Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.07**

Chelsea Embankment Foreshore

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

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January 2013

Thames Tideway Tunnel

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Thames Tideway Tunnel

Navigational Issues and Preliminary Risk Assessment: Chelsea Embankment Foreshore

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Chelsea Embankment Foreshore

Main Report

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1 Executive summary

1.1 Purpose

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

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

1.1.3 The preliminary risk assessment follows 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:

Phase A: construction of cofferdam

Phase B: construction of drop shaft/culvert/connections

Phase C: removal of cofferdam

Phase D: permanent works site

1.2 Issues to be addressed

1.2.1 The proposed Chelsea Embankment Foreshore site lies approximately 200m west of Chelsea Bridge on the north bank of the River Thames. The outer boundary of the cofferdam is approximately 27m from the designated authorised channel in this area. Part of the Limits of land to be acquired or used (LLAU) lies within the authorised channel, and represents a hazard that is considered within this report.

1.2.2 The outer line of the LLAU encroaches up to 11m into the authorised channel. These outer areas will only be required as working area in the event of poor ground conditions being encountered whilst connecting the site to the main tunnel.

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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 Chelsea Embankment Foreshore site. The report informs the *Transport Assessment and Environmental Statement* and the PLA approval process.

2.2 Introduction

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

2.2.2 The project comprises the following elements:

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

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

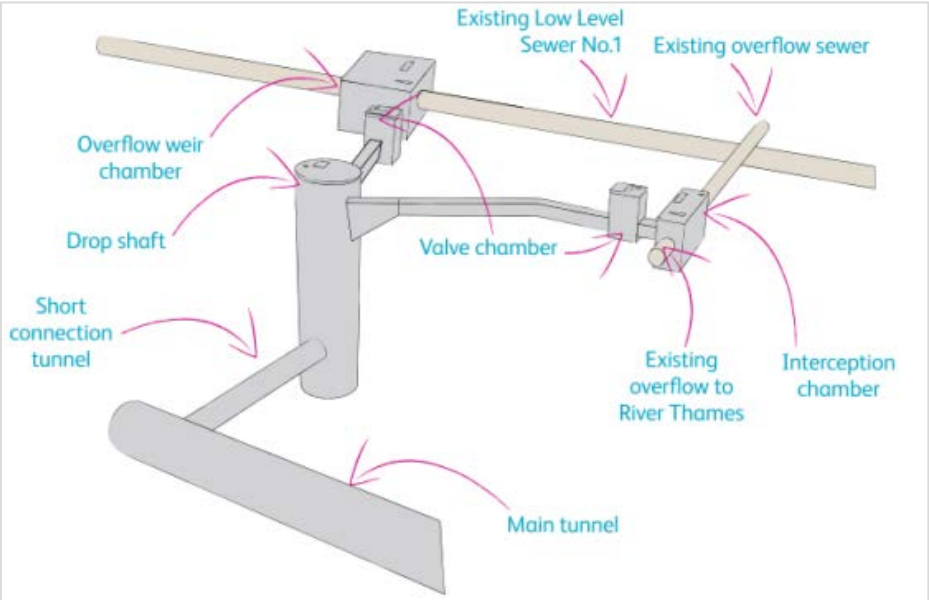
c. control of two CSOs by locally modifying the sewerage system requiring two system modification sites

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

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

2.2.4 The Chelsea Embankment Foreshore CSO site would be required to intercept the Ranelagh CSO and also to control other CSOs located in central London via a connection to the northern Low Level Sewer No.1, 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 Chelsea Embankment Foreshore site would accommodate:

a. a CSO drop shaft – 12m internal diameter, approximately 45m deep
b. a connection to the Ranelagh CSO outfall
c. an overflow weir chamber on the northern Low Level Sewer No.1 located within the existing river wall structure
d. connection culverts and valve chambers
e. air management structures
f. 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 limits of land to be acquired or used (LLAU) for this site extends approximately 80 meters from the shoreline. The LLAU extends into the authorised channel by approximately 11m.

2.3.2 This 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 lists the various design, construction and site layout drawings.

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:

Phase A: construction of cofferdam

Phase B: construction of drop shaft/culvert/connection tunnel

Phase C: removal of cofferdam

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 A campshed would be constructed in the foreshore adjacent to the eastern wall of the cofferdam.

2.7 Phase B: Drop shaft, culvert and connections construction

2.7.1 The CSO drop shaft would be constructed by sprayed concrete lining or by precast segmental lining using caisson and underpinning. The connection tunnel would be constructed by sprayed concrete linings and the interception chambers by traditional reinforced concrete structures.

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

2.7.3 There may be a requirement to place a jack-up barge within the authorised channel during construction of the connection tunnel. This would be necessary should there be poor ground conditions requiring ground treatment for the construction of the connection tunnel. Should there be a requirement to place a jack-up barge further in to the authorised channel, it is proposed that this activity is covered under a separate risk assessment, similar to those conducted for the borehole sampling activities undertaken as part of site investigation work for the project.

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 25m into the river from the foreshore and is greater than 40m away from the authorised channel

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3 Study aim and area

3.1 Introduction

3.1.1 The aim of this assessment is to identify and assess navigational hazards project-specific to construction activities at the Chelsea Embankment Foreshore 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 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 AIS data were undertaken in order to provide a comprehensive understanding of the operations specific to the 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 Chelsea Bridge, and the effects on river traffic beneath the bridge have been taken into consideration within this assessment.

3.1.6 The project proposes to use barges during Phases A and C, to bring in and take away the material used to fill the cofferdam and during phase B to remove excavated material.

3.2 General navigation

3.2.1 The site is located within the Battersea section of the River Thames and is included in PLA Chart No 314.

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 Bridges

3.3.1 Chelsea Bridge has three main arches, all three of which are navigable (dependant on tide and vessel characteristics) with arch No2 designated as the working arch.

Table 3.1 Individual arch bridge clearances above Mean High Water Springs

(Chelsea Bridge)

Bridge Arch	1	**2**	3
Arch Clearance	6.3 m	**6.6 m**	6.3 m

Table 3.2 Arch No2 bridge clearance

(Chelsea Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	13.0 m	7.8 m	12.3 m	12.8 m	6.1 m

3.3.2 Victoria Rail Bridge has four main arches, with arches No2 and 3 designated as working arches.

Table 3.3 Arch bridge clearances above Mean High Water Springs (Victoria Rail Bridge)

Bridge Arch	1	**2**	**3**	4
Arch Clearance	6.0 m	**6.1 m**	**6.0 m**	6.0 m

Table 3.4 Arch No3 bridge clearance

(Victoria Rail Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	12.4 m	7.2 m	11.7 m	12.2 m	5.5 m

3.3.3 Westminster Bridge has the lowest available navigational arch clearance heights of the remaining bridges in the central London area.

3.3.4 Westminster Bridge has seven main arches, all of which are available for navigation with arches No3, 4, 5 and 6 designated as working arches.

Table 3.5 Individual arch bridge clearances Mean High Water Springs

(Westminster Bridge)

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

Table 3.6 Arch No4 bridge clearance heights above (Westminster Bridge)

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

3.4 The authorised channel

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

3.4.2 The authorised channel in the Chelsea Embankment Foreshore area varies between 90m and 100m wide and incorporates the working arches of Chelsea Bridge and Victoria Rail Bridge.

3.4.3 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".

3.5 Tide set

3.5.1 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.

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

3.5.3 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.

3.5.4 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.

3.5.5 The tide set in and around Chelsea Bridge is assessed as 'Slight to the North' on the flood tide and 'Moderate to the North' on the ebb tide.

3.6 Existing river users and local speed limits

3.6.1 In order for the project team to gain a greater understanding of typical vessels likely to be on the river within the study area and to aid the risk assessment process, vessel surveys were conducted.

3.6.2 The PLA is actively encouraging the use of the tidal Thames for recreational boat users, with a dedicated website www.boatingonthethames.co.uk that provides advice, guidance and safety information to a wide variety of leisure users

3.6.3 The PLA provide practical advice and guidance for recreational river users, including[1]:

> *Primarily at weekends, large numbers of recreational craft manoeuvre above Chelsea Embankment. Motor vessels must therefore observe the 8 knot speed limit at all times and pay special attention to their wash. If you are navigating an unpowered craft, you must be familiar with the code of practice for paddle powered vessels which is on the PLA website* - www.boatingonthethames.co.uk

3.6.4 On Sunday 1st July 2012 the new Port of London Thames Byelaws 2012 came into effect. Whilst the majority of byelaws remained unchanged, several were revised and a number of new byelaws were introduced.

3.6.5 Byelaw 16 - Speed Limits were revised and is of particular relevance to existing river users in this study area. By way of a notice to mariners, an available exemption to the existing speed limits above Margaretness and below Wandsworth has been introduced. The exemption applies to a vessel providing it meets certain qualifying criteria e.g. wash characteristics, vessel design, an improved passage plan that includes considerations for moving through the river at high speeds etc.

3.6.6 The speed limit for those who do not have an exemption would be 12 knots from Magaretness to Wandsworth, then 8 knots from Wandsworth up (west), providing that the wash does not exceed acceptable proportions.

3.6.7 For those with an exemption, such as Thames Clipper, the following applies:

> Where the harbourmaster has issued a certificate of compliance, which allows the vessel, subject to continued compliance with the International Collision Regulations (as modified by these byelaws), to navigate up to but not exceeding a speed of:

[1] Port of London Authority - 'The River Users Guide for the tidal River Thames' Side Two - Teddington to Broadness

i 25 knots through, on or over the water in the area of the Thames between Wandsworth Bridge and Lambeth Bridge, and

ii 30 knots through, on or over the water in the area of the Thames between St Saviour's Dock and the Margaretness limit.

3.7 Existing vessel traffic movements

3.7.1 A number of freight operators service wharves upriver of the Chelsea Embankment Foreshore site, these include;

a. GPS Marine - aggregates delivery to Pier Wharf

b. Cory Environmental Ltd - waste transfer service to Smugglers Way.

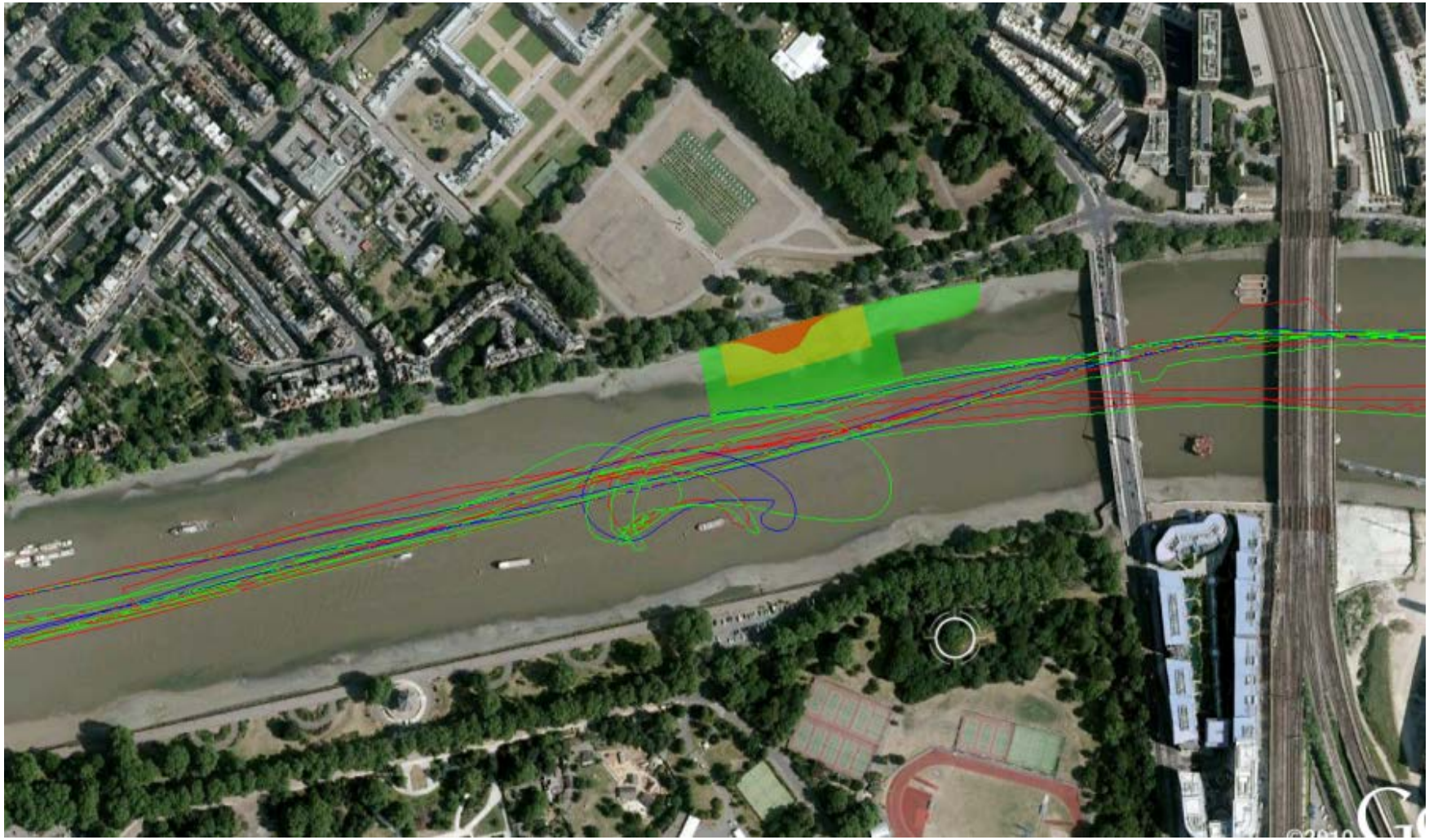
3.7.2 The majority of inward bound freight movements can be expected to pass through the study area around two hours before high water, providing them with sufficient time to reach wharves further upriver. For outbound transits, Cory Environmental Ltd vessels can be expected an hour before high water and GPS Marine Ltd about an hour after high water due to the fact that they are moving empty barges and therefore require a little more headroom on the tides.

3.7.3 Figure 3.1 shows inbound Cory tug/barge movements in this area; note the occasional usage of the mooring points directly opposite the proposed development site.

3.7.4 The Thames is used by tourists as a means of sightseeing and consequently traffic levels are seasonal with the greatest tourist traffic being in the summer months. Throughout Central London, sightseeing vessels tend to operate on the river all day, with lunchtime/afternoon sightseeing cruises being most popular. These tours concentrate on the main landmarks and as such, the majority of sightseeing tours tend not to operate within the study area of this report.

3.7.5 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

Figure 3.1Cory Environment AIS data tracks at Chelsea Embankment



4 Summary of navigational issues

4.1 Interaction with existing river traffic

4.1.1 There are fewer scheduled services in the upper part of the river with only Complete Pleasure Boats operating above St George Wharf pier at Vauxhall and onwards to Putney. This service operates only during AM and PM peak hours (3 boats in the morning and 3 boats in the evening). There is also one river tour service operated by the Passenger Services Association (4 to 5 boats per day in each direction).

4.1.2 There are also occasional charter boats that transit past this site.

4.1.3 Several freight operators service piers/wharves upriver, including:

a. Cory Environmental Ltd - Waste transfer service to Smugglers Way/Wangas Wharf

b. GPS Marine Ltd - Aggregates service to Pier Wharf.

4.1.4 It has been observed that Cory occasionally use the moorings opposite the Chelsea Embankment Foreshore site as part of their operations to Smugglers Way/Wangas Wharf.

4.1.5 There is less commercial traffic in this reach compared with the Central London area. Leisure vessels, rowers and others based further upriver are likely to be seen more frequently here than at locations further downstream.

4.2 Proximity to Chelsea Bridge

4.2.1 Chelsea Bridge has one designated working arch, arch No2. Arch No2 is normally used by all vessels heading both upstream and downstream, subject to the height of the tide.

4.2.2 The temporary works are located in line with arch No1 which is currently unused as it is obstructed by barges moored at the bridge. It is expected that the arch would remain open, but would continue to be obstructed by the barges moored at the railway bridge during construction works.

4.3 Wash

4.3.1 Thames Clippers permitted to pass through this reach at 25 knots and are known to generate wash. This could cause barges that are berthed at the cofferdam to break out of their moorings if they are not sufficiently secured.

4.4 Houseboats at Cadogan Pier

4.4.1 These houseboats are 800m upstream from the site and a project barge breaking away from its mooring could impact upon the houseboats permanently moored at Cadogan Pier.

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5 Stakeholder consultation

5.1 Consultation meetings

5.1.1 Several meetings were held with Cory at their Farringdon Office and Cringle Dock Waste Transfer Facility. Cory have moorings opposite the site and also transit past the site on their way to the Smugglers Way waste transfer station. The site at Chelsea, along with navigational issues, was discussed during that meeting and no objections were raised by Cory.

5.1.2 At a meeting with the PLA on Monday 2 July2012, the marine issues associated with the site were presented and agreed in principle.

5.1.3 Liaison with Cory, Thames Clippers, PLA and other stakeholders are ongoing.

5.2 Observation notes

5.2.1 Direct observation of this site was not conducted, however, AIS analysis was performed making use of data supplied by Cory. This analysis can be found within Appendix B.

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6 Risk assessment

6.1 Risk assessment: Methodology

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

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

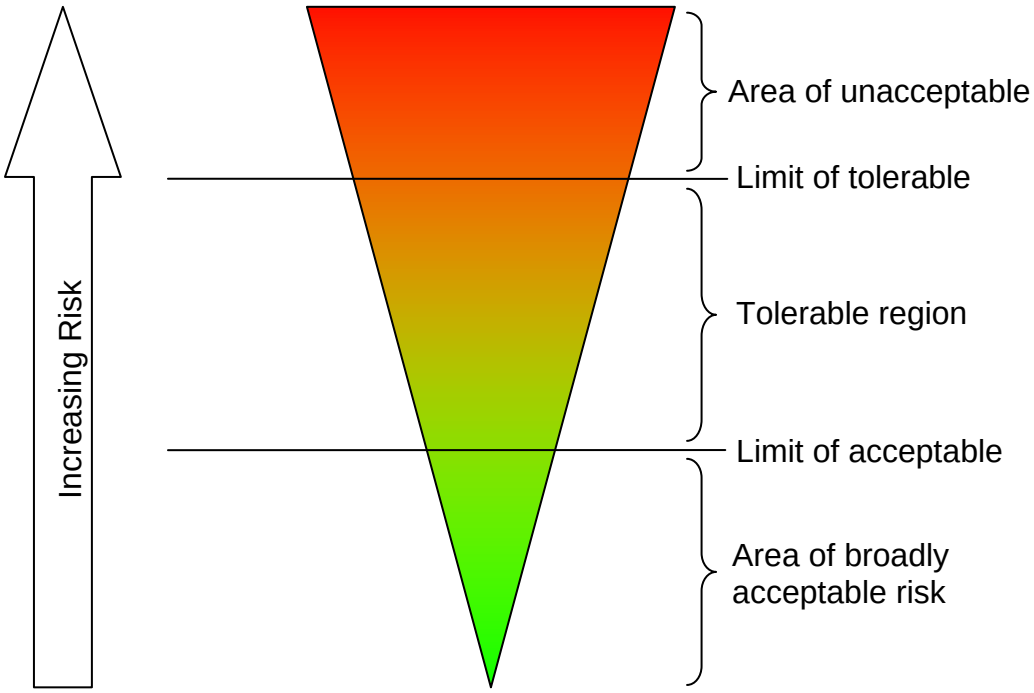
b. Risk: a relative measure of harm or loss, derived from the combination of the severity of a particular consequence together with the probability of the consequence occurring.

c. Consequence: a particular scenario (expressed as harm to people, damage to the environment, an operational impact and/or negative media attention) that results 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 an 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. However, the site at Chelsea Embankment Foreshore was not included in this physical model.

6.5 Mitigation strategy

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

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 (eg. 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 Appendix B of this report contains detailed analysis of vessel tracks through the Chelsea Reach area of the Thames, including tracking data for Cory Environmental Ltd. The data showed that Cory tug and tows used the centre arch of Chelsea Bridge on inbound and outbound transits.

7.2 Interaction with existing river traffic

7.2.1 A number of freight operators service piers or wharves upstream of this site, including:

a. Cory Environmental Ltd: waste transfer service to Smugglers Way/Wangas Wharf;

b. GPS Marine Ltd: aggregates service to Pier Wharf.

7.2.2 It has been observed that Cory occasionally use the moorings opposite the Chelsea Embankment Foreshore site as part of their operations to Smugglers Way/Wangas Wharf.

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

Actions required

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

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

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

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

Mitigation of issues: Design

7.2.5 Designing the project has been an iterative process, influenced by the ongoing navigational risk assessment process. Measures to eliminate or reduce navigational hazards identified in early risk assessments were embedded into the design of the temporary and permanent works to eliminate or reduce navigational hazards. This assessment therefore assesses the residual risk assuming the effective implementation of these measures. The embedded measures include:

a. The temporary cofferdam would be at least 28 from the authorised channel and barges moored at it would be at least 15 from the authorised channel.

7.2.6 Although the LLAU extends into the authorised channel to provide the ability to undertake ground treatment from a jack-up barge should bad ground conditions be encountered on the connection tunnel, most of the works would be undertaken outside of the authorised channel. Constraints have been placed on the working areas within the river to minimise the duration and extent of obstructions in the river. Should there be a requirement to place a jack-up barge further in to the authorised channel, it is proposed that this activity is covered under a separate risk assessment, similar to those conducted for the borehole sampling activities undertaken as part of site investigation work for the project.

7.2.7 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 to existing users

b. meeting with Cory Environmental Ltd 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 barges 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.

7.3 Proximity to Chelsea Bridge

7.3.1 Chelsea Bridge has one designated working arch, arch No2. The arch is normally used by all vessels heading both upstream and downstream, subject to the height of the tide.

7.3.2 It is expected that the arch would remain open, but would continue to be obstructed by the barges moored at the railway bridge during construction works.

Actions required

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

a. Conduct analysis of vessel movements through Chelsea Bridge to ascertain potential project impact on an arch closure.

Mitigation of issues: Design

7.3.4 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 works would be approximately 200m upstream of Chelsea Bridge. The location of the shaft was moved upstream following phase one consultation, increasing the distance to the bridge.

b. Planned closure of arch No2 should not take place during the works. General bridge inspections are carried out every 2 years, but do not require closure of the arch. Principal bridge inspections are carried out every six years. Principal bridge inspections would be conducted immediately prior to project work commencing.

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

Mitigation of issues: Physical

7.3.6 None identified

Mitigation of issues: River operations

7.3.7 None identified

7.4 Houseboats at Cadogan Pier

7.4.1 These houseboats are 800m upriver from the site. As with all sites associated with the project, mooring arrangements would need to take into consideration the tidal conditions and the speed of passing vessels to ensure that barges are moored securely and that the likelihood of a barge breakout is reduced.

7.5 Wash

7.5.1 Thames Clippers operate a high speed service which passes the site at higher speed than on most other sections along the river.

Actions required

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

a. consider the case of potential barge break out caused by Thames Clippers passing the site at speed during the design stage of the project.

Mitigation of issues: Physical

7.5.3 Mitigation measures include:

provide moorings for construction barges that would tolerate wash/draw-off from passing high-speed Thames Clippers

8 General navigational hazards

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

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

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

8.2 Project phases A to D: Most likely

Table 8.1 Most likely risk scores

				Score			
Hazard Id	Hazard title	Hazard description	Phase	People	Environment	Operational	Media
1	Emergency arch closure - arch No2	There may be an emergency requirement to close arch No2.	A	8	4	6	6
			B	8	4	6	6
			C	8	4	6	6
			D	8	4	6	6
2	Planned arch closure - arch No2	There may be a requirement to close arch No2 for maintenance.	A	8	4	6	6
			B	8	4	6	6
			C	8	4	6	6
			D	N/A	N/A	N/A	N/A
3	Planned arch closure - arch No1	During construction/use/deconstruction of the temporary cofferdam, the project proposes to close arch No1 to all navigation.	A	12	6	12	6
			B	12	6	12	6
			C	12	6	12	6
			D	N/A	N/A	N/A	N/A
4	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels, particularly through the arches of Chelsea or Victoria Rail Bridge.	A	9	6	6	9
			B	9	6	6	9
			C	9	6	6	9
			D	9	6	6	9

5	Contact - High Speed Passenger Vessel with worksite	A High Speed Passenger Vessel comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D				
	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
7	Contact - private leisure vessel with worksite	A private leisure vessel comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
8	Contact - commercial freight operator with worksite	A commercial freight operator comes into contact with the project's temporary or permanent work site at Chelsea Embankment Foreshore.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
9	Contact - tug and tow with worksite	A tug and tow comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
10	Grounding - all vessels due to 'Squat Effect'	At periods of low water, vessels may be affected by the 'Squat Effect', causing them to be closer to the river bed than expected.	A	6	2	6	6
			B	6	2	6	6
			C	6	2	6	6
			D	6	2	6	6

11	Mooring Breakout	A vessel involved in project activities breaks free from moorings	A	6	4	6	4
			B	6	4	6	4
			C	6	4	6	4
			D	N/A	N/A	N/A	N/A
12	Collision - High Speed Passenger Vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a High Speed Passenger Vessel (e.g. Thames Clipper) in the vicinity of Chelsea Embankment Foreshore	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
13	Collision - Class V passenger vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a Class V passenger vessel in the vicinity of Chelsea Embankment Foreshore.	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
14	Collision - private leisure vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a private leisure vessel in the vicinity of Chelsea Embankment Foreshore.	A	9	6	9	9
			B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
15	Collision - commercial freight operator (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a commercial freight operator in the vicinity of Chelsea Embankment Foreshore.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	9	6	9
			D	N/A	N/A	N/A	N/A
16	Collision - tug and tow (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a tug and tow in the vicinity of Chelsea Embankment. Foreshore	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	9	6	9
			D	N/A	N/A	N/A	N/A
17	Contact - Chelsea or Victoria Bridge (construction/de construction)	A vessel conducting project construction/deconstruction activities makes contact with Chelsea or Victoria Bridge, including arches, abutments and any associated bridge superstructure.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	3	6	6
			D	N/A	N/A	N/A	N/A
18	Collision - High Speed Passenger Vessel (delivery/materia l removal)	A vessel conducting project delivery/material removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

19	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 Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
20	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 Chelsea Embankment Foreshore.	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
21	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 Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	6	9	6	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
22	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 Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	6	9	6	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
23	Contact with Chelsea or Victoria Bridge (delivery/material removal)	A vessel conducting project delivery/material removal activities makes contact with Chelsea or Victoria Bridge, including arches, abutments and any associated bridge superstructure.	A	N/A	N/A	N/A	N/A
			B	6	3	6	6
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

8.3 Project phases A to D: Worst case

Table 8.2 Most likely risk scores

				Score			
Hazard Id	**Hazard title**	**Hazard description**	**Phase**	**People**	**Environment**	**Operational**	**Media**
1	Emergency arch closure - arch No2	There may be an emergency requirement to close arch No2.	A	5	3	4	4
			B	5	3	4	4
			C	5	3	4	4
			D	5	3	4	4
2	Planned arch closure - arch	There may be a requirement to close arch No2 for	A	5	3	4	4
			B	5	3	4	4

	No 2	maintenance.	C	5	3	4	4
			D	N/A	N/A	N/A	N/A
3	Planned arch closure - arch No1	During construction/use/deconstruction of the temporary cofferdam, the project proposes to close arch No1 to all navigation.	A	10	6	10	6
			B	10	6	10	6
			C	10	6	10	6
			D	N/A	N/A	N/A	N/A
4	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels, particularly through the arches of Chelsea or Victoria Rail Bridge.	A	12	9	9	12
			B	12	9	9	12
			C	12	9	9	12
			D	12	9	9	12
5	Contact - High Speed Passenger Vessel with worksite	A High Speed Passenger Vessel comes into contact with project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	10	6	8	10
			B	10	6	8	10
			C	10	6	8	10
			D	10	6	8	10
6	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	10	6	8	10
			B	10	6	8	10
			C	10	6	8	10
			D	10	6	8	10
7	Contact - private leisure vessel with worksite	A private leisure vessel comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	10	6	8	8
			B	10	6	8	8
			C	10	6	8	8
			D	10	6	8	8
8	Contact - commercial freight operator with worksite	A commercial freight operator comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore.	A	8	6	8	6
			B	8	6	8	6
			C	8	6	8	6
			D	8	6	8	6
9	Contact - tug and tow with worksite	A tug and tow comes into contact with the project's temporary or permanent worksite at Chelsea Embankment Foreshore .	A	8	6	8	6
			B	8	6	8	6
			C	8	6	8	6
			D	8	6	8	6
10	Grounding - all vessels due to 'Squat Effect'	At periods of low water, vessels may be affected by the 'Squat Effect', causing them to be closer to the river bed than expected.	A	8	4	8	8
			B	8	4	8	8
			C	8	4	8	8
			D	8	4	8	8
11	Mooring breakout	A vessel involved in project activities breaks free from	A	8	6	8	6
			B	8	6	8	6

		moorings.	C	8	6	8	6
			D	N/A	N/A	N/A	N/A
12	Collision - High Speed Passenger Vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Chelsea Embankment Foreshore	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
13	Collision - Class V passenger vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a Class V passenger vessel in the vicinity of Chelsea Embankment Foreshore.	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	8	4	6	8
			D	N/A	N/A	N/A	N/A
14	Collision - private leisure vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a private leisure vessel in the vicinity of Chelsea Embankment Foreshore.	A	8	6	8	8
			B	N/A	N/A	N/A	N/A
			C	8	6	8	8
			D	N/A	N/A	N/A	N/A
15	Collision - commercial freight operator (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a commercial freight operator in the vicinity of Chelsea Embankment Foreshore.	A	9	12	9	9
			B	N/A	N/A	N/A	N/A
			C	9	12	6	6
			D	N/A	N/A	N/A	N/A
16	Collision - tug and tow (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a tug and tow in the vicinity of Chelsea Embankment Foreshore.	A	9	12	9	9
			B	N/A	N/A	N/A	N/A
			C	9	12	9	9
			D	N/A	N/A	N/A	N/A
17	Contact with Chelsea or Victoria Bridge (construction/de construction)	A vessel conducting project construction/deconstruction activities makes contact with Chelsea or Victoria Bridge, including arches, abutments and any associated bridge superstructure.	A	9	6	9	9
			B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
18	Collision - High Speed Passenger Vessel (delivery/materia l removal)	A vessel conducting project delivery/material removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Chelsea Embankment Foreshore	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
19	Collision - Class V passenger	A vessel conducting project delivery/material removal	A	N/A	N/A	N/A	N/A
			B	6	4	6	8

	vessel (delivery/material removal)	activities collides with a Class V passenger vessel in the vicinity of Chelsea Embankment Foreshore.	C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
20	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 Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	8	6	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
21	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 Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	9	12	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
22	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 Chelsea Embankment Foreshore.	A	N/A	N/A	N/A	N/A
			B	9	12	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
23	Contact with Chelsea or Victoria Bridge (delivery/material removal)	A vessel conducting project delivery/material removal activities makes contact with Chelsea or Victoria Bridge, including arches, abutments and any associated bridge superstructure.	A	N/A	N/A	N/A	N/A
			B	9	6	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

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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 most relevant to the project operations.

9.2 Proposed mitigation

9.2.1 The proposed risk reduction/mitigation measures were divided into three categories: design, physical and river operations. This is to provide the PLA with assurance that the measures proposed throughout this assessment 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 temporary cofferdam would be at least 28m from the authorised channel and barges moored at it would be at least 15m from the authorised channel

b. The works would be approximately 200m upstream of Chelsea Bridge. The location of the shaft was moved upstream following phase one consultation, increasing the distance to the bridge.

c. Planned closure of arch No. 2 should not take place during the works. General bridge inspections are carried out every 2 years, but do not require closure of the arch. Principal bridge inspections are carried out every six years. Principal bridge inspections would be conducted immediately prior to project work commencing.

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

9.4 Physical

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

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

c. provide moorings for construction barges that would tolerate wash/draw-off from passing high-speed Thames Clippers

9.5 River operations

a. Appoint Berthing Co-ordination Manager 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. This would include co-operation with Cory operations and maintaining an awareness of leisure users in the vicinity.

b. Issue Notices to Mariners informing operators and river users of planned operations in area and highlighting times when project river movements are likely to be servicing the site.

Table 9.2 Mitigation measures within the project's control

Procedural	Informational	Qualifications / Personnel	Guidance / Publications	Site Specific
Safe Systems of Work	Sound Warnings	Berth Master (term to be defined)	Temporary Notice to Mariners	Grab Chains
Contractors Risk Assessment	Light Warnings	Qualifications / Competence of on site personnel	Permanent Notice to Mariners	Fendering
Site Working 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 Chelsea Embankment 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 At a meeting with the PLA on Monday 2nd July 2012, the Chelsea Embankment site was discussed and marine issues identified.

10.2.2 Several meeting were held with Cory Environmental representatives during which no objections/concerns were raised with regards to this site.

10.2.3 Liaison with stakeholders is ongoing.

10.2.4 A number of issues were identified throughout the risk assessment process, including:

a. interaction with existing river users

b. changes in river flow

c. potential wash caused by vessels passing at speed

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 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 10.1and 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	2	2	2	3
Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.	56	55	55	26
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances.	9	10	10	2
Slight: No action is required.	1	1	1	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.	11	11	11	7
Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.	48	48	48	21
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances.	9	9	9	4
Slight: No action is required.	0	0	0	0

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

10.3.4 For ‘Worst Credible’ scenarios, the majority of pre mitigation hazards fell within the ‘high risk’ category, indicating that the work can only be performed after authorisation from the Harbour Master.

10.4 Overall

10.4.1 The Chelsea Embankment site is located in an area that experiences relatively low levels of river traffic compared to those sites of Central London. There are a number of commercial and freight operations that

transit past the site however, it is felt that the works are set sufficiently back from the authorised channel as to not impact negatively on these operations. It is however possible that plant may require temporary placing inside the navigational channel should additional ground treatment be required to connect the site with the main tunnel. This placement would be short-term, intermittent and impede into the navigational channel by a maximum of 10 metres.

10.4.2 In the event of additional ground treatment being required during temporary works there is the possibility of jack-up barges being placed within the authorised channel. However no specific issues or concerns have been raised during stakeholder liaison.

10.4.3 The temporary works are located in line with arch No1 but this is currently unused as it is obstructed by barges moored at the railway bridge. The arch is expected to remain open during construction works.

10.4.4 The navigation issues were summarised as follows:

a. interaction with existing river users

b. Proximity to Chelsea Bridge

c. Potential Wash caused by vessels passing at speed

d. Potential impact on Cadogan Pier

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 project recommends implementing the mitigations measures set out in Section 7. Additionally, the below should be given consideration:

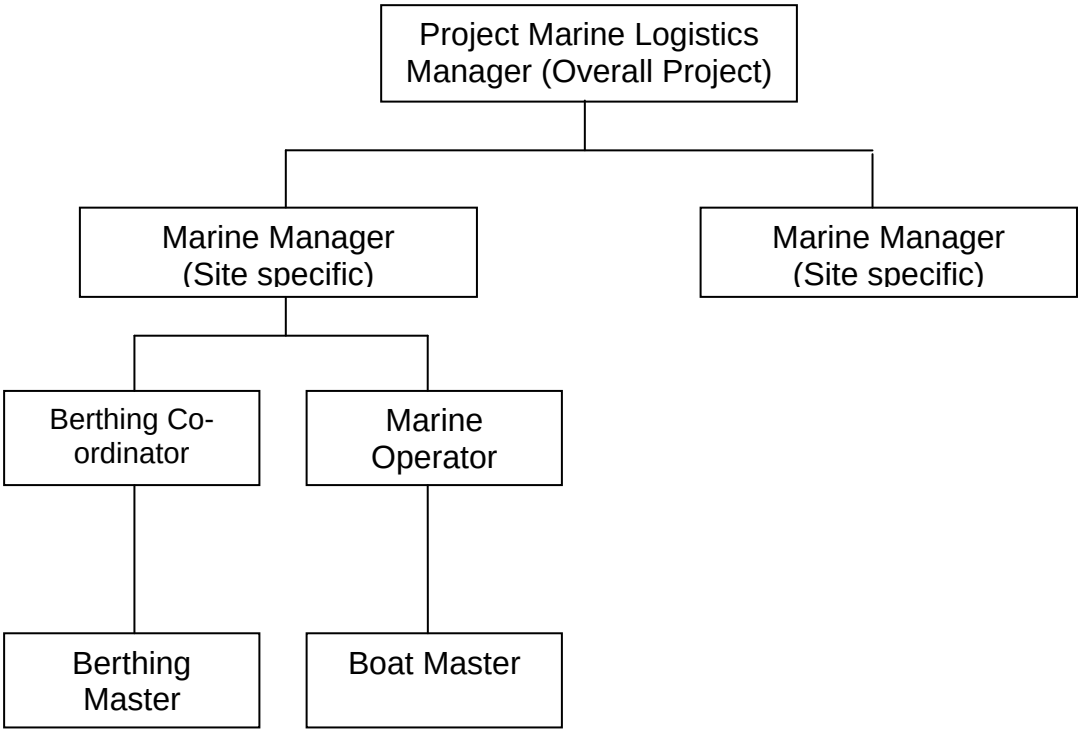
11.1.2 **Continued communication**: The project should continue to maintain communication and liaison with the freight, passenger and leisure users in order to disseminate information relevant to the project.

11.1.3 **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.

11.1.4 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.

11.1.5 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 11.1Potential marine logistics hierarchy



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Abbreviations

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

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Appendices

List of appendices in order

Appendix A: Project drawings

Appendix B: Freight tracks and AIS analysis

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.07**

Chelsea Embankment 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 and tunnelling	Phase B
Construction phases - Construction of other structures	Phase B
Construction phases - Site demobilisation	Phase C
Permanent works layout Sheet 1 of 2	Phase D
River foreshore zones of working	

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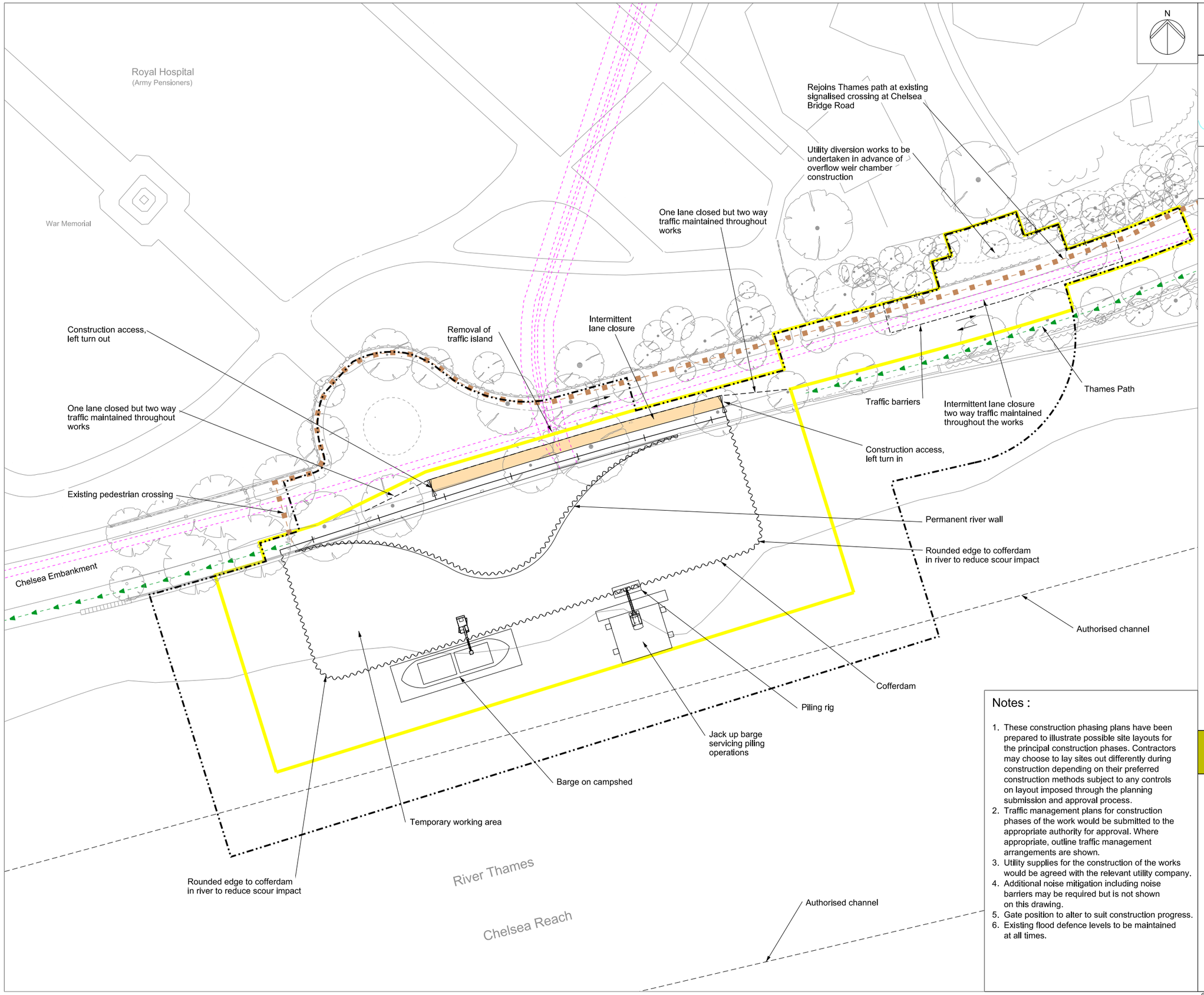


Keyplan:

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

Key:

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

10m 0 40m

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

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. Gate position to alter to suit construction progress.
6. Existing flood defence levels to be maintained at all times.

ILLUSTRATIVE

Location

Chelsea Embankment Foreshore
Royal Borough of Kensington & Chelsea

Document Information

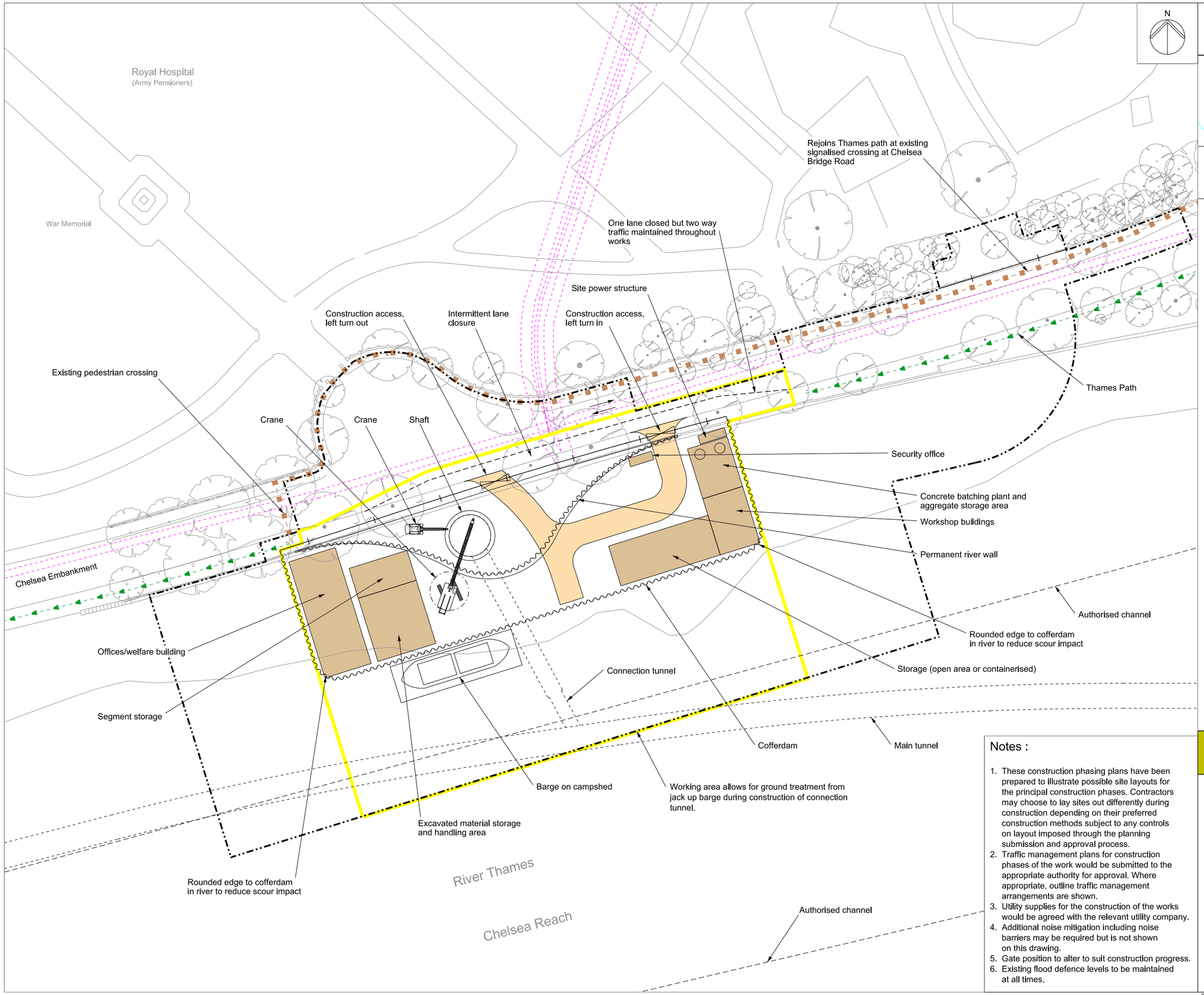
Application for Development Consent

Construction phases - phase 1
Site setup
Book of plans - section 14

DCO-PP-12X-CHEEF-140019
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



Keyplan:

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

Key:

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

10m 0 40m

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

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. Gate position to alter to suit construction progress.
6. Existing flood defence levels to be maintained at all times.

ILLUSTRATIVE

Location

Chelsea Embankment Foreshore
Royal Borough of Kensington & Chelsea

Document Information

Application for Development Consent

Construction phases - phase 2
Shaft construction & tunnelling
Book of plans - section 14

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January 2013

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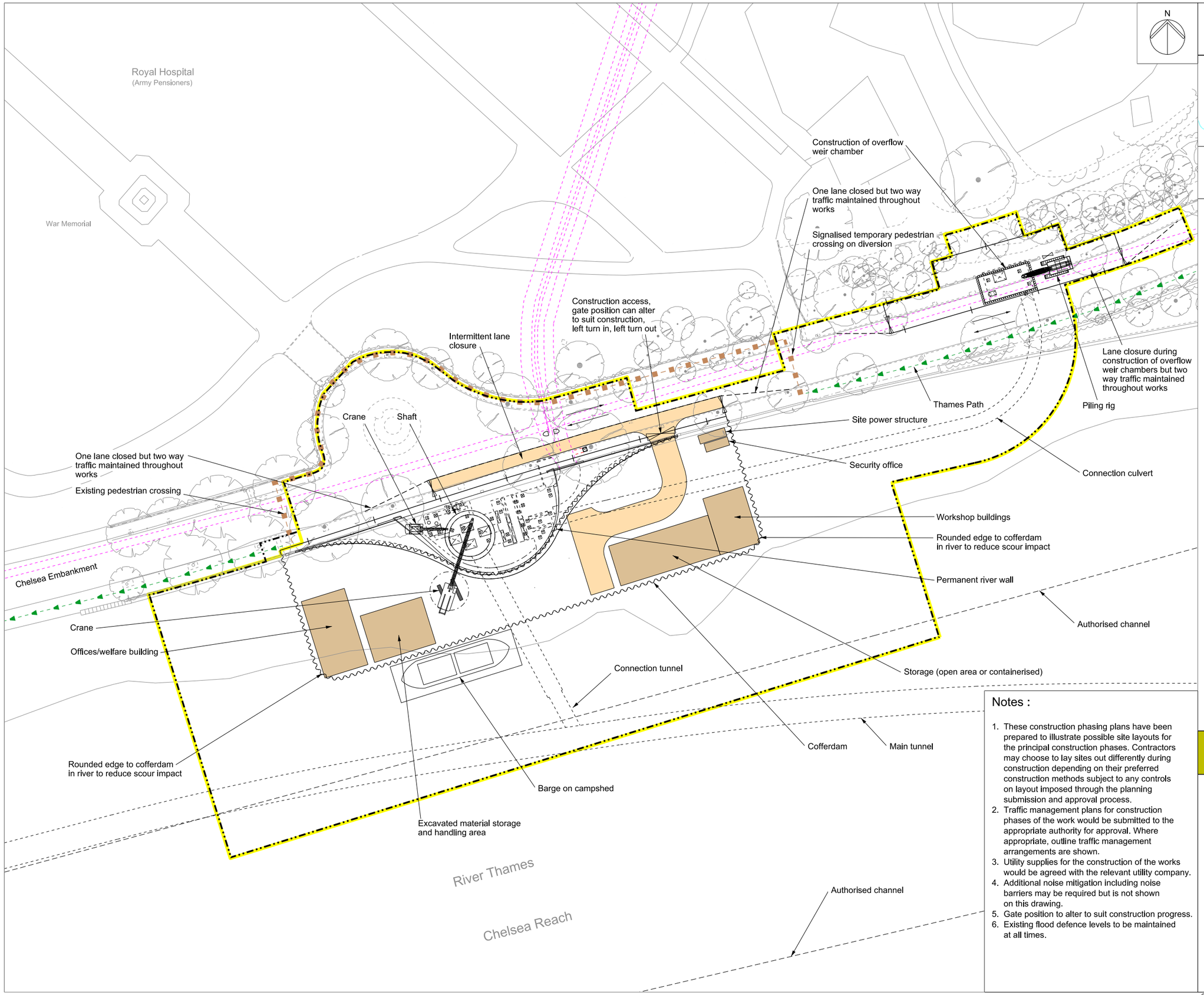
Creating a cleaner, healthier River Thames

Thames Water



Keyplan:

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

Key:

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

10m 0 40m

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

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.
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4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Gate position to alter to suit construction progress.
6. Existing flood defence levels to be maintained at all times.

ILLUSTRATIVE

Location

Chelsea Embankment Foreshore
Royal Borough of Kensington & Chelsea

Document Information

Application for Development Consent

Construction phases - phase 3
Construction of other structures
Book of plans - section 14

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Thames Tideway Tunnel
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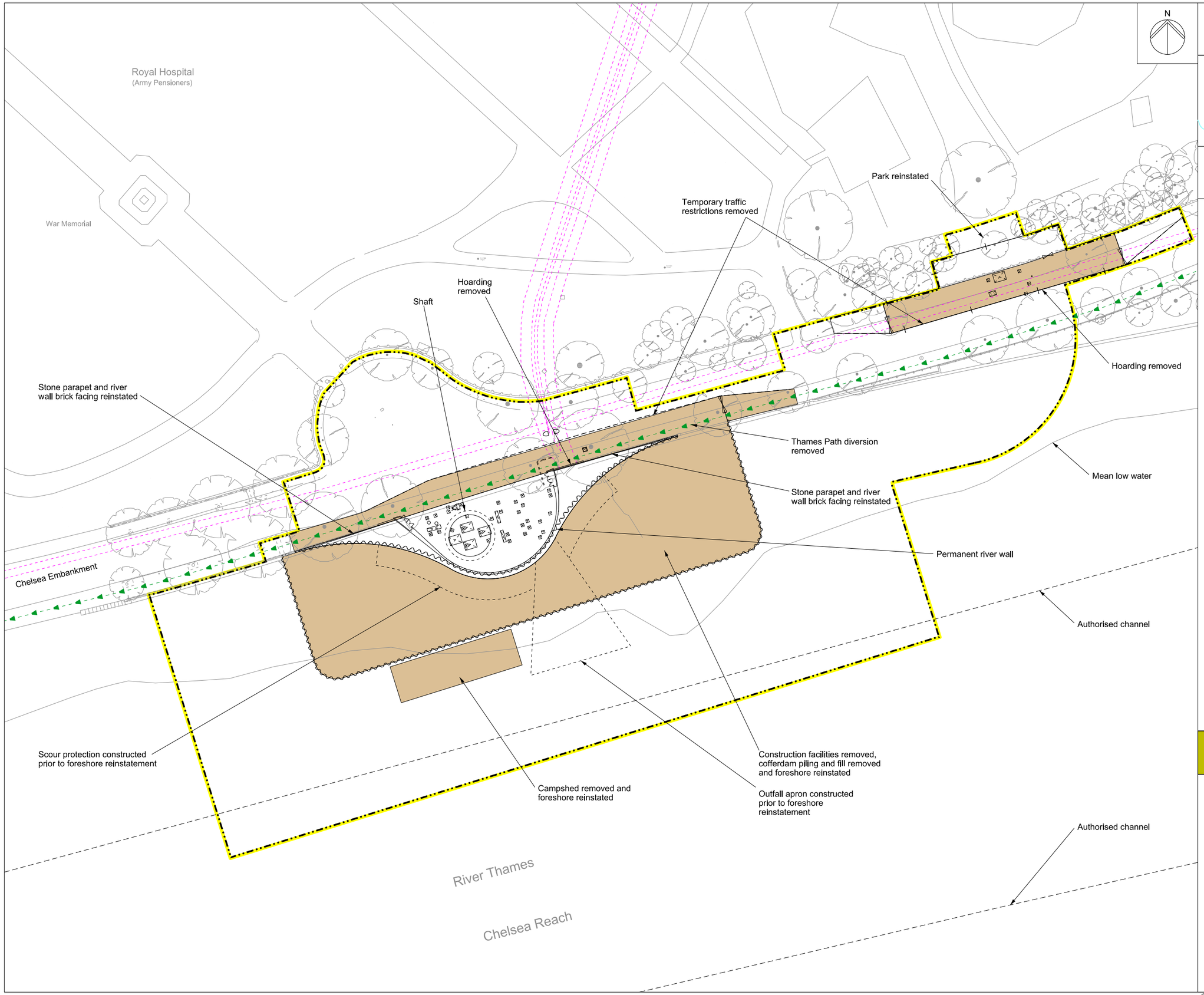
Thames Water



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:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Site access
- Existing sewers
- Sheet piles

10m 0 40m

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

ILLUSTRATIVE

Location

Chelsea Embankment Foreshore
Royal Borough of Kensington & Chelsea

Document Information

Application for Development Consent

Construction phases - phase 4
Site demobilisation
Book of plans - section 14

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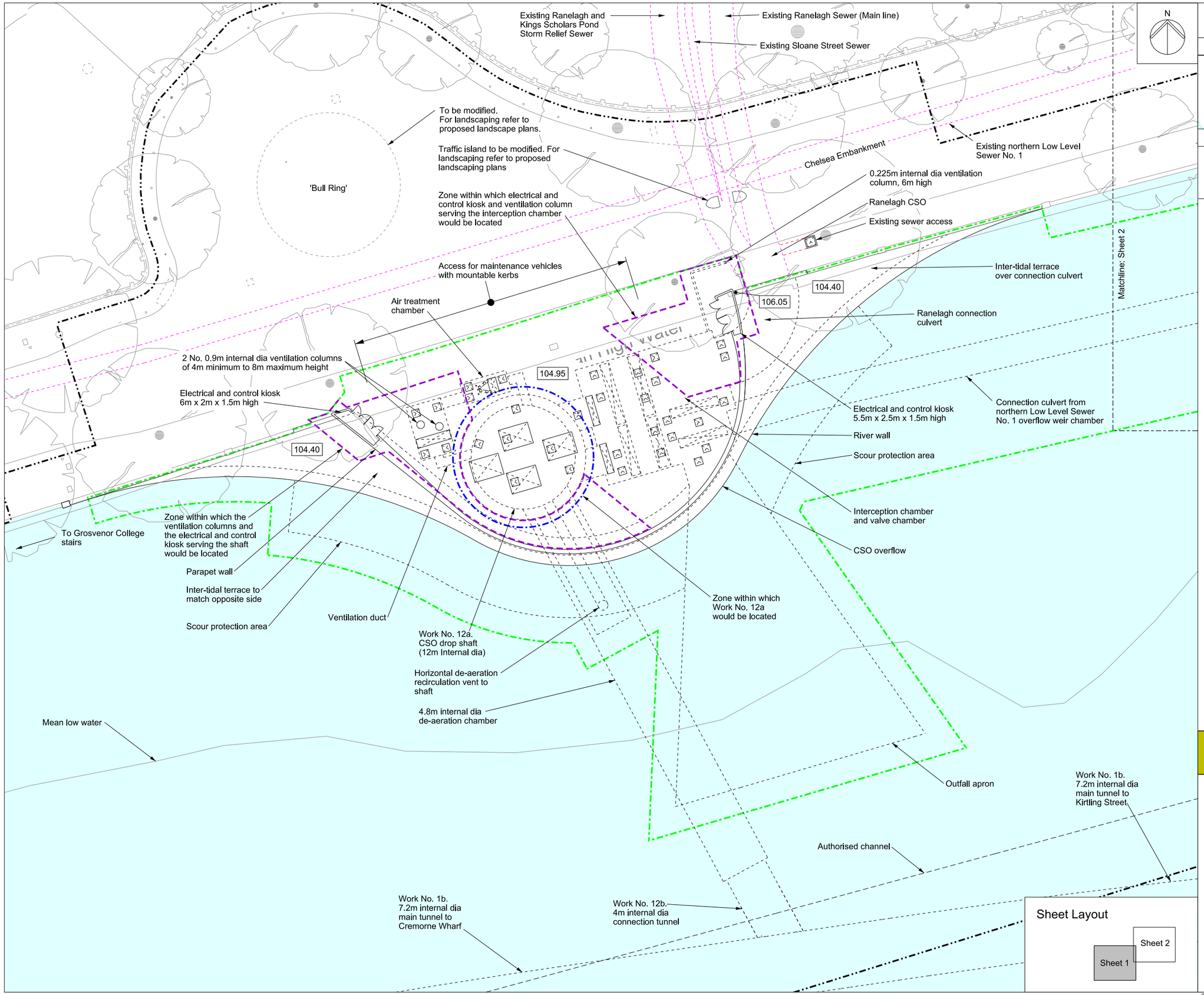
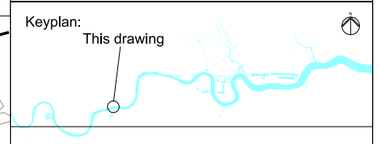
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



Keyplan:



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

Key:

- Limits of land to be acquired or used (LLAU)
- 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.

10m 0 10m

Scale 1:200 at A1
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Sheet Layout

ILLUSTRATIVE

Location

Chelsea Embankment Foreshore
Royal Borough of Kensington & Chelsea

Document Information

Application for Development Consent

Permanent works layout
Sheet 1 of 2
Book of plans - section 14

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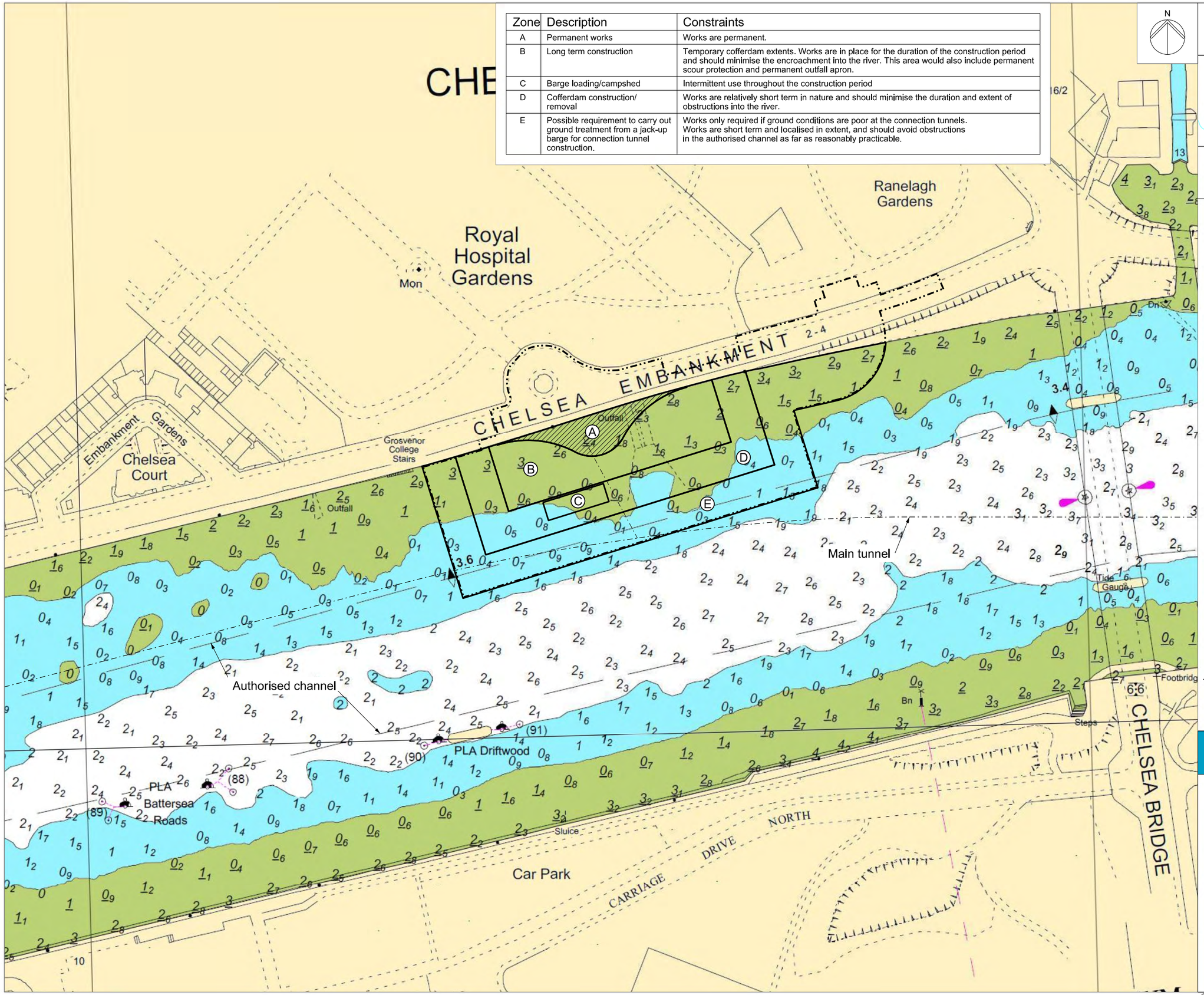
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water

Zone	Description	Constraints
A	Permanent works	Works are permanent.
B	Long term construction	Temporary cofferdam extents. Works are in place for the duration of the construction period and should minimise the encroachment into the river. This area would also include permanent scour protection and permanent outfall apron.
C	Barge loading/campshed	Intermittent use throughout the construction period
D	Cofferdam construction/ removal	Works are relatively short term in nature and should minimise the duration and extent of obstructions into the river.
E	Possible requirement to carry out ground treatment from a jack-up barge for connection tunnel construction.	Works only required if ground conditions are poor at the connection tunnels. Works are short term and localised in extent, and should avoid obstructions in the authorised channel as far as reasonably practicable.



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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 - Battersea Reach to Chelsea Reach

   Port of London Authority Hydrographic Service

   H.O. Ref. No....113-314-062....Date....22/12/2010

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Scale 1:1000 at A1
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Location

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Royal Borough of Kensington & Chelsea

Document Information

Application for Development Consent

River foreshore zones of working

DCO-PP-12X-CHEEF-140025
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: **7.20.07**

Chelsea Embankment Foreshore

Appendix B

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

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix B: Freight tracks & AIS analysis

B.1 Introduction & Summary

B.1.1 The project proposes to use the Chelsea Embankment site for construction work and to accommodate permanent structures required to operate the main tunnel. The site would be used to connect the existing local CSO to the main tunnel.

B.1.2 Construction activities would be required to intercept the CSOs via interception chambers. Connection culverts would link the interception chambers to a drop shaft, approximately 45m deep, through which flows would pass down a short connection tunnel. This would then join the main tunnel.

B.1.3 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 Vessel Routing

Inbound and Outbound Traffic

B.2.1 Chelsea Bridge has three main arches, all three of which are navigable (dependant on tide and vessel characteristics) with arch No 2 designated as the working arch.

B.2.2 Vessels transiting past the Chelsea Embankment site, heading up and down river, currently use arch No2 of Chelsea Bridge. Analysis of data collected confirms that Cory Environmental Ltd tugs and barges use arch No2.

B.3 Cory Environmental Ltd

Cory Tug & Tow Inbound GPS Tracks

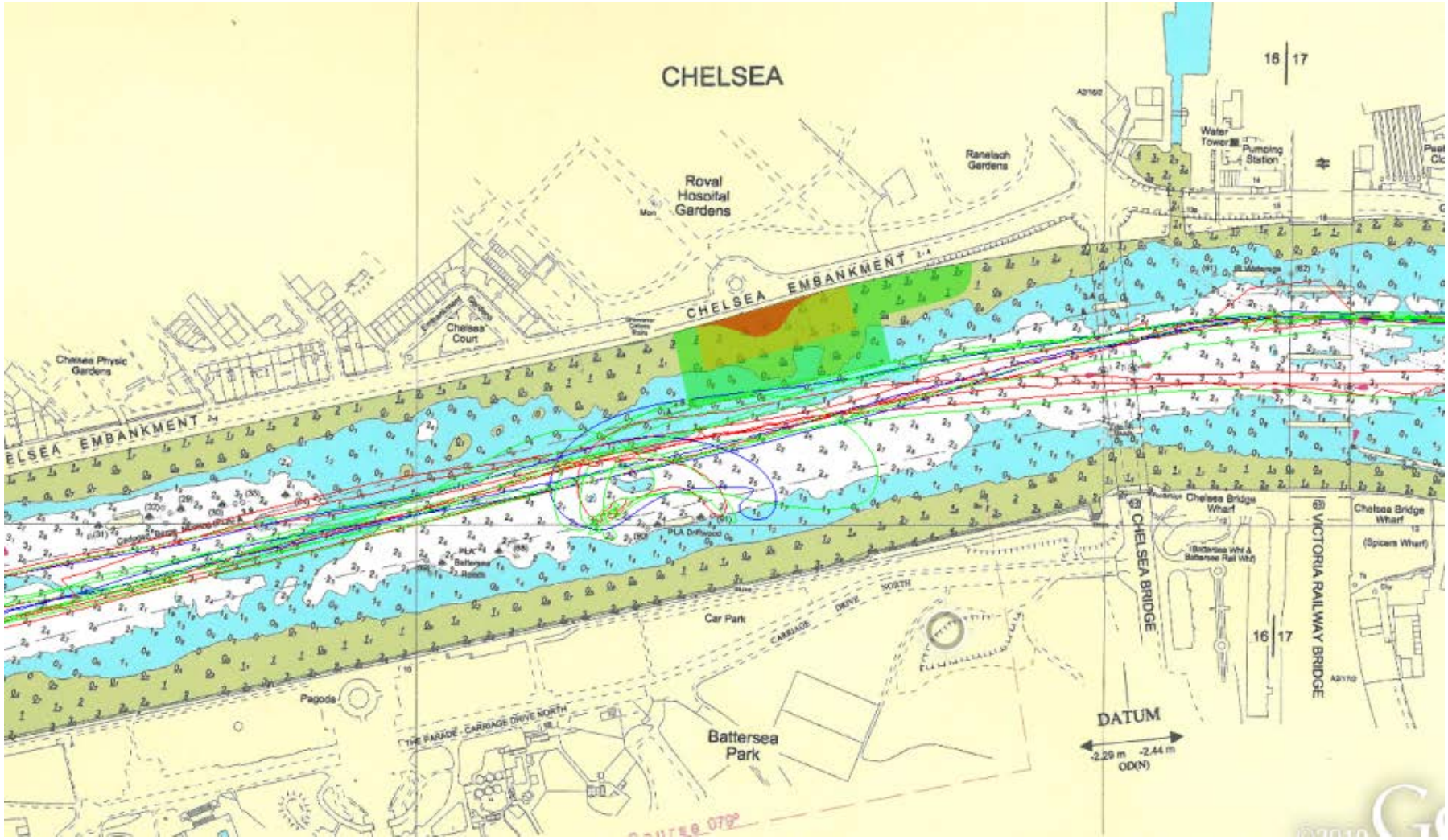
B.3.1 Cory environmental supplied the project with a set of GPS data showing the movements of their tugs and barges. The data covered 14 days in November 2011, a total of 35 tug movements. This data was analysed and visualised to inform various sections of this report. Included below in Figure B.1 is a GIS output of all tracks overlaid over a chart of the Chelsea Embankment area.

B.3.2 By individually investigating each of the tracks supplied it was possible to speculate on the potential impacts of the various phases of development.

B.3.3 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 five have been included in this report. These five (highlighted yellow in Table B.1) represent a good cross section of possible routes taken by Cory Environmental.

Figure B.1 GPS Tracks of Cory tugs and barges



Cory Track Summary

B.3.4 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	Green	Recovery	Cringle	Wangas		NE	3	11:21	6.2	Figure B.2
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	
11/11/11	Red	Reclaim	Cringle	Cringle	Wangas	E	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	Figure B.3
18/11/11	Red	Regain	Cringle	Wangas	Cringle	S	5	18:33	6.4	Figure B.4
22/11/11	Green	Reclaim	Cringle	Cringle		E	2	10:34	6.5	Figure B.5
23/11/11	Red	Reclaim	Wangas	Wangas		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	
24/11/11	Green	Recovery	Cringle	Cringle	Cringle	SW	4	12:31	7.1	Figure B.6
25/11/11	Blue	Recovery	Wangas	Wangas		W	10	13:22	7.2	

Cory Individual Tracks

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

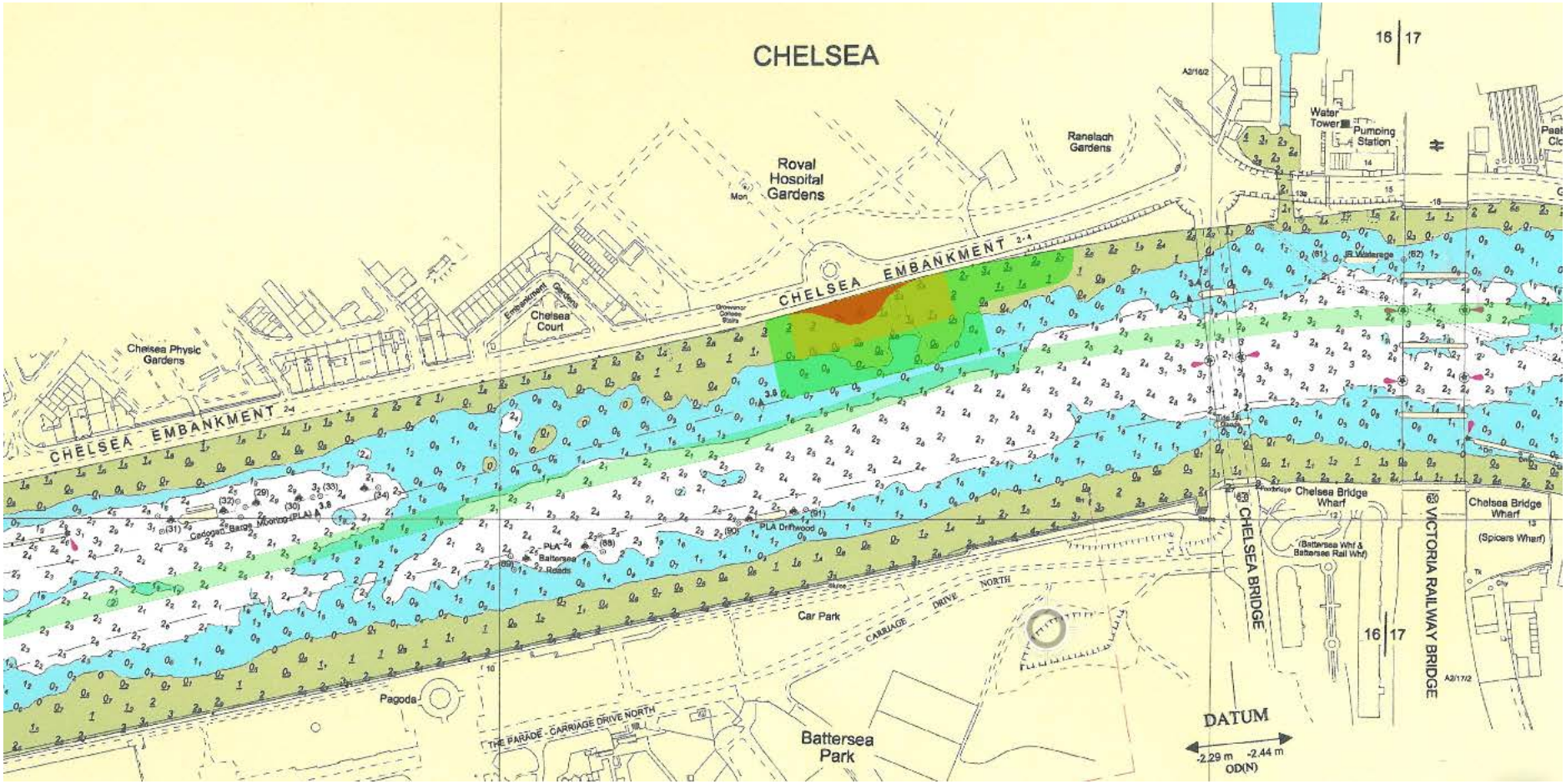


Figure B.3 14/11/2011 - Green Track image

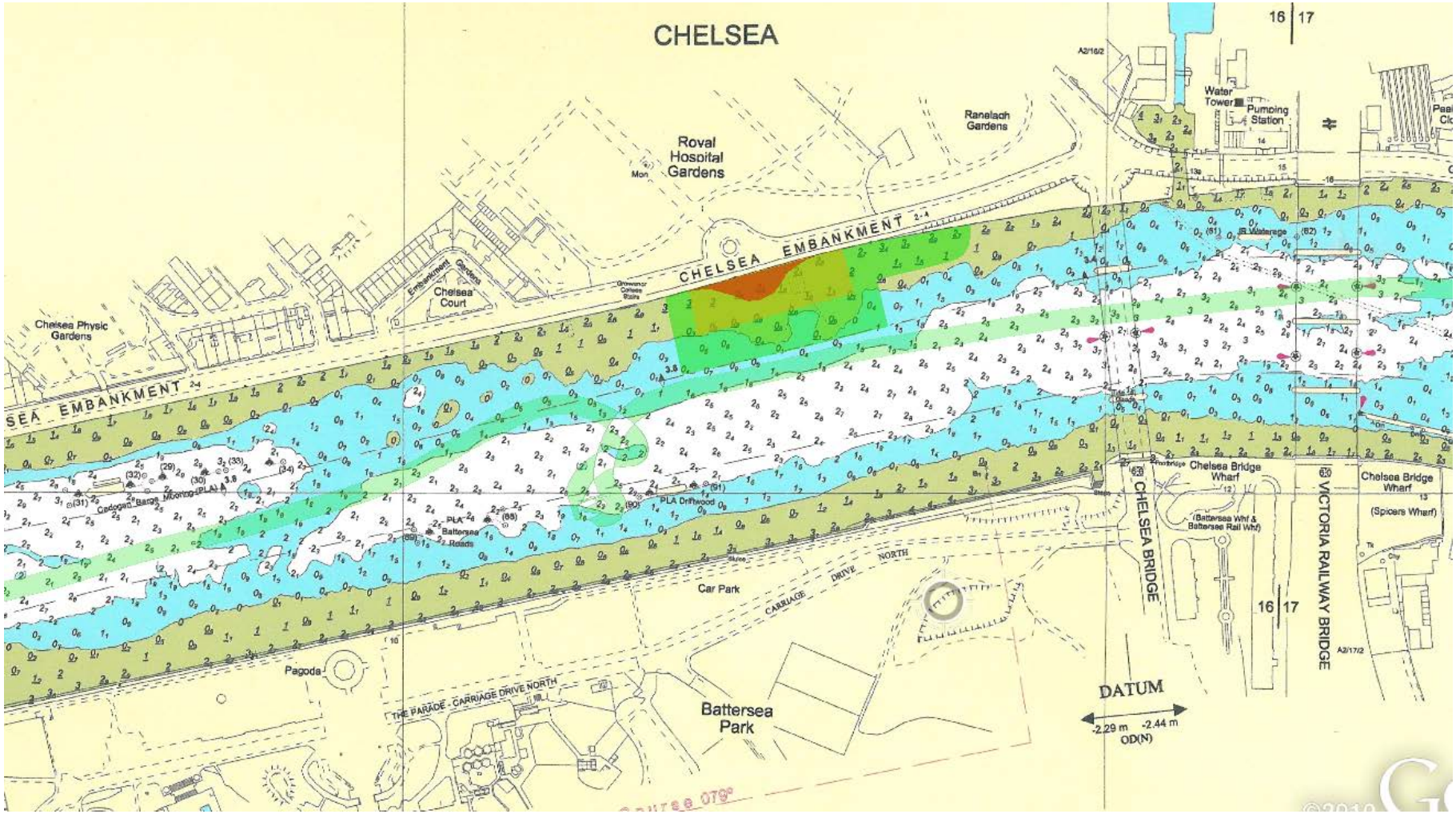


Figure B.4 18/11/2011 - Red Track image

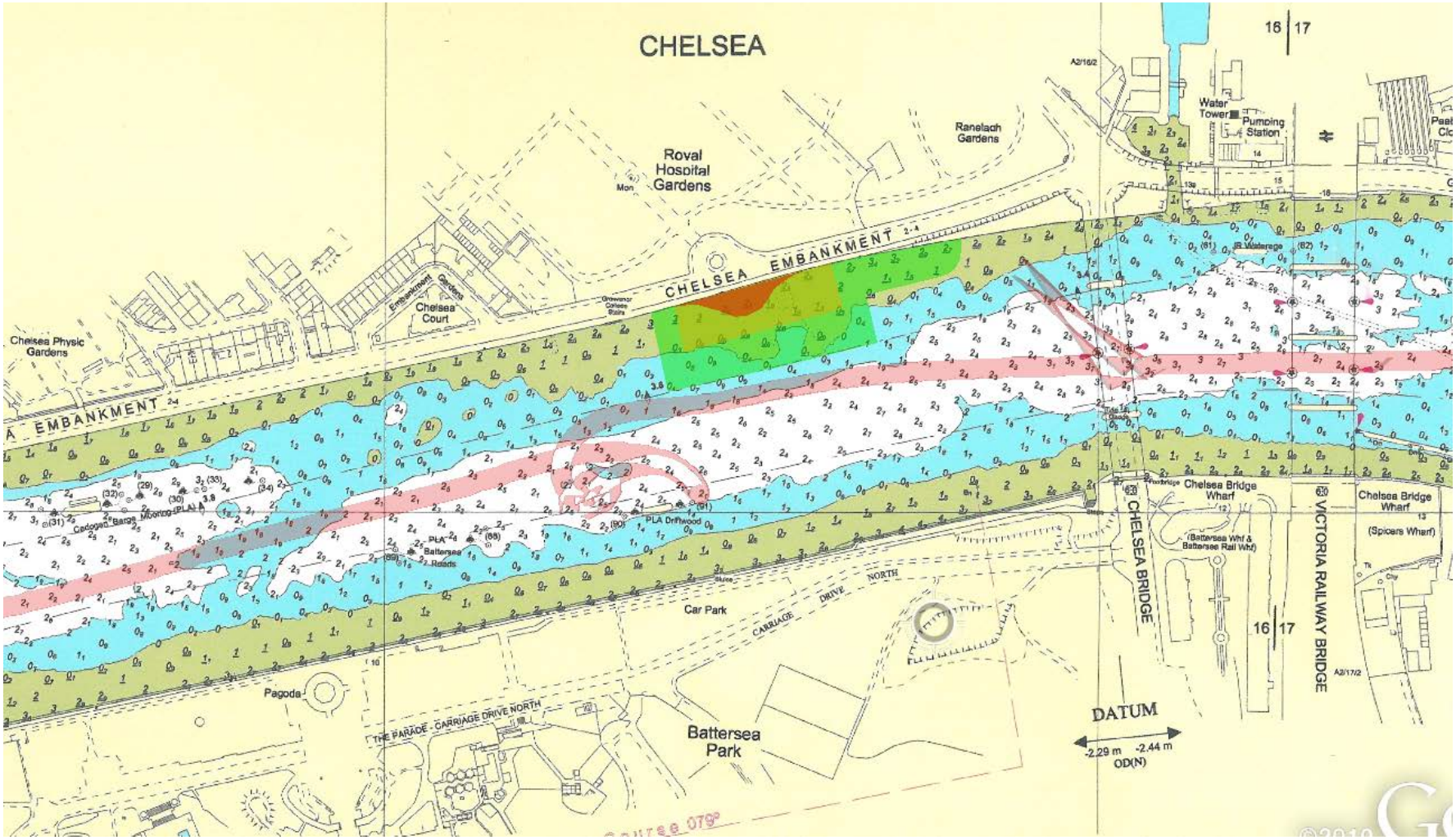


Figure B.5 22/11/2011 - Green Track image

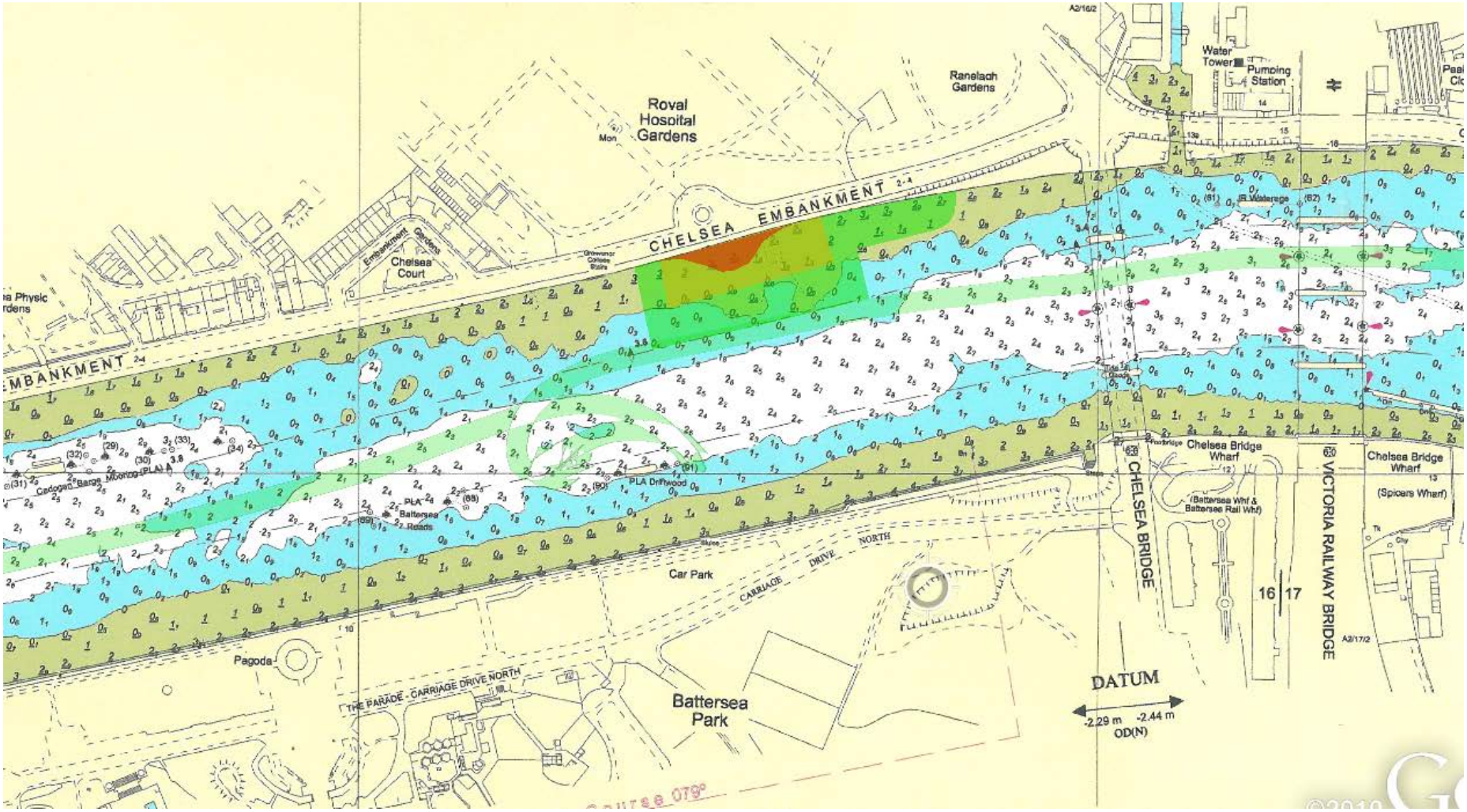
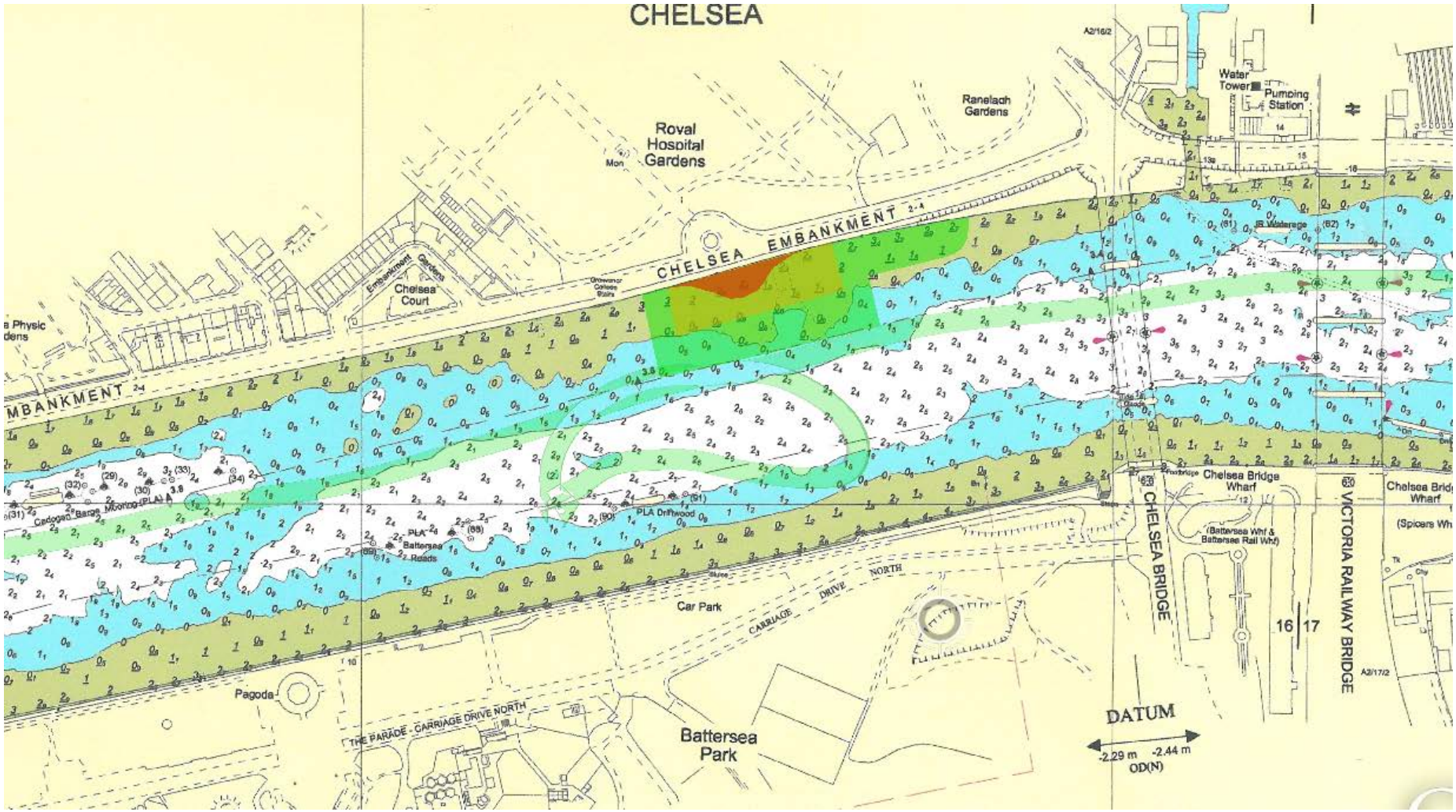


Figure B.6 24/11/2011 - Green Track image



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