	N/A	N/A	N/A
14	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	6	4	6	6
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
15	Collision - Class V	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
	passenger vessel (delivery/material removal)	delivery/material removal activities collides with a Class V passenger vessel in the vicinity of King Edward Memorial Park.	B	6	4	6	6
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
16	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 King Edward Memorial Park.	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
17	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	4	6	4	6
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
18	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	4	6	4	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 hazard log summary

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
1	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels.	A	8	4	6	6
			B	12	6	9	9
			C	8	4	8	6

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
			D	8	4	8	6
2	Contact - High Speed Passenger Vessel with worksite	A High Speed passenger vessel comes into contact with the project's worksite at King Edward Memorial Park.	A	8	4	8	8
			B	8	4	6	8
			C	8	4	8	8
			D	8	4	8	8
3	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with project's worksite at King Edward Memorial Park.	A	8	4	8	8
			B	8	4	6	8
			C	8	4	8	8
			D	8	4	8	8
4	Contact - private leisure vessel with worksite	Private leisure vessel, including narrow boats, comes into contact with project's worksite at King Edward Memorial Park.	A	8	2	8	8
			B	8	2	6	8
			C	8	2	8	8
			D	8	4	8	8
5	Contact - commercial freight operator with worksite	Commercial freight comes into contact with project's worksite at King Edward Memorial Park.	A	8	6	6	8
			B	6	8	8	8
			C	8	6	8	8
			D	8	6	8	8
6	Contact - tug and tow with worksite	A tug and tow comes into contact with project's worksite at King Edward Memorial Park.	A	8	8	6	8
			B	8	4	8	8
			C	8	6	8	8
			D	8	6	8	8
7	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 riverbed than expected.	A	4	2	6	4
			B	4	2	6	4
			C	4	2	6	4
			D	6	2	6	6

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
8	Mooring breakout	A vessel involved in the projects activities breaks free from moorings.	A	3	3	3	3
			B	6	4	6	6
			C	3	3	3	3
			D	N/A	N/A	N/A	N/A
9	Collision - High Speed Passenger Vessel (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities for the cofferdam collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of King Edward Memorial Park.	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
10	Collision - Class V passenger vessel (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities for the cofferdam collides with a Class V passenger vessel in the vicinity of King Edward Memorial Park.	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
11	Collision – private leisure vessel (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities for the cofferdam collides with a private leisure vessel in the vicinity of King Edward Memorial Park.	A	8	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
12	Collision - commercial freight operator (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities for the cofferdam collides with a commercial freight operator in the vicinity of King Edward Memorial Park.	A	6	6	6	6
			B	N/A	N/A	N/A	N/A
			C	6	6	6	6
			D	N/A	N/A	N/A	N/A
13	Collision - tug and tow (construction/deconstruction)	A vessel conducting project construction/ deconstruction activities for the cofferdam collides with a tug and tow in the vicinity of King Edward Memorial Park.	A	6	6	6	6
			B	N/A	N/A	N/A	N/A
			C	6	6	6	6
			D	N/A	N/A	N/A	N/A
14	Collision - High	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
	Speed Passenger Vessel (delivery/material removal)	delivery/ material removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of King Edward Memorial Park.	B	8	4	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
15	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	8	4	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
16	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	10	6	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
17	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	6	6	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
18	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 King Edward Memorial Park.	A	N/A	N/A	N/A	N/A
			B	6	6	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

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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 relevant to Thames Tideway Tunnel 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 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 and this assessment therefore only assesses the residual risk assuming the effective implementation of these measures:

a. The design and 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, whilst incorporating the necessary works, and is set back from the authorised channel. This would reduce the extent that work site would extend into the river and therefore reduce the likely impact on existing river users.

b. jack-up barges would be a minimum of 30m from the authorised channel while constructing and removing the temporary cofferdam (phase A and C). The temporary cofferdam would be a minimum of 50m from the authorised channel. The permanent structure would be more than 70m from the authorised channel.

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

d. The temporary moorings for construction barges would be designed to protect the moored barges from wash/draw-off from passing high speed vessels.

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'.

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

9.4 Physical

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

b. Include timber piles beneath the proposed permanent cantilever to prevent craft becoming fouled or from going underneath the structures, or eliminate the overhang.

c. meeting with freight operators, such as Cory Environmental, to get their views and input into interaction issues and possible working relationships at this site.

9.5 River operations

a. appoint 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 / conflict.

b. issue 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.

c. promulgate traffic movements and schedules to the Activity Centre, Sailing Club and the PLA.

Table 9.2 Mitigation measures within project 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 Practises	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

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10 Conclusion

10.1 Assessment

10.1.1 This *Navigation Issues and Preliminary Risk Assessment* assessed the potential impact of the proposed works at King Edward Memorial Park Foreshore on existing 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 risk assessment criteria, assessment matrix, terminology and risk classification were provided by the PLA. The assessment also follows the Formal Safety Assessment (FSA) methodology:

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, including:

a. interaction with existing freight traffic

b. impact on existing river users.

c. changes in flow.

10.3 Risk analysis

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

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

Table 10.1 Hazard overview: 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.	0	0	0	0

Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.	29	33	29	24
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances.	17	18	17	3
Slight: No action is required.	6	1	6	1

Table 10.2 Hazard overview: 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.	0	2	0	0
Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.	38	40	38	23
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances.	12	8	12	5
Slight: No action is required.	2	2	2	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, and a number fell within the 'minor risk' category.

10.4 Overall

10.4.1 The King Edward Memorial park site is located downstream of Tower Bridge and away from the busiest section of the river.

10.4.2 The proposed project works introduces additional freight movements and in-river infrastructure and consequently these would need to be coordinated with other users.

10.4.3 Changes in flow speed and direction in the area of the site are small and have not been raised as a concern.

10.4.4 The navigational issues are summarised below:

a. Interaction with existing commercial river users;

b. Interaction with users of Shadwell Basin Outdoor Activity Centre;

c. Intrusion into river - proximity to authorised channel.

10.4.5 This report sought to provide an independent, evidence-based assessment of current river operations and the likely impact that project operations would have on existing river users.

10.4.6 The overall responsibility for safety on the River Thames lies with the Port of London Authority, which needs to determine whether the issues and hazards set out in this report present a ‘tolerable’ navigational risk

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11 Recommendations

11.1 General

11.1.1 The Shadwell Basin Outdoor Activity Centre has concerns about project related works and structures exacerbating wash under specific wind conditions, especially when these occur at high water. It is recommended that the project continues to work with Shadwell Basin Outdoor Activity Centre to develop a safe window of operation that takes into account these specific conditions.

11.1.2 Experience indicates that the majority of reflected wave problems are best solved by trying to damp out the waves at a given location. The designers of the permanent/temporary structure should be able to shape the structure to minimise wave reflections and/or use special 'wave damping' walls that disperse the wave energy. This should be further investigated if the proposed works are pursued.

11.1.3 Further, it is recommended that the project assesses the benefit to be gained from the deployment of booms for wave absorption and to mitigate any concerns over drifting vessels.

11.1.4 The project recommends implementing the mitigations measures set out in Section 8. Additionally, the below should be given consideration:

11.1.5 **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 project's over an extended time period. Dedicated marine logistic managers and experienced marine staff are employed on this project to ensure that the 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.

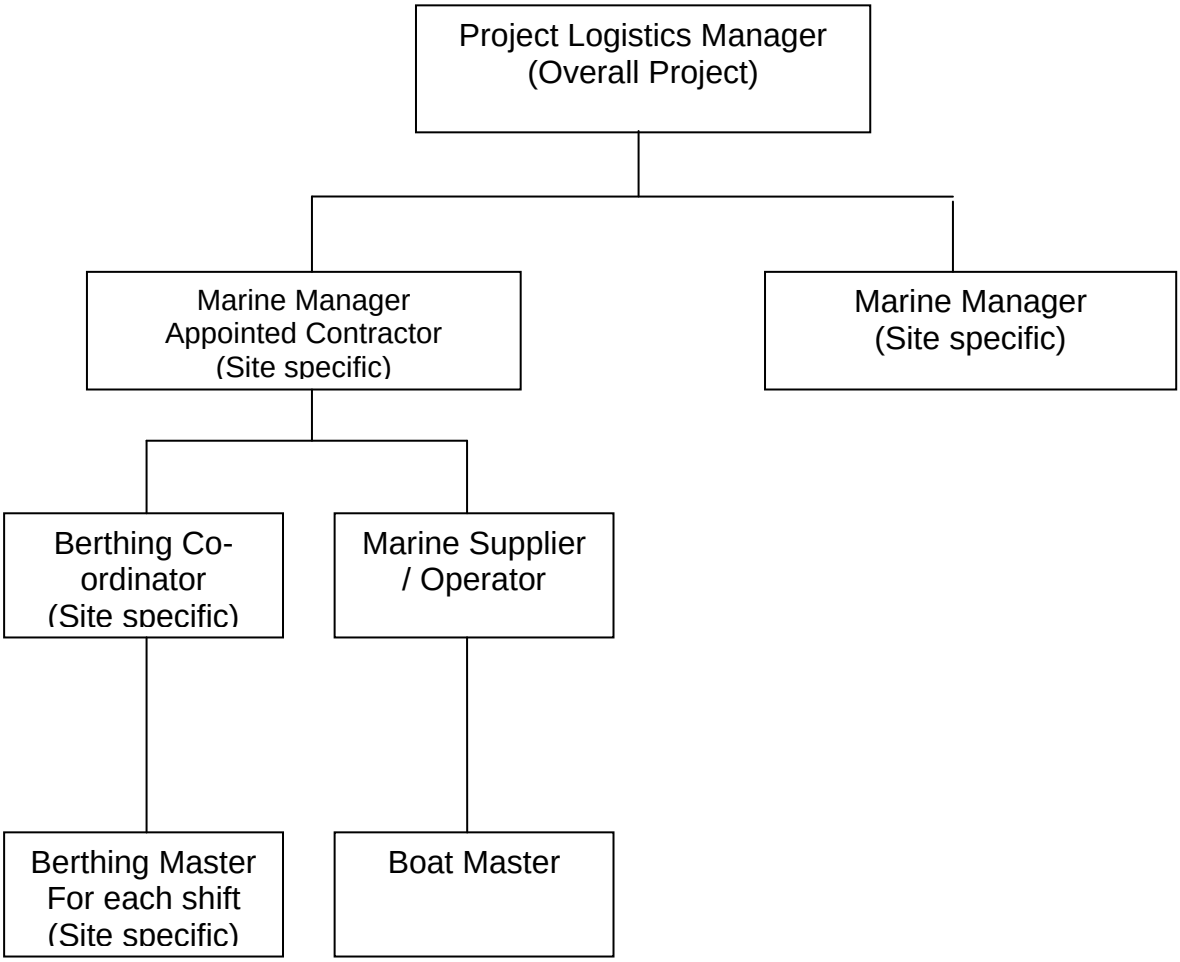
11.1.6 **Continued communication**: The project should continue to maintain communication and liaison with the member so of the Activity Centre and Sailing Club.

11.1.7 **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.

11.1.8 The project recommends considering the designated Berthing Co-ordinator's authority and responsibilities. One responsibility of the Berth Co-ordinator would be to liaise regularly with the PLA and local stakeholders. Clear lines of delegation and responsibilities would need to be established prior to commencing project works to ensure that potential conflict of interest issues would be managed and to prevent confusion to mariners and authorities regarding various traffic control systems.

11.1.9 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.

Figure 11.1 Potential marine logistics hierarchy



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

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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: **7.20.11**

King Edward Memorial Park Foreshore

Appendix A

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

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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	Phase B
Construction phases - Construction of other structures	Phase B
Construction phases - Site demobilisation	Phase C
Permanent works layout	Phase D
River foreshore zones of working	

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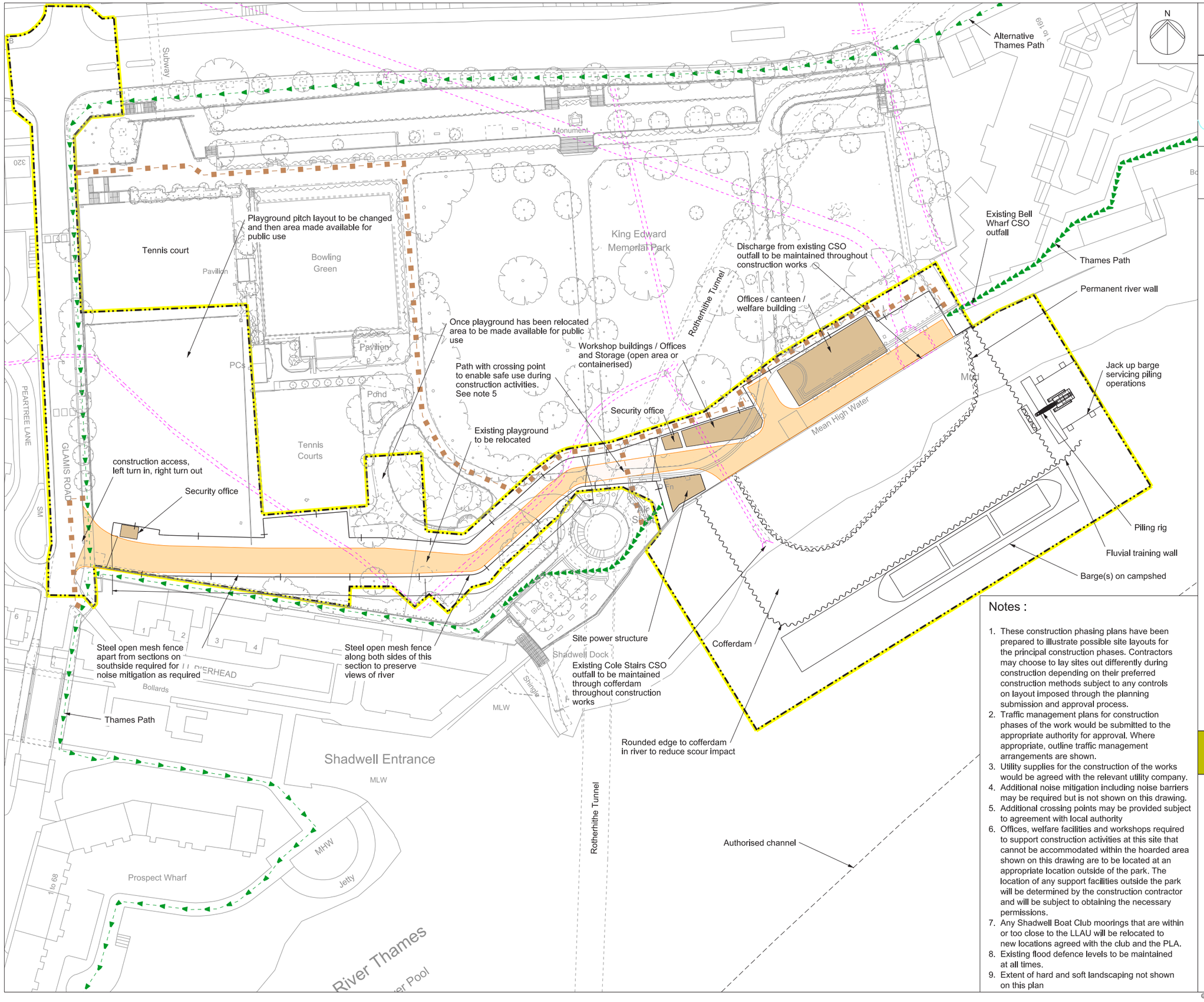

Keyplan:

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 permissive right of way
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal 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. Additional crossing points may be provided subject to agreement with local authority
6. Offices, welfare facilities and workshops required to support construction activities at this site that cannot be accommodated within the hoarded area shown on this drawing are to be located at an appropriate location outside of the park. The location of any support facilities outside the park will be determined by the construction contractor and will be subject to obtaining the necessary permissions.
7. Any Shadwell Boat Club moorings that are within or too close to the LLAU will be relocated to new locations agreed with the club and the PLA.
8. Existing flood defence levels to be maintained at all times.
9. Extent of hard and soft landscaping not shown on this plan

10m 0 40m

Scale 1:500 at A1
1:1000 if reproduced at A3

ILLUSTRATIVE

Location

KIng Edward Memorial Park Foreshore
London Borough of Tower Hamlets

Document Information

Application for Development Consent

Construction phases - phase 1
Site setup
Book of plans - section 25

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January 2013

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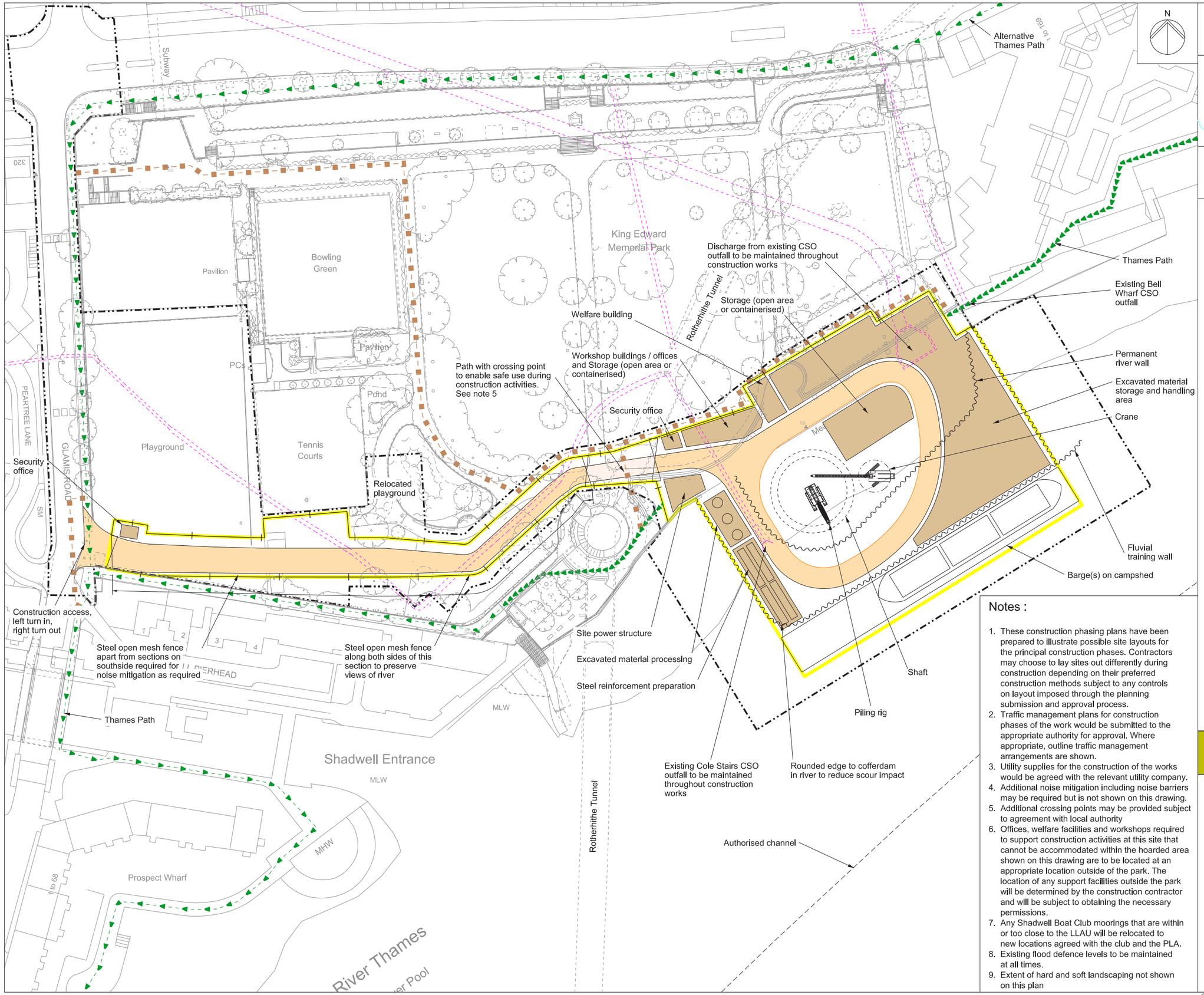
Thames Water



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)
- Hoarding
- Maximum extent of working area
- Existing permissive right of way
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal 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. Additional crossing points may be provided subject to agreement with local authority
6. Offices, welfare facilities and workshops required to support construction activities at this site that cannot be accommodated within the hoarded area shown on this drawing are to be located at an appropriate location outside of the park. The location of any support facilities outside the park will be determined by the construction contractor and will be subject to obtaining the necessary permissions.
7. Any Shadwell Boat Club moorings that are within or too close to the LLAU will be relocated to new locations agreed with the club and the PLA.
8. Existing flood defence levels to be maintained at all times.
9. Extent of hard and soft landscaping not shown on this plan

10m 0 40m

Scale 1:500 at A1
1:1000 if reproduced at A3

ILLUSTRATIVE

Location

KIng Edward Memorial Park Foreshore
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Document Information

Application for Development Consent

Construction phases - phase 2
Shaft construction
Book of plans - section 25

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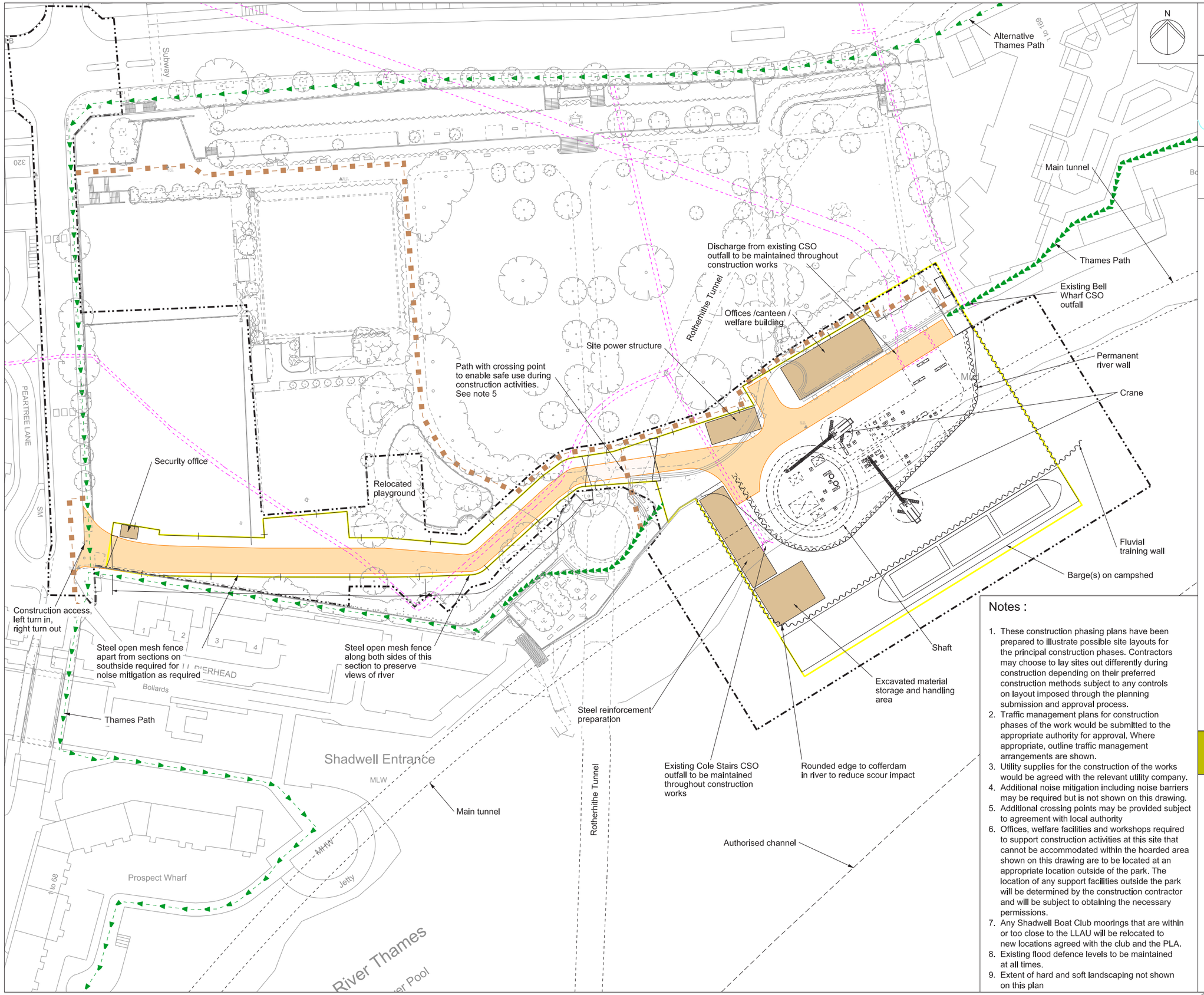

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Keyplan:

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 permissive right of way
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal 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. Additional crossing points may be provided subject to agreement with local authority
6. Offices, welfare facilities and workshops required to support construction activities at this site that cannot be accommodated within the hoarded area shown on this drawing are to be located at an appropriate location outside of the park. The location of any support facilities outside the park will be determined by the construction contractor and will be subject to obtaining the necessary permissions.
7. Any Shadwell Boat Club moorings that are within or too close to the LLAU will be relocated to new locations agreed with the club and the PLA.
8. Existing flood defence levels to be maintained at all times.
9. Extent of hard and soft landscaping not shown on this plan

10m 0 40m

Scale 1:500 at A1
1:1000 if reproduced at A3

ILLUSTRATIVE

Location

King Edward Memorial Park Foreshore
London Borough of Tower Hamlets

Document Information

Application for Development Consent

Construction phases - phase 3
Construction of other structures
Book of plans - section 25

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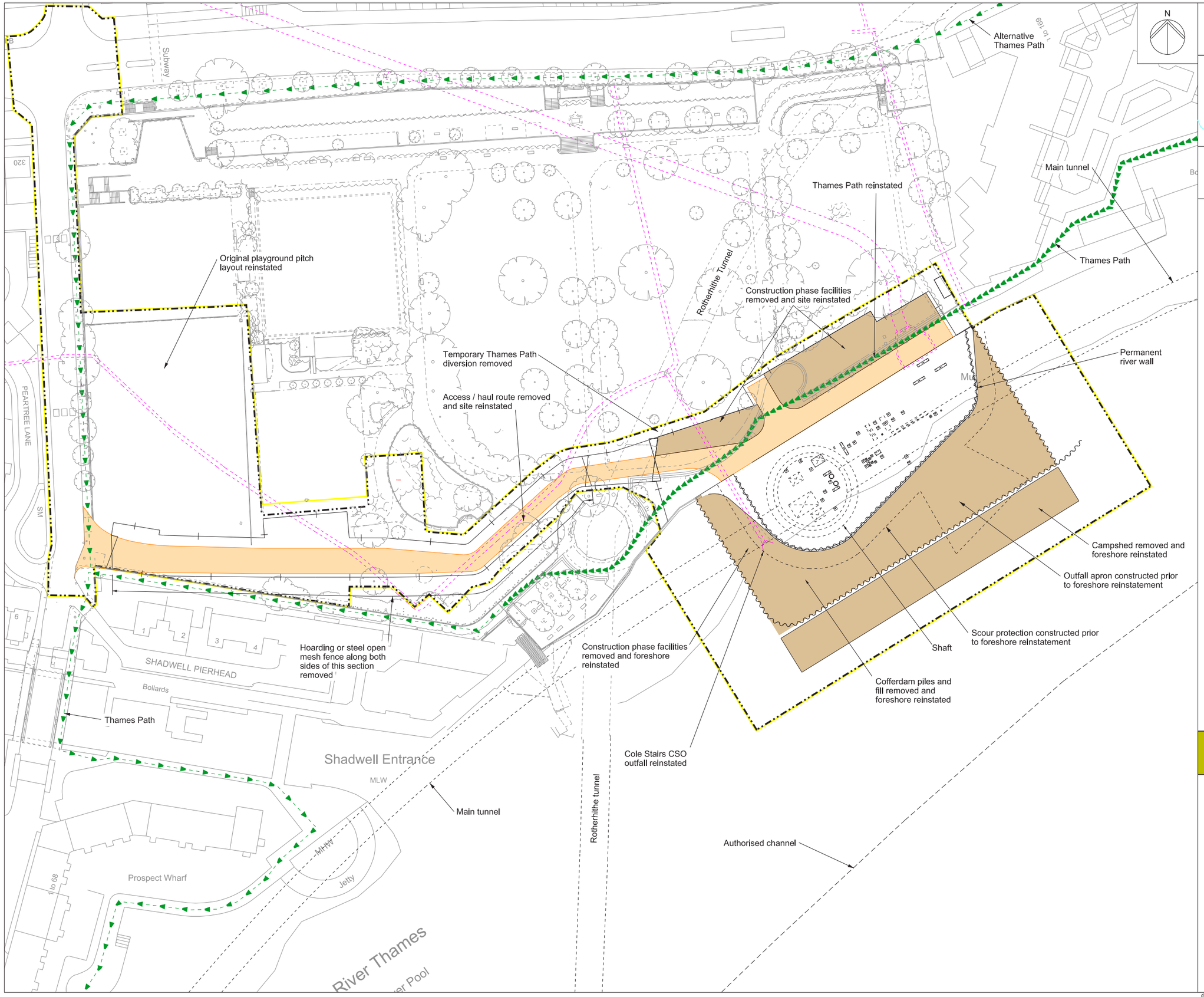

Keyplan:

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 permissive right of way
- Existing public right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles

10m 0 40m

Scale 1:500 at A1
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Location

King Edward Memorial Park Foreshore
London Borough of Tower Hamlets

Document Information

Application for Development Consent

Construction phases - phase 4
Site demobilisation
Book of plans - section 25

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Thames Tideway Tunnel
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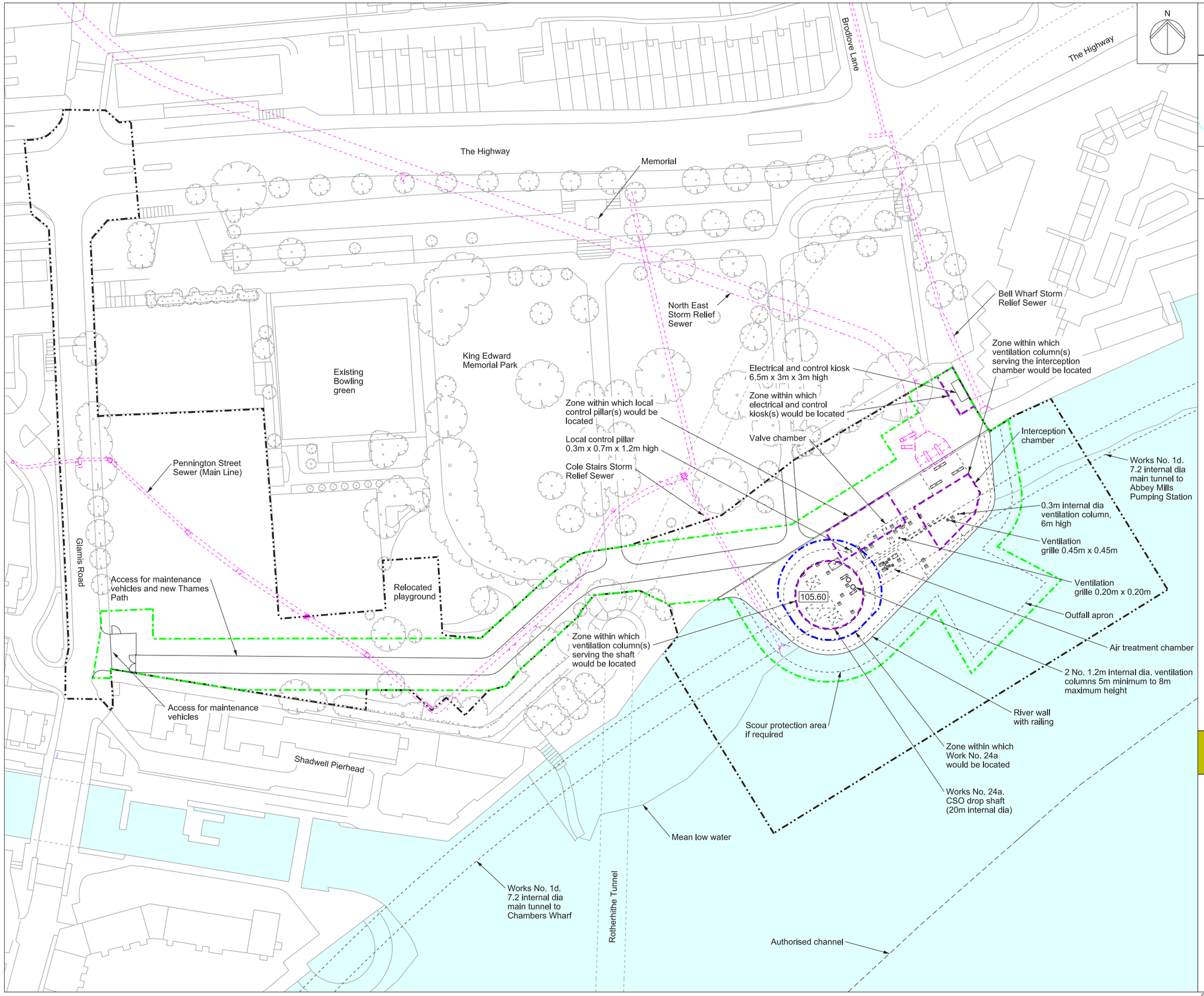
Thames Water



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:

- Local authority boundary
- 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

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.
4. Any Shadwell Boat Club moorings within or too close to the LLAU will be relocated to new locations agreed with the club and PLA.
5. Access road or hardstanding required for vehicle access to electrical and control kiosk (not shown).

10m 0 40m

Scale 1:500 at A1
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Permanent works layout

Book of plans - section 25

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January 2013

Thames Tideway Tunnel
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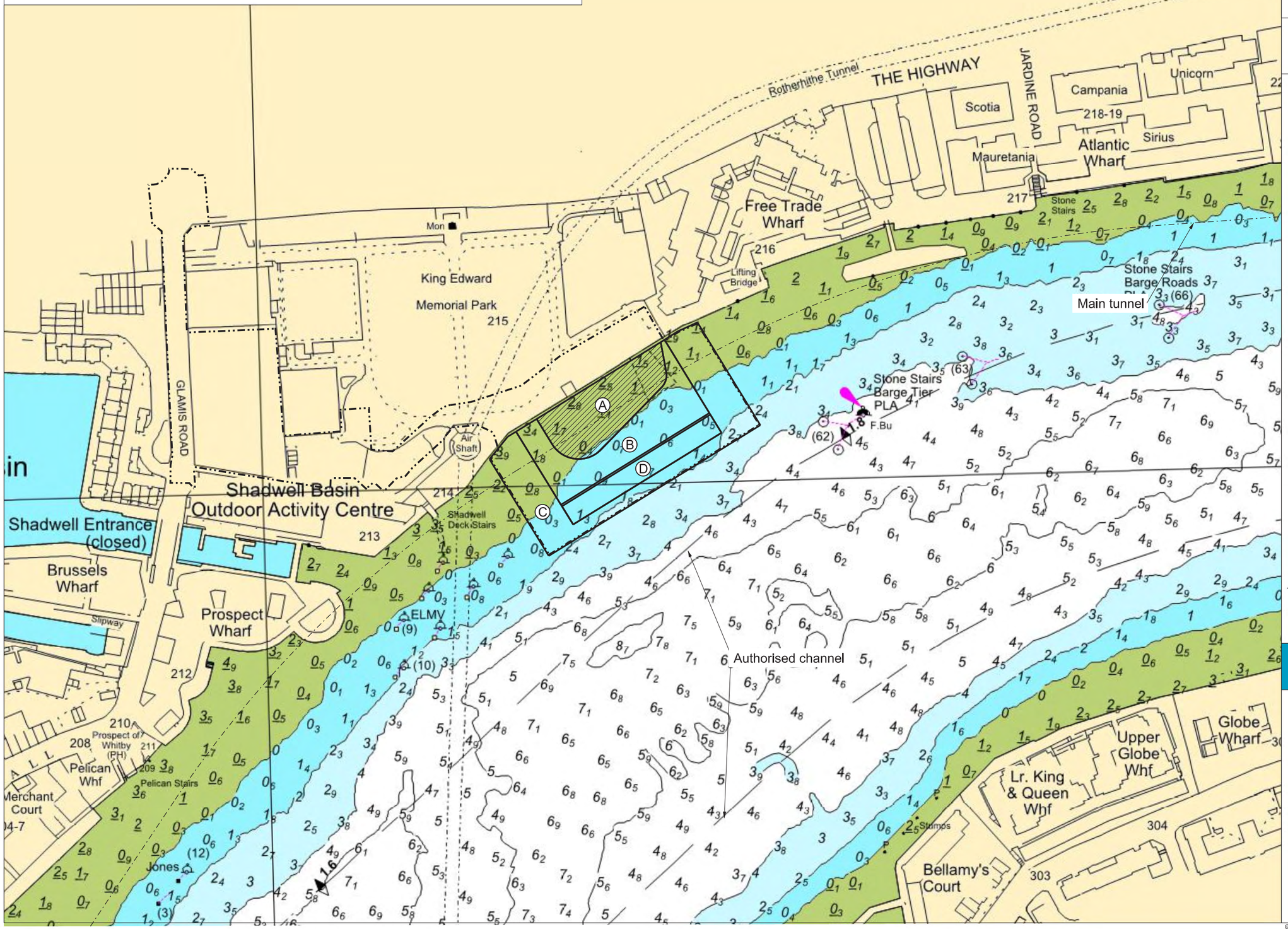
Thames Water

Zone	Description	Constraints
A	Permanent works	Works are permanent and should minimise the extent of encroachment into the river.
B	Long term construction	Temporary cofferdam extents. Works are in place for the duration of the construction period. This area would also include permanent scour protection and permanent outfall apron.
C	Cofferdam construction / removal	Works are relatively short term in nature and should minimise the duration and extent of obstructions into the river as far as reasonably practical. This area would also include permanent scour protection and permanent outfall apron.
D	Barge loading / campshed	Intermittent use throughout the construction period. This area would also include a new outfall apron which is permanent.



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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 - Lower Pool to Limehouse Reach

   Port of London Authority Hydrographic Service

   H.O. Ref. No....113-319-111....Date....30/01/2011

10m 0 100m

Scale 1:1000 at A1
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FOR INFORMATION

Location

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London Borough of Tower Hamlets

Document Information

Application for Development Consent

River foreshore zones of working

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January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.11**

King Edward Memorial Park Foreshore

Appendix B

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

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Thames Tideway Tunnel

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Appendix B: Freight tracks & AIS analysis

B.1 Introduction & Summary

B.1.1 The project propose to use the King Edward Memorial Park (KEMP) site for construction work and to accommodate permanent structures required to operate the main tunnel. The site would be used to intercept the existing North East Storm Relief CSO and connect it to the main tunnel within the foreshore area.

B.1.2 It is proposed that the site at KEMP would contain an interception chamber to intercept the CSO. A connection culvert would link the interception chamber to a drop shaft (approximately 60m deep) through which flows would pass into the main tunnel.

B.1.3 A temporary cofferdam would be required in the foreshore during the construction phase. Permanent structures would be located in a smaller, reclaimed area in the foreshore.

B.1.4 A review of AIS track information of inbound freight movements passing through this section of the river 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.

B.2 Cory Environmental Ltd

Cory Tug & Tow Inbound GPS Tracks

B.2.1 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 B.1 is a GIS output of all tracks overlaid over a chart of the King Edward Memorial Park area.

B.2.2 By individually investigating each of the tracks supplied it was possible to speculate on the potential impacts of the various phases of development.

B.2.3 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 a tug towing at least two barges (side by side). However due to the similarities between the vast majority of these lines, only six have been included in this report. These six (highlighted yellow in Table B.1) represent a good cross section of possible routes taken by Cory Environmental..

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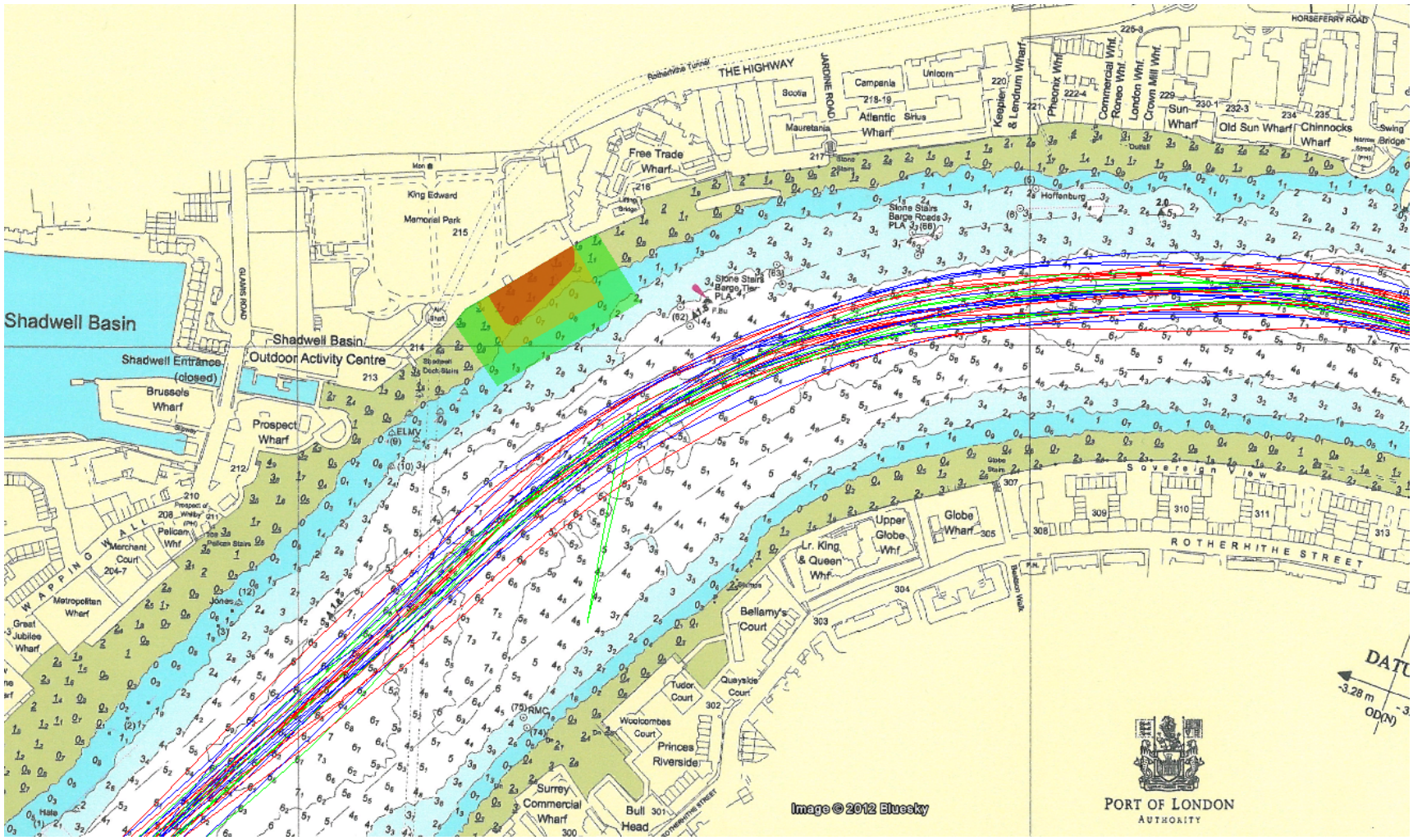
Figure B.1 GPS Tracks of Cory tugs and barges



Cory Track Summary

B.2.4 Table B.1 - Cory AIS Data 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. Wind Direction - Approximate Wind Direction

h. Wind Speed - Wind speed in m/s

i. High tide – time at which high tide was (taken from the PLA 2011 tide times booklet)

j. Tidal height – projected height of tide at Tower Bridge (taken from the PLA 2011 tide times booklet)

k. Figure – reference in this document for the image of the GPS tracks.

Table B.1 Cory AIS Data

Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Figure
07/11/11	Red	Resource	Cringle	Cringle		NE	3	11:21	6.2	
07/11/11	Blue	Reclaim	Cringle	Cringle	Walbrook	NE	3	11:21	6.2	Figure B.2
07/11/11	Green	Recovery	Cringle	Wangas		NE	3	11:21	6.2	
08/11/11	Red	Reclaim	Cringle	Cringle	Cringle	SE	9	12:10	6.5	
08/11/11	Blue	Regain	Cringle	Cringle		SE	8	12:10	6.5	
08/11/11	Green	Resource	Cringle	Cringle	Wangas	SE	8	12:10	6.5	
09/11/11	Red	Resource	Cringle	Walbrook		SE	3	12:51	6.7	
09/11/11	Blue	Recovery	Cringle	Wangas	Wangas	SE	3	12:51	6.7	
09/11/11	Green	Redoubt	Cringle	Cringle	Wangas	SE	5	12:51	6.7	
10/11/11	Red	Resource	Cringle	Cringle	Wangas	E	3	13:27	6.8	
10/11/11	Blue	Regain	Cringle	Cringle	Wangas	E	4	13:27	6.8	Figure B.3
11/11/11	Red	Reclaim	Cringle	Cringle	Wangas	E	4	14:00	6.9	Figure B.4
11/11/11	Blue	Recovery	Walbrook	Cringle		SE	4	14:00	6.9	
11/11/11	Green	Resource	Cringle	Cringle	Wangas	SE	4	14:00	6.9	
14/11/11	Red	Resource	Wangas	Cringle		E	4	15:39	6.9	

Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Figure
14/11/11	Blue	Recovery	Walbrook	Cringle		E	4	15:39	6.9	
14/11/11	Green	Regain	Wangas	Cringle		E	4	15:39	6.9	
16/11/11	Red	Redoubt	Walbrook	Cringle		SE	3	16:55	6.7	
16/11/11	Blue	Reclaim	Cringle	Cringle	Cringle	E	3	16:55	6.7	Figure B.5
16/11/11	Green	Recovery	Cringle	Wangas	Cringle	E	3	16:55	6.7	
17/11/11	Red	Redoubt	Cringle	Cringle	Cringle	SW	5	17:40	6.6	
17/11/11	Blue	Reclaim	Wangas	Wangas		SW	5	17:40	6.6	
18/11/11	Red	Regain	Cringle	Wangas	Cringle	S	5	18:33	6.4	
18/11/11	Blue	Recovery	Cringle	Cringle		S	4	18:33	6.4	Figure B.6
22/11/11	Red	Regain	Wangas	Wangas		E	2	10:34	6.5	
22/11/11	Blue	Recovery	Cringle	Cringle	Cringle	E	2	10:34	6.5	
22/11/11	Green	Reclaim	Cringle	Cringle		E	2	10:34	6.5	
23/11/11	Red	Reclaim	Wangas	Wangas		SW	2	11:35	6.8	
23/11/11	Blue	Redoubt	Cringle	Walbrook		SW	2	11:35	6.8	
23/11/11	Green	Regain	Transponder on tug			SW	2	11:35	6.8	
24/11/11	Red	Resource	Wangas	Wangas		SW	4	12:31	7.1	Figure B.7

Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Figure
24/11/11	Blue	Reclaim	Cringle	Cringle	Cringle	SW	4	12:31	7.1	
24/11/11	Green	Recovery	Cringle	Cringle	Cringle	SW	4	12:31	7.1	
25/11/11	Red	Resource	Walbrook	Cringle		W	10	13:22	7.2	
25/11/11	Blue	Recovery	Wangas	Wangas		W	10	13:22	7.2	
25/11/11	Green	Redoubt	Cringle	Cringle	Cringle	W	10	13:22	7.2	

Cory Individual Tracks

Figure B.2 07/11/2011 - Blue Track image

Figure B.3 10/11/2011 - Blue Track image

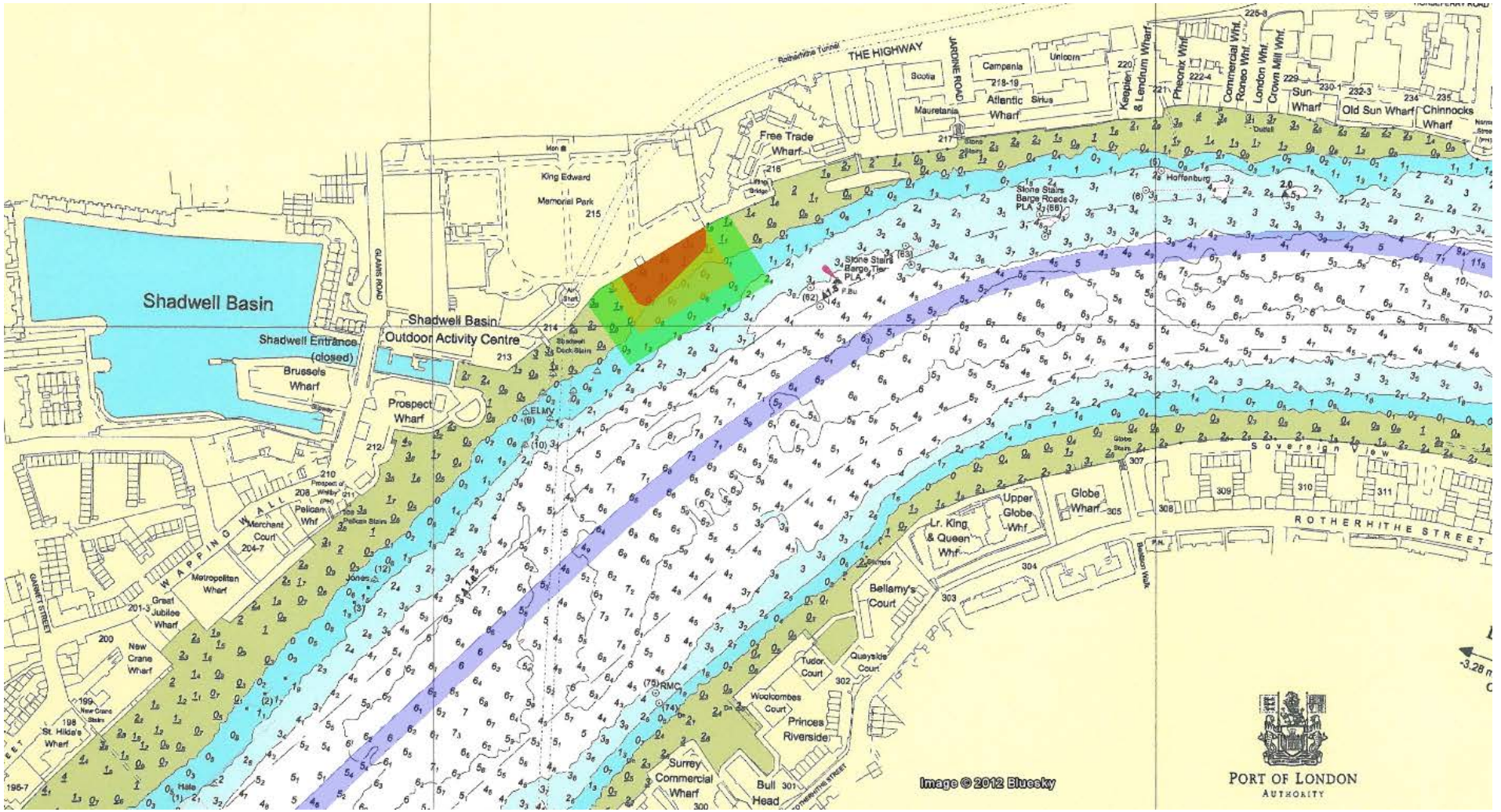


Figure B.4 11/11/2011 - Red Track image

Figure B.5 16/11/2011 – Blue Track image

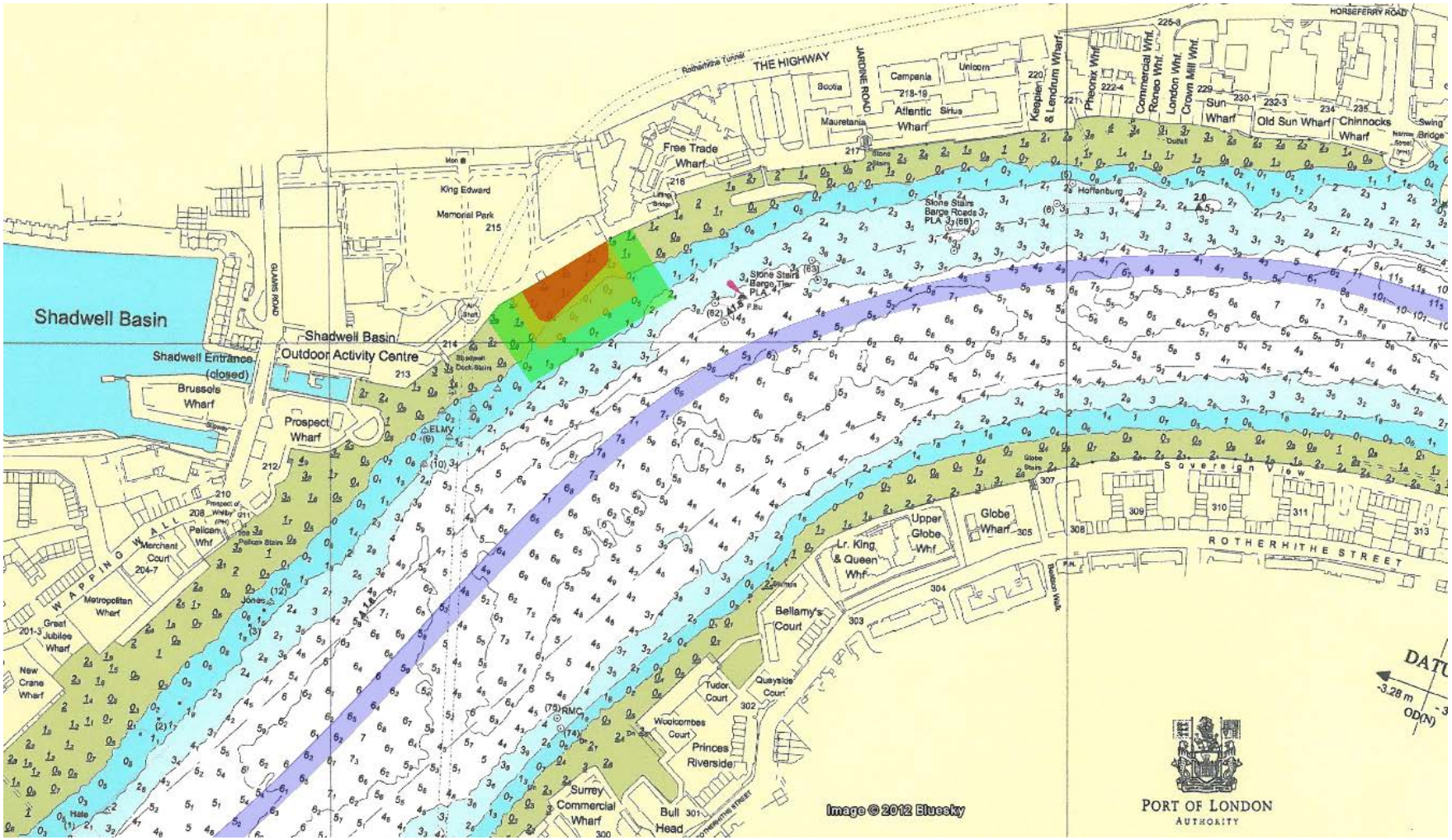


Figure B.6 18/11/2011 - Blue Track image

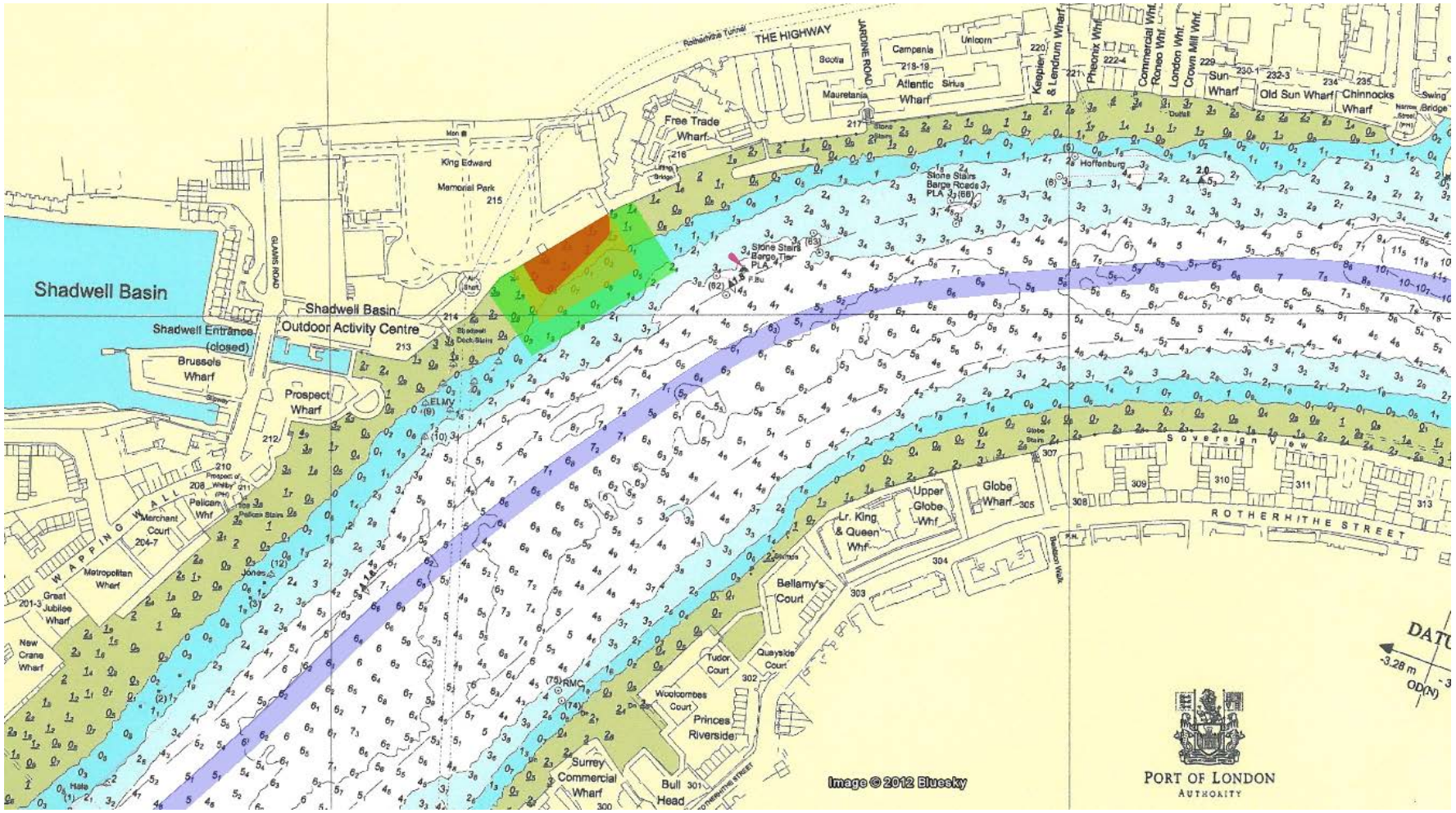


Figure B.7 24/11/2011 - Red Track image

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