Lower Thames Crossing

7.15 Preliminary Navigational Risk Assessment

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Lower Thames Crossing

7.15 Preliminary Navigational Risk Assessment

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1 Executive summary

1.1 Introduction

1.1.1 The objective of this preliminary Navigational Risk Assessment (pNRA) is to assess and quantify the navigation risk posed by the National Highways A122 Lower Thames Crossing (the Project) during its construction and operational phases. The pNRA supports the submission of a Development Consent Order (DCO) application for the Project.

1.1.2 The scope has been developed and agreed with the Statutory Harbour Authority (SHA) – the Port of London Authority (PLA) and key stakeholders, including the Port of Tilbury London Ltd. (PoTLL) and is defined in the Lower Thames Crossing Shipping and Navigational Specification (pNRA Specification) included in Appendix A to this document.

1.1.3 National Highways has ensured that the assumptions, particularly those related to use of the River Thames in connection with the project, reflected in this document are consistent with the assumptions made in the Transport Assessment (Application Document 7.9) and Environmental Statement (Application Document 6.1).

1.1.4 This revision of the pNRA has been updated to incorporate the inclusion of an additional temporary works activity within the temporary works construction phase of the pNRA and replaces the previous iteration of the report (TR010032/APP/7.15)

1.2 The Project and draft DCO

1.2.1 The A122 Lower Thames Crossing (the Project) would provide a connection between the A2 and M2 in Kent and the M25 south of junction 29, crossing under the River Thames through a tunnel. The Project route is presented in Plate 1.1.

1.2.2 The A122 would be approximately 23km long, 4.25km of which would be in tunnel. On the south side of the River Thames, the Project route would link the tunnel to the A2 and M2. On the north side, it would link to the A13, M25 junction 29 and the M25 south of junction 29. The tunnel portals would be located to the east of the village of Chalk on the south of the River Thames and to the west of East Tilbury on the north side.

1.2.3 Junctions are proposed at the following locations:

a. New junction with the A2 to the south-east of Gravesend

b. Modified junction with the A13/A1089 in Thurrock

c. New junction with the M25 between junctions 29 and 30

1.2.4 To align with National Policy Statement for National Networks (Department for Transport, 2014) policy and to help the Project meet the Scheme Objectives, it is proposed that road user charges would be levied in line with the Dartford Crossing. Vehicles would be charged for using the new tunnel.

1.2.5 The Project route would be three lanes in both directions, except for:

d. link roads

e. stretches of the carriageway through junctions

f. the southbound carriageway from the M25 to the junction with the A13/A1089, which would be two lanes

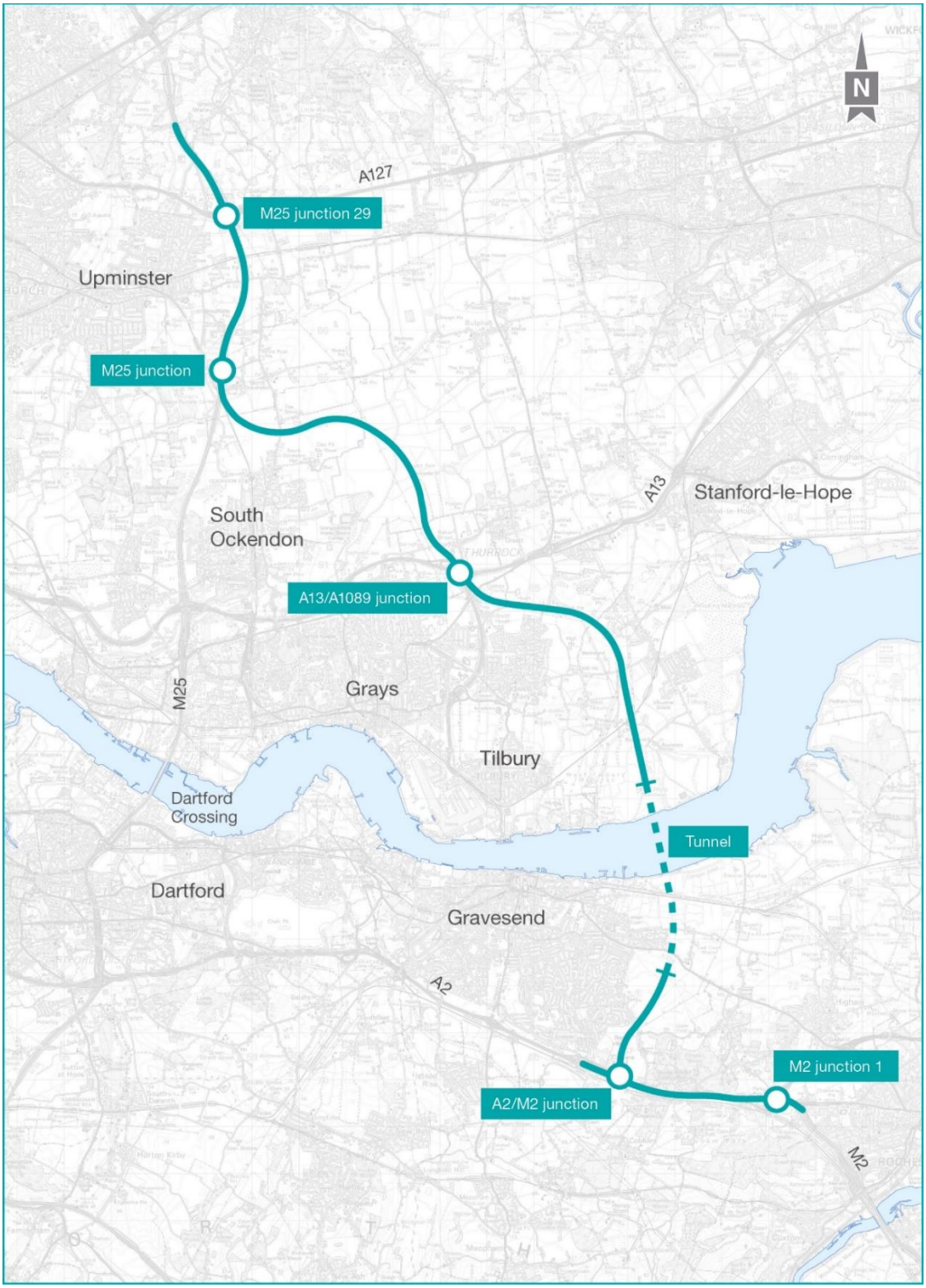
1.2.6 In common with most A-roads, the A122 would operate with no hard shoulder but would feature a 1m hard strip on either side of the carriageway. It would also feature technology including stopped vehicle and incident detection, lane control, variable speed limits and electronic signage and signalling. The A122 design outside the tunnel would include emergency areas. The tunnel would include a range of enhanced systems and response measures instead of emergency areas.

1.2.7 The A122 would be classified as an ‘all-purpose trunk road’ with green signs. For safety reasons, walkers, cyclists, horse riders and slow-moving vehicles would be prohibited from using it.

1.2.8 The Project would include adjustment to a number of local roads. There would also be changes to a number of Public Rights of Way, used by walkers, cyclists and horse riders. Construction of the Project would also require the installation and diversion of a number of utilities, including gas pipelines, overhead electricity powerlines and underground electricity cables, as well as water supplies and telecommunications assets and associated infrastructure.

1.2.9 The Project has been developed to avoid or minimise significant effects on the environment. The measures adopted include landscaping, noise mitigation, green bridges, floodplain compensation, new areas of ecological habitat and two new parks.

Plate 1.1 Lower Thames Crossing route



1.2.10 The Project includes the construction of two 4.25km road tunnels under the River Thames to the east of Gravesend and East Tilbury jetty.

1.2.11 The draft DCO includes Land Plans which show the Order Limits extend into and across the river Thames (see Plate 1.2). The draft DCO seeks a range of powers necessary to undertake the Project, including powers in relation to construction of temporary and permanent structures, navigation, discharge of

water and survey of the river and land. These may affect navigation. Note – the information shown within Plate 1.2, other than as identified within the legend, is embedded within the underlying Admiralty chart and does not form part of the Project or assessment.

1.2.12 The Project proposes to install a pipeline and diffuser on the northern side of the River Thames to allow site drainage to be discharged during construction (see Plate 1.3). This has the potential to impact navigation for some vessels but would be a temporary feature.

1.2.13 A permanent outfall would also be installed for surface runoff. It would be located in the seawall on the north bank of the River Thames (see Plate 1.3) and would not impact on navigation.

1.2.14 A temporary working area is required to facilitate works to construct a permanent self-regulating Water Inlet with self-regulating valve or equivalent structure, (Plate 1.3).

Plate 1.2 Draft Order Limits in the River Thames

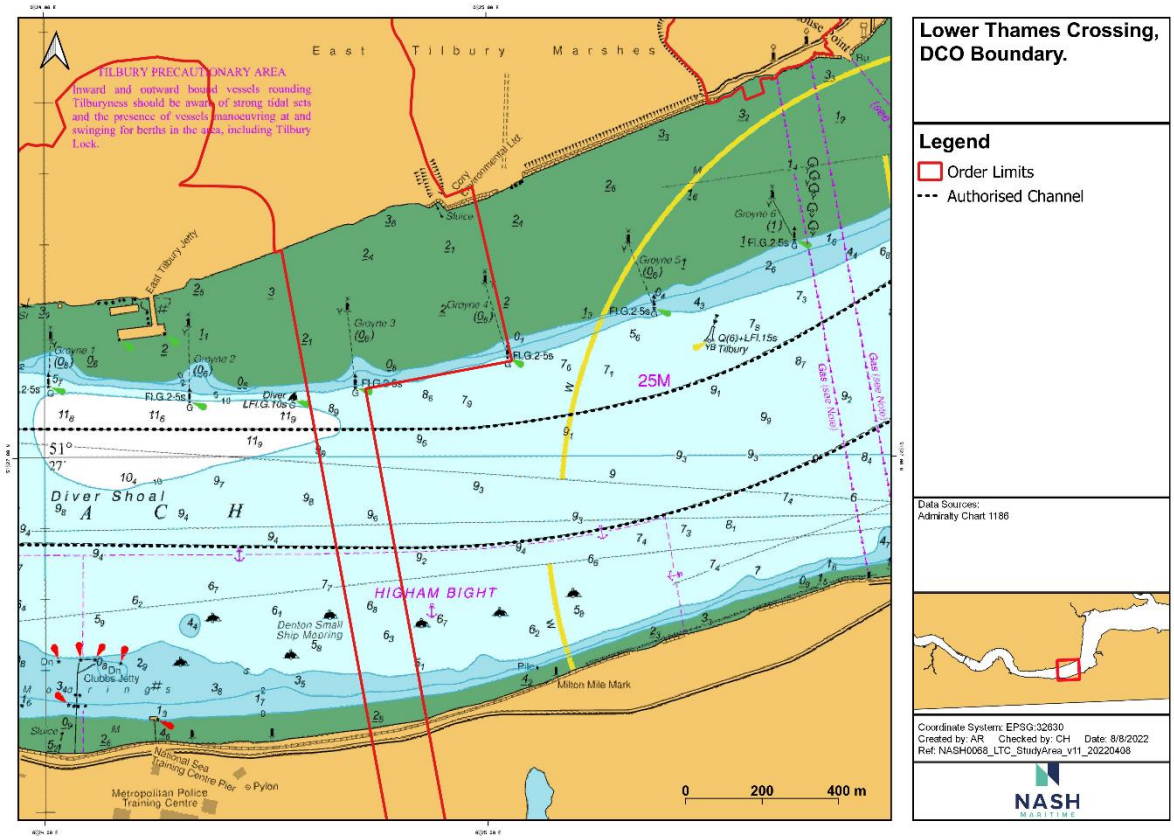
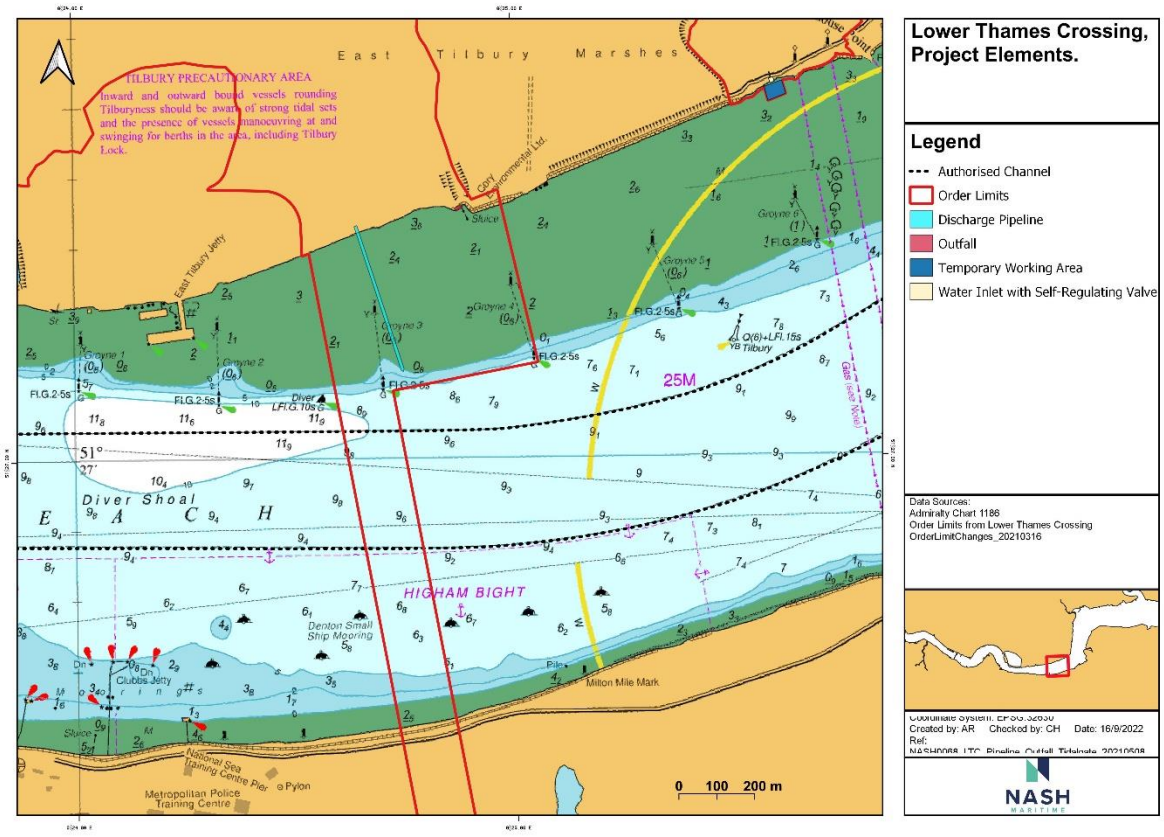


Plate 1.3 Discharge Pipeline, Outfall, Water Inlet with self-regulating valve, Pipeline and Temporary Working Area Locations



1.2.15 The main permanent features of the Project relevant to navigation are two protection zones which would be established surrounding the tunnel route (see DCO document TR010032/APP/2.14. Article 48 of the draft DCO sets out permanent restrictions which would apply within these zones. Article 48 sets out that within first protection zone activities such as dredging, excavation, anchoring and any other activity which might reasonably be expected to affect the safe operation of the tunnels, are not permitted without the consent of National Highways.

1.3 Regulation and vessel traffic characterisation

1.3.1 Navigation safety in the area is managed primarily by the PLA as the SHA and local lighthouse authority, through legislation, guidance, procedures and practices.

1.3.2 The PLA has defined an authorised navigation channel within the area which is marked on relevant charts. The PLA General Directions (PLA, 2021b) require vessels of 13.7m or more in length overall to navigate only within the authorised channel except in specific circumstances or manoeuvres.

1.3.3 Automatic Information System (AIS) data from 2018, 2019 and 2020 was used to characterise existing vessel traffic in the area. National Highways also consulted with local rowing and sailing clubs to better understand their use of the River Thames in the area of the Project.

1.3.4 The area is used by a wide variety of vessel types including seagoing commercial vessels, tugs and service vessels, inland freight vessels, inland passenger vessels, and recreational craft such as yachts, motorboats and rowing boats. The larger vessels navigate within the authorised channel with up to 900 vessels per month, while the smaller vessels normally navigate outside this channel.

1.3.5 Future traffic through the Port of London and Port of Tilbury (PoTLL) is expected to grow to service other projects and demand in the region, but not to materially change the types of vessels transiting the area.

1.3.6 Project vessel traffic would comprise:

a. Tunnel site investigation vessels – excluded from this pNRA as such vessels are already covered by the NRA for the Site Investigation (SI) survey that was carried out as part of the outline design development (see Appendix F). This pNRA refers to this NRA for SI survey as a guide to the contractor to produce their final NRA once more information is known at a later stage. No type of vessel is therefore scoped out, rather the risk control mitigation measures in connection with these vessels and methodological approach used for site investigations form part of the previous NRA for SI survey. For the avoidance of doubt, control measures for vessels which would be used in connection with any site investigations are therefore adequately secured.

b. Temporary works site investigation vessels – small inshore survey vessel/barge.

c. Temporary work construction vessels – barge with excavator and piling equipment, supported by a supply barge.

d. Material supply vessels to support tunnel construction – excluded from this pNRA as they would use established facilities and would therefore be subject to the NRAs for those facilities. There are no new, or bespoke, vessels used in connection with the Project which would necessitate their consideration for the purposes of this pNRA.

1.4 Risk assessment

1.4.1 The risk assessment in relation to the temporary pipeline and diffuser followed the International Maritime Organization Formal Safety Assessment and the PLA risk matrix in accordance with the PLA risk assessment methodology.

1.4.2 Eighteen hazards were used to characterise the relevant navigation risks in the area related to the Project. These included collision between vessels, contact between a vessel and a structure or moored vessel, grounding of vessels and breakout of moored vessels.

1.4.3 The assessment determined that the risk (product of severity and likelihood) associated with these hazards was acceptable given suitable risk control measures. These included:

a. The PLA's five embedded risk controls:

i. Charting provided by the PLA

ii. Aids to navigation managed by the PLA

iii. Requirements to navigate with due care and attention

iv. Requirements for passage plans

v. Requirements for pilotage for certain vessels navigating the area

b. Three additional risk controls identified during the risk assessment workshop:

i. Notice to mariners – to be issued in relation to relevant works

ii. Marine operations plan and stakeholder engagement and coordination – to be undertaken for relevant works

iii. Safety boat – to be provided for relevant works including Site Investigation operations

1.4.4 The risk controls above are legally secured within the protective provisions for the PLA in the draft DCO. In particular, the protective provisions require that 'plans' which include final NRAs are submitted to the PLA. The protective provisions further require that the final NRA is substantially in accordance with this pNRA and incorporates the additional risk controls identified above unless otherwise agreed by the PLA.

1.5 Hazards for permanent works

Anchor seabed penetration within the protection zones

1.5.1 National Highways assessed the potential depth of burial of ships' anchors deployed within the Higham Bight anchorage and within the authorised channel within the protection zones running along the route of the tunnel.

1.5.2 This estimated a maximum depth of anchor penetration within the Higham Bight anchorage of 2.6m and within the authorised navigation channel of 4.9m. The protection zones ensure that depth of cover to the tunnel would be sufficient to protect against accidental impact loading from anchor penetration to these depths.

Explosives Licence at Higham Bight anchorage location and usage

1.5.3 The PLA maintains an explosives licence at Higham Bight. This licence (issued under Part IX of the Dangerous Substances in Harbour Areas Regulations 1987) permits explosives to be brought to, carried and handled within the Higham Bight anchorage area. The licence sets limits on the distance from the vessel within which certain activities are proscribed.

1.5.4 The explosives licence information has been reviewed in developing the draft DCO application. National Highways proposes to disapply via the DCO the explosives licence at Higham Bight such that it ceases to have effect over any area in, on, under or over the part of the river Thames to ensure the safe construction and operation of the tunnel infrastructure.

1.5.5 Therefore, no specific risk assessment in relation to the explosives Licence at Higham Bight is carried out within this document.

1.6 Summary risk statement

1.6.1 This pNRA has considered the impacts of the Project on navigational safety. The results demonstrate that all hazards can be mitigated to acceptable risk levels. However, no matter how much hazards are reduced, both in terms of hazard consequence and likelihood, there remains a possibility that they will be realised. As such, this pNRA and the associated risk controls that it mandates should be reviewed, in consultation with the PLA, in the event that any aspect of the Project, including additional hazards or the risk controls, change during the operational lifespan of the Project.

1.7 Recommendations

Tunnel pre-construction

1.7.1 Further site investigations over the tunnel route in the River Thames should use the 2019 pNRA, developed for previous site investigations, as the basis for an updated final NRA, including all risk controls as previously established and agreed.

Temporary works in the river

1.7.2 The sections of this pNRA dealing with the temporary works in the River Thames should be reviewed and updated as necessary when further details of the works are developed and a marine contractor is engaged for the works, or if any details of the works materially change earlier than this. The risk controls noted for these works should be implemented.

Contract use of non-port river facilities

1.7.3 This pNRA does not cover the use or establishment of non-port river facilities for its operations. For the avoidance of doubt, no such facility is anticipated or proposed under the terms of the draft DCO.

Protection zones

1.7.4 Anchor penetration into the seabed within the protection zones surrounding the tunnel should be considered within the detailed design of the Project tunnel sections under the river. The protection zones ensure that depth of cover to the tunnel is sufficient to protect against accidental impact loading in this regard.

Explosives licence

1.7.5 There is currently a licence issued by the Health and Safety Executive (HSE) allowing vessels carrying explosives to be moored within the Higham Bight anchorage.

1.7.6 The disapplication of the explosives licence in the Higham Bight is required to ensure the safe construction and operation of the tunnel infrastructure below the river Thames. Article 48 of the draft DCO therefore includes this disapplication of the power to anchor or berth vessels carrying those materials which give rise to this risk.

1.7.7 National Highways is in discussion with the PLA and the HSE on its proposal to disapply within the DCO. HSE has agreed to the dispensation of the explosive licence at the Higham Bight.

2 Scope of document

2.1 Objective

2.1.1 The objective of this pNRA is to assess and quantify the navigation risk posed by the Project during its construction and operational phases. The pNRA supports the submission of a DCO application (Application Document 3.1) for the Project.

2.2 Scope of assessment

2.2.1 The scope of the assessment is defined in the Lower Thames Crossing Shipping and Navigational Specification (pNRA Specification) included in Appendix A and subsequently updated to include the Water Inlet with self-regulating valve, and its temporary works, as described in Sections 3.3.4 and 3.3.2 respectively.

2.2.2 The scope has been developed and agreed with the SHA – the PLA and key stakeholders, including the PoTLL.

2.2.3 National Highways has ensured that the assumptions, particularly those related to use of the River Thames in connection with the Project, reflected in this document are consistent with the assumptions made in the Transport Assessment (Application Document 7.9) and Environmental Statement (Application Document 6.1).

2.2.4 Four approaches have been taken in the assessment, reflecting different Project phases and activities as summarised below and described in more detail within the pNRA Specification (Appendix A).

Tunnel pre-construction site investigations

2.2.5 A contractor would be appointed to carry out detailed design and construction of the tunnel. The contractor would review the need for further SIs to support the detailed design.

2.2.6 A NRA (Highways England, 2019) undertaken for in-river SI in 2019 (NRA for SI survey) and the risk controls agreed in that document (See Appendix F) Further site investigations over the tunnel route in the River Thames should use the NRA for SI survey, developed for previous site investigations, as the basis for a final NRA, including all the risk controls as previously established and agreed.

2.2.7 As the contractor develops the SI scope and method for the work, the NRA for SI survey will be reviewed and implemented where appropriate.

Temporary in-river works: site investigation, construction and operation

2.2.8 The formal assessment of risk for this phase comprises:

a. Review of existing vessel traffic and navigation and projections for future traffic in the area of the Project

b. Hazard identification and analysis, including consultation with stakeholders to identify and understand navigation safety issues

c. Formal NRA and identification of risk controls

Material supply during construction of the tunnels and associate facilities

2.2.9 Marine imports would be to existing established facilities. The use of established facilities will not give rise to the use of any vessels or any additional vessel movements that would not otherwise be likely to occur in the absence of the Project. Therefore, these movements would be in the scope under existing NRAs of the PLA and any other SHA (e.g. PoTLL if movements enter their limits). This position was agreed with the PLA and PoTLL in a meeting on 10 May 2021 (see Appendix B). On this basis, material supply vessels for the Project are excluded from this pNRA.

2.2.10 [National Highways has carried out an assessment which confirms that a maximum of 21 vessel movements per quarter. These limited movements must be seen in the context of existing port operations. For example, prior to the consenting of Tilbury2, the Port of Tilbury averaged 3,260 two-way vessel movements per annum. The RoRo berth and aggregate berth associated with Tilbury2 alone will carry 1,792 two-way vessel movements per year. The Project's use of the existing operations is therefore negligible and would, as explained above, fall under the scope of the existing operations which are controlled under their existing NRAs. In light of navigational risk for those movements already being controlled, and with the agreement of the port authorities, they have been scoped out of this assessment. The use of the river by Project vessels and material supply vessels has been considered in the Environmental Impact Assessment. Within each topic chapter of the ES, a section is included on 'use of the river'. These sections explain the relevance, if any, of vessel movements to the topic in question, and, where relevant, include a qualitative assessment of any effects. As a result of these assessments, no significant environmental effects resulting from vessel movements have been identified. For completeness, the Outline Materials Handling Plan contains commitments in relation to river use, but those commitments do not conflict with the approach adopted here

2.2.11 The establishment of project-specific marine facilities for import are not anticipated, and do not form part of the powers which are proposed to be consented under the terms of the DCO.

Protection zones and tunnel operation

2.2.12 The protection zones have been scoped out of the formal pNRA as described in the pNRA Specification (Appendix A). This has been agreed with the PLA and PoTLL in a meeting on 10 May 2021 (see Appendix B). This is because the river restrictions proposed under Article 48 do not give rise to any navigational risk, as they control works and activities, rather than the free movement of vessels in the navigable river. This has been agreed with the PLA, and on that basis, they are not considered further. However, two pertinent navigation aspects are considered in this report:

d. Anchor seabed penetration within the protection zones (see Section 3.3 and 7.3)

e. Explosives licence at Higham Bight location and usage (see Section 3.3 and 7.3) as currently licensed within or close to the protection zones

3 Description of the Project

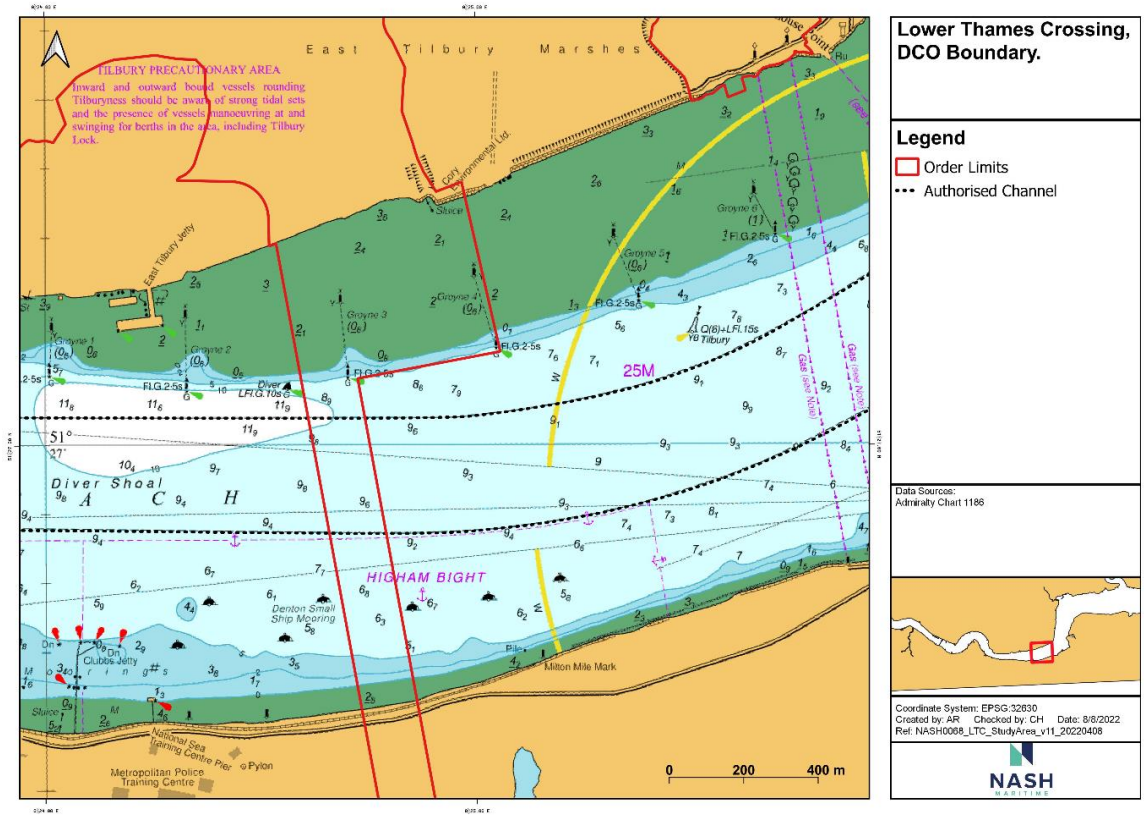
3.1 Introduction

3.1.1 The proposed development includes the construction of two 4.25km road tunnels under the Thames, located to the east of Gravesend on the south side of the river and to the east of East Tilbury jetty on the north side. The tunnels would be constructed using tunnel boring machines and pre-cast concrete tunnel segments launched from a large compound (the North Portal) to the north of the River Thames.

3.2 Order Limits and powers sought in the River Thames

3.2.1 The draft DCO includes Land Plans which show the Order Limits extend into and across the River Thames, as shown in Plate 3.1 .

Plate 3.1 Draft Order Limits in the River Thames



3.2.2 The draft DCO also seeks a range of powers which may affect navigation, as identified in Sections 2.2.1, 2.2.2 and 2.2.3 of the pNRA Specification (Appendix A).

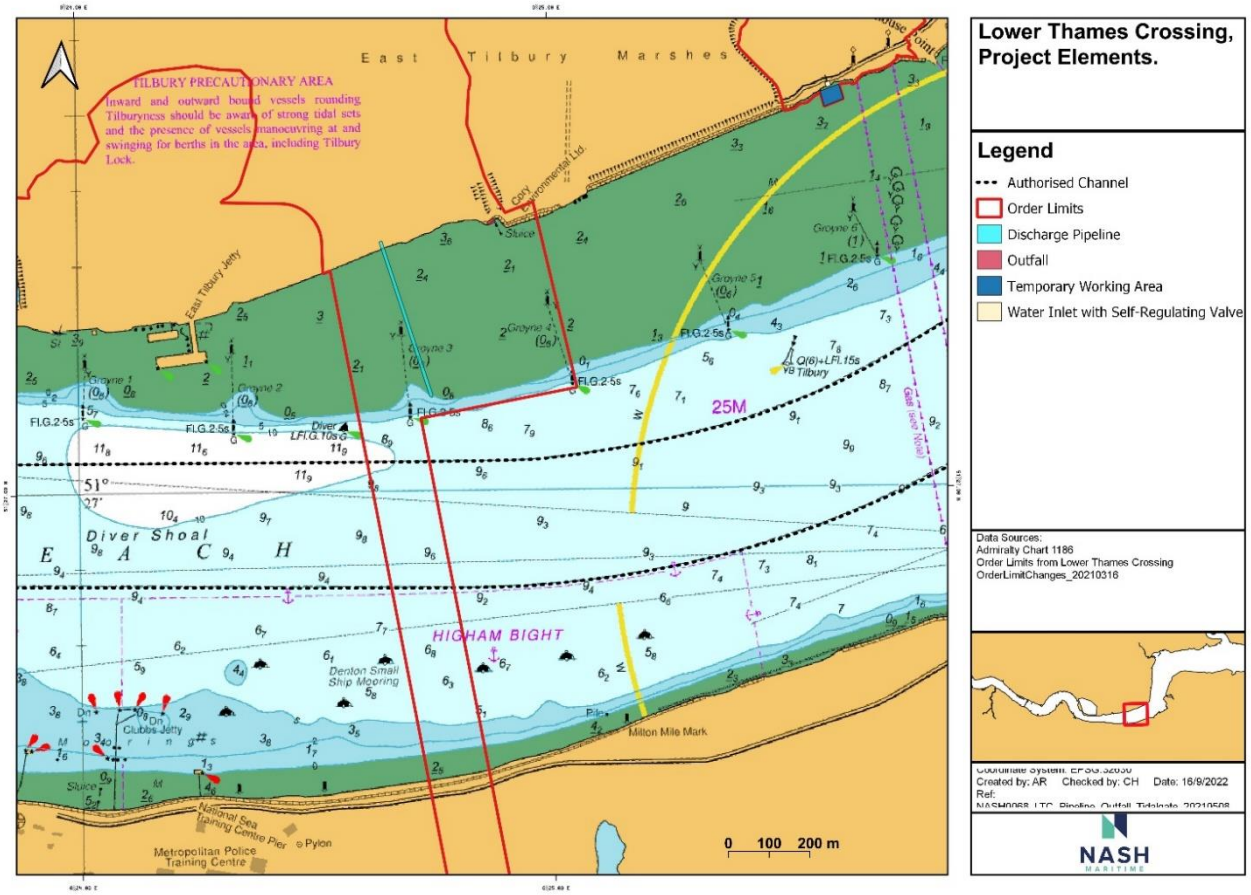
3.3 Key project features relevant to navigation

Temporary features

3.3.1 A temporary feature of the Project relevant to navigation is the discharge pipeline and diffuser that would installed on the northern side of the river (see Plate 3.2) between the existing groynes three and four. This would allow site drainage to be discharged during construction of the Project. The pipeline would terminate at its offshore end with a diffuser.

3.3.2 A temporary cofferdam, west of the high-pressure gas pipeline that crosses beneath the River Thames is also relevant to navigation. This is required to establishing a temporary working area of approximately 20m (longitudinally to the flood defence) and 35m (extending into the Thames) asdepicted in blue in Plate 3.2 . The temporary working area is required to facilitate works to construct a permanent self-regulating Water Inlet with self-regulating valve or equivalent structure (further detailed in Section 3.3.4).

Plate 3.2 Discharge pipeline and outfall locations



Permanent features

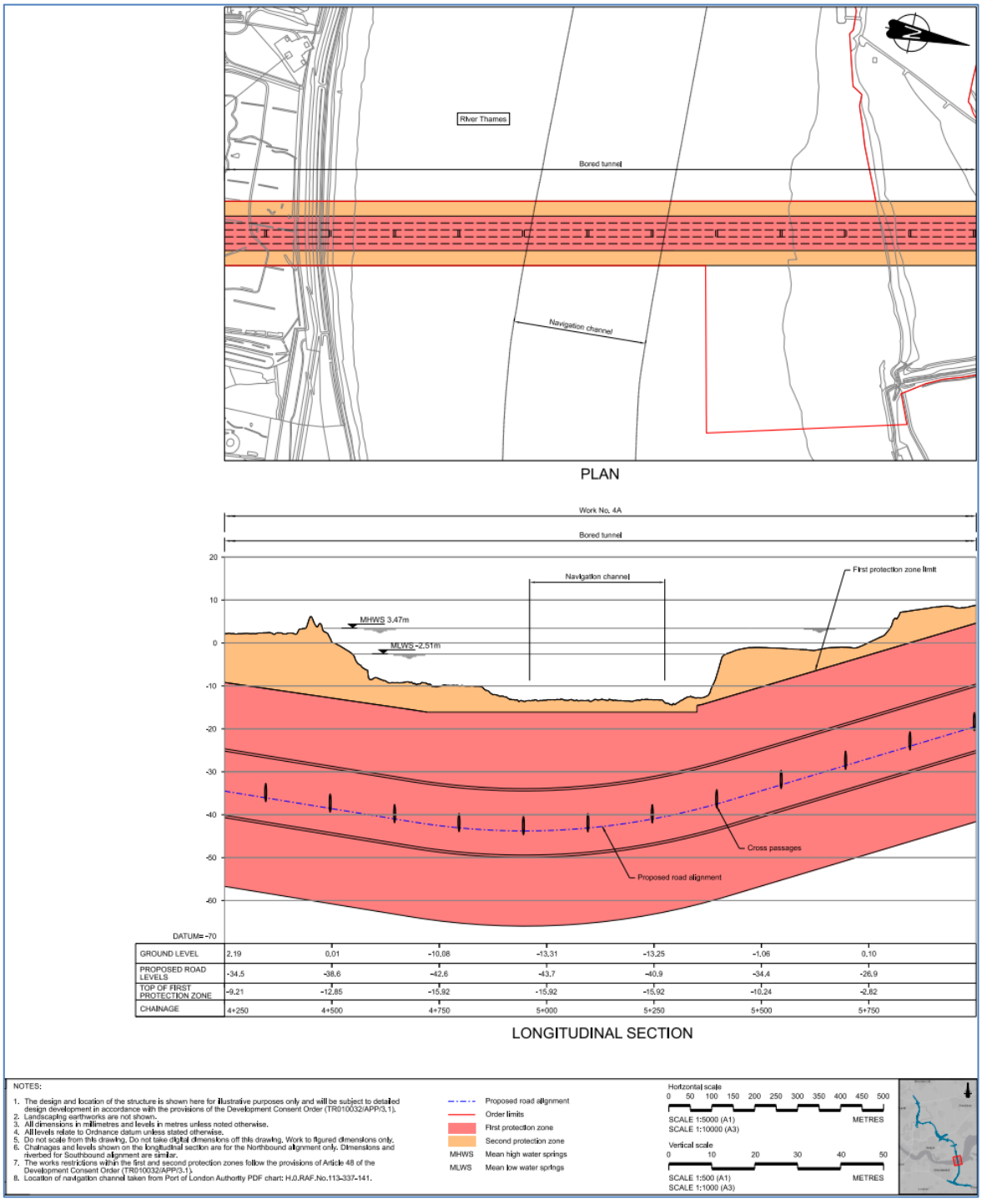
3.3.3 A permanent outfall would be installed on the shoreline for surface runoff (see Plate 3.2). This is not considered navigationally relevant due to its location in the seawall on the shoreline at/above mean high water (MHW). This location is not only outside the navigation channel but out of the river in all but very high tides.

3.3.4 A permanent self-regulating Water Inlet with self-regulating valve or similar structure and associated pipeline is required to provide a direct supply of water from the River Thames to maintain a range of depths within the proposed ecological habitat mitigation site in proximity to Coalhouse Fort. As with the permanent outfall, in Section 3.3.3, this is not considered navigationally relevant due to its location in in the existing flood defence above mean high water (MHW). This location is not only outside the navigation channel but out of the river in all but high tides.

3.3.5 The main permanent features of the Project relevant to navigation would be the protection zones surrounding the tunnel route as set out in the river restriction

plans (see Plate 3.3 DCO Document 2.14). Article 48 of the draft DCO sets out a number of permanent restrictions which would apply above the tunnels in the River Thames. In particular, Article 48 sets out that activities such as dredging, excavation, anchoring and any other activity which might reasonably be expected to affect the safe operation of the tunnels, would not be permitted without the consent of National Highways. The Article sets out particular works that is to be excluded from the requirement for this consent.

Plate 3.3 Protection zones in the River Restrictions Plan



3.4 Schedule

3.4.1 The Project indicative schedule can be found in the Environmental Statement Chapter 2: Project Description. (DCO document 6.1)

3.4.2 Further SIs in the river in the vicinity of the tunnel within the Order Limits, may be carried out by the tunnel contractor, once appointed, to support detailed design of the tunnel. No schedule information is available for these further SIs for the tunnel, but they can be assumed to be of a similar eight-week duration to those carried out in September 2019 and would need to be completed before construction commences.

3.4.3 Similarly, no schedule information is available for the SIs for, or the construction of, the temporary in-river features (pipeline and diffuser), and so assumptions have been developed. Given the small scale of the work, the SIs would likely take four weeks or less. Pipeline and diffuser installation is estimated to take 8–12 weeks overall. It would likely take place during site preparation/construction. The temporary pipeline and diffuser would be in place to support the management of process wastewater and rainwater runoff for the duration of the construction programme (2025 to 2030). The infrastructure may need to remain in place after the main construction works have been completed, until completion of the final landscaping and placement of excavated material stockpiles.

3.4.4 The protection zones would be in place from the approval of the DCO throughout the lifespan of the Project. This has a design life of 120 years.

4 Navigation in the area/baseline vessel traffic characterisation

4.1 Regulatory control

4.1.1 Navigation safety in the study area is managed through the legislation, guidance, procedures and practices noted below.

4.1.2 A defined authorised navigation channel is marked on Admiralty and PLA charts as shown in Plate 4.1. Clause 19.1 for the PLA General Directions (PLA, 2021b) states '*All Vessels of 13.7 metres or more in Length Overall navigating to the west of the Margaretness Limit must navigate only in the authorised channel as identified on PLA charts, and as required by Rule 9 of the International Collision Regulations, except in an emergency, for the purposes of overtaking, with the permission of London VTS, or when manoeuvring to or from berths, moorings or anchorages.*'

Legislation

a. Harbours, Docks and Piers Clauses Act 1847

b. Thames Conservancy Act 1932

c. Harbours Act 1964

d. Docks and Harbours Act 1966

e. Port of London Act 1968

f. British Transport Docks Act 1972

g. The Thames Barrier Flood Prevention Act 1972

h. Transport Act 1981

i. Thames Water Authority Land Drainage Byelaws 1981

j. International Ship and Port Facility Security Code 2004

k. Port of London Thames Byelaws 2012

4.1.3 The PLA has applied for a Harbour Revision Order that may result in some changes to the Port of London Act 1968[1].

[1] https://server1.pla.co.uk/assets/markupofportoflondonact1968-1.pdf

Guidance, procedures, practices

4.1.4 The following Maritime and Coastguard Agency (MCA) and PLA regulations, codes of practice and guidance as published on the PLA website (www.pla.co.uk) that are relevant here are:

a. Port Marine Safety Code (Department for Transport and Maritime and Coastguard Agency, 2016)

b. Port Marine Safety Code – Guide to Good Practice (Department for Transport and Maritime and Coastguard Agency, 2018)

c. Port of London General Directions (PLA, 2021b)

d. Port of London Marine Safety Management System (PLA, 2021c)

e. General Directions for Navigation in the Port of London 2021

f. Port of London Pilotage Directions 2017 (as amended) (PLA, 2017b)

g. Code of Practice for Craft Towage Operations on the Thames 2017 (as amended) (PLA, 2017a)

h. Code of Practice for Rowing & Paddling on the Tidal Thames (PLA, 2019)

i. Tidal Thames Recreational Users Guide (PLA, 2018)

j. Other codes of practice for mooring, berth operators etc.

4.2 Initial vessel traffic characterisation

4.2.1 An initial characterisation of the baseline vessel traffic in the area of the Project is presented in Section 4 of the pNRA Specification (Appendix A) using the AIS data from September 2018.

4.3 Updated vessel traffic characterisation

4.3.1 In this section, the initial vessel traffic characterisation and analysis from 2018 is updated using the AIS data (Class A (including Thames AIS Class A) and Class B) from July and October 2019 sourced from the PLA, as detailed in Section 5.1.3 of the pNRA Specification (Appendix A). The AIS data was also obtained from PoTLL for September and October 2020 (for specific analysis of Tilbury2 as presented in Chapter 5.4, which was not operational in 2019). The use of data from 2020 or 2021 is not considered appropriate given the potential impacts of COVID, and so the use of the data from 2018, as updated and validated in 2019, is considered valid for the purposes of this assessment.

4.3.2 The AIS data from 2019 and 2020 and the PLA reported incident data from 2010 to 2020 are described and presented in the following sections.

4.3.3 The area is used by a wide variety of vessel types including seagoing commercial vessels, tugs and service vessels, inland freight vessels, inland passenger vessels, and recreational craft such as yachts, motorboats and rowing boats. These groupings have been used to describe and assess the AIS data in this section and within the subsequent risk assessment of Chapters 8 and 9.

Overall traffic density

4.3.4 The vessel traffic density plot (Plate 4.1) shows the highest traffic density within the authorised channel with up to 900 transits per month. There is also some use of the navigable water on the north side of the channel and within the Order Limits running roughly east to west just north of the authorised channel.

4.3.5 To the west of the in-river Order Limits, there are also up to 100 transits per month to/from the East Tilbury jetty. These are mostly related to tunnel material exports from the Thames Tideway project activity, which will likely be largely complete before DCO grant. The current planning permission (17/00224/FUL) for the East Tilbury jetty which expired on 24 Aug 2022 and requires that the jetty is removed on or before that date. Though the jetty may be used for other purposes/projects in future, no specific projects are known to have specified its use at this stage. Furthermore, any future use would require an extension/application for planning permission and/or river works licence and a NRA for the intended use. Therefore, for the purpose of this pNRA, no future vessel movements on/off the East Tilbury jetty have been assumed.

4.3.6 The concentration of traffic volumes within the authorised channel are illustrated further in Plate 4.2, showing directional and spatial distribution across the river width. There are westbound peaks in vessel transits to the northern side of the channel and eastbound peaks to the south, i.e. on the starboard side of the authorised channel. North of the authorised channel, almost all transits are also westbound where vessels that are able to navigate outside the authorised channel . A greater directional mix is seen south of the authorised channel (although the majority of transits are still eastbound) which is likely due to the use of the Higham Bight anchorage, moorings and approaches to/from the range of marine facilities on this side of the river for vessels (for the avoidance of doubt, these vessels rarely anchor whilst carrying explosive materials).

Plate 4.1 Vessel traffic density 2019

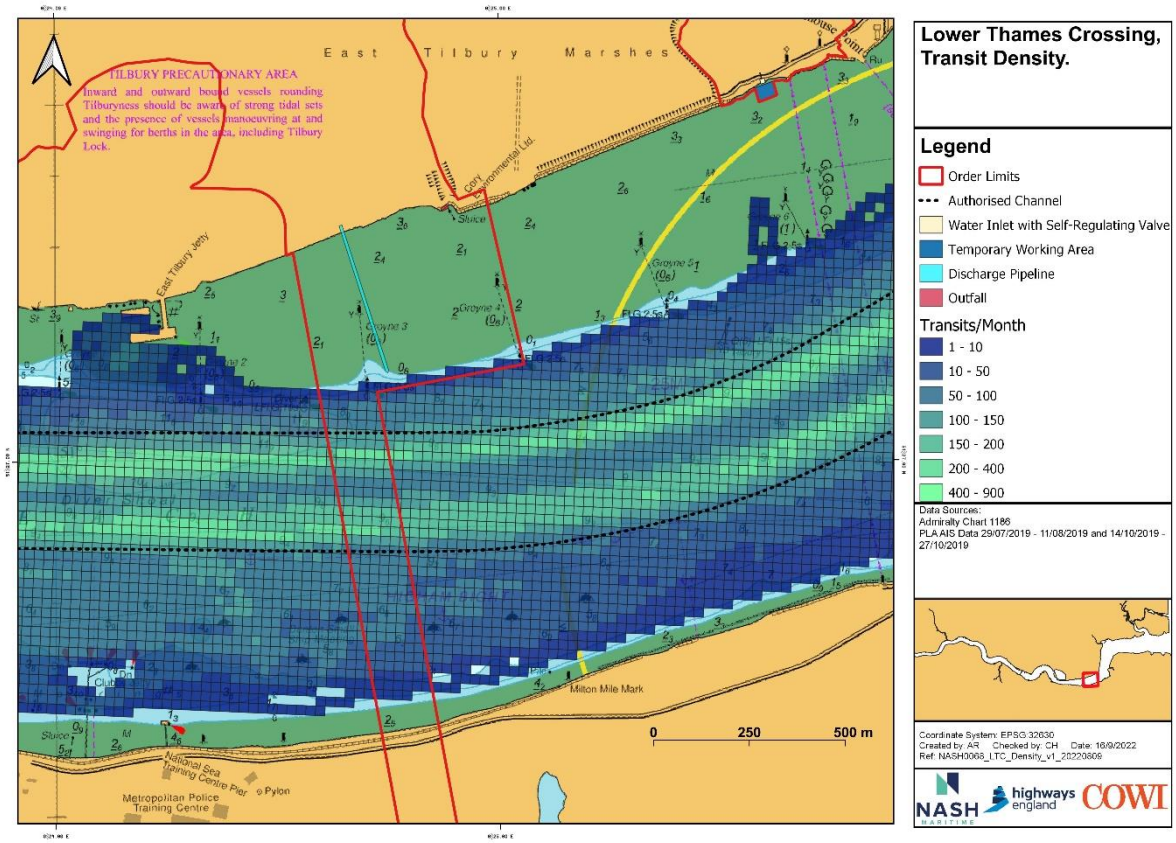
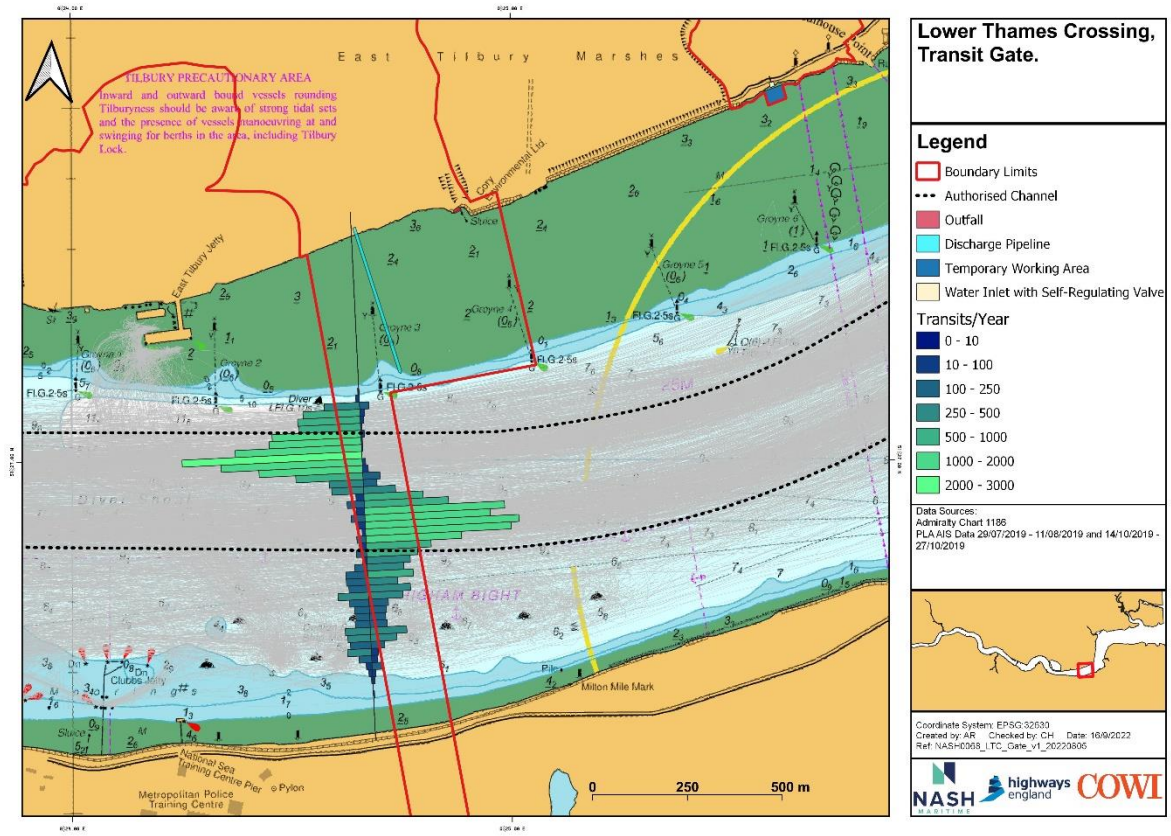


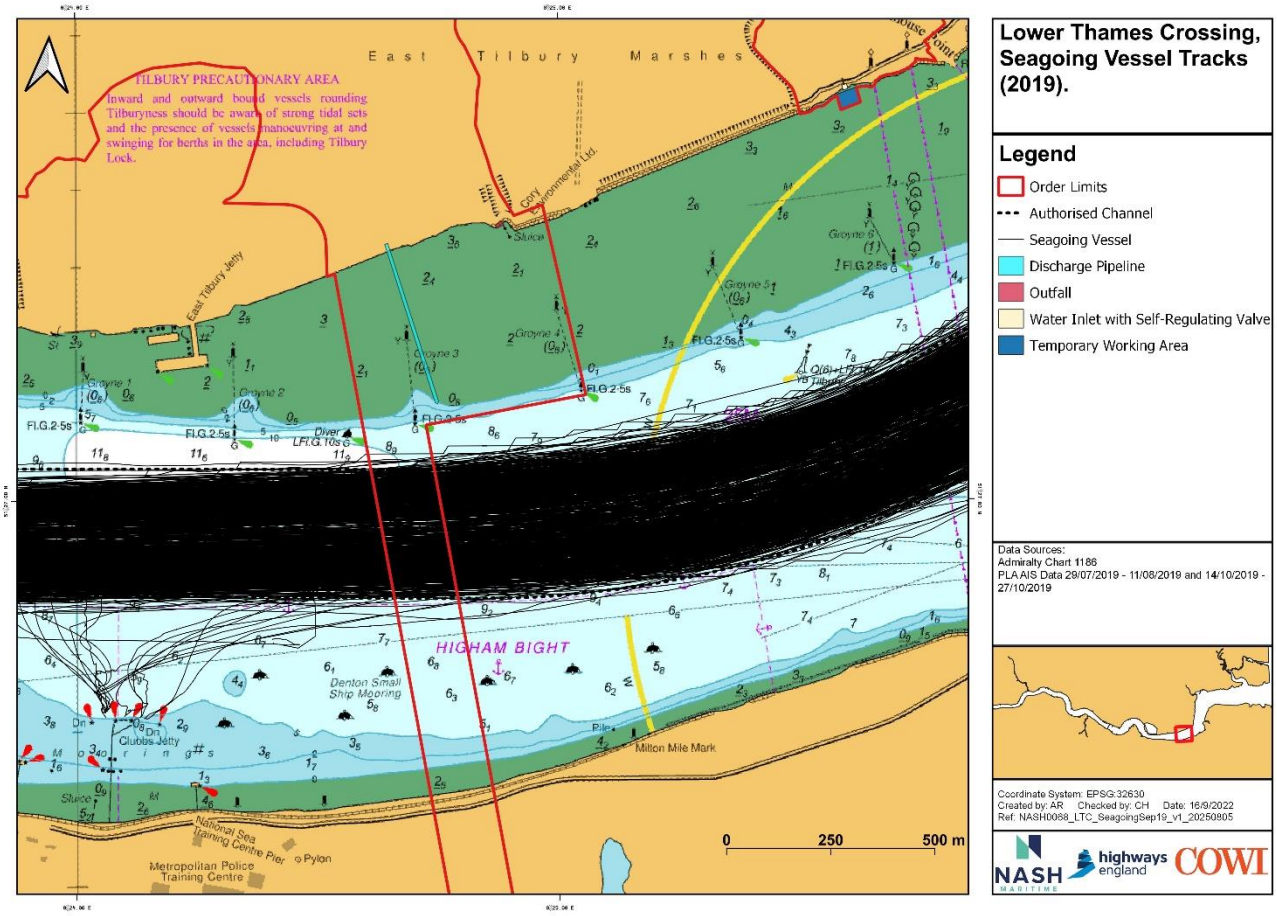
Plate 4.2 Vessel gate analysis 2019



Seagoing vessels

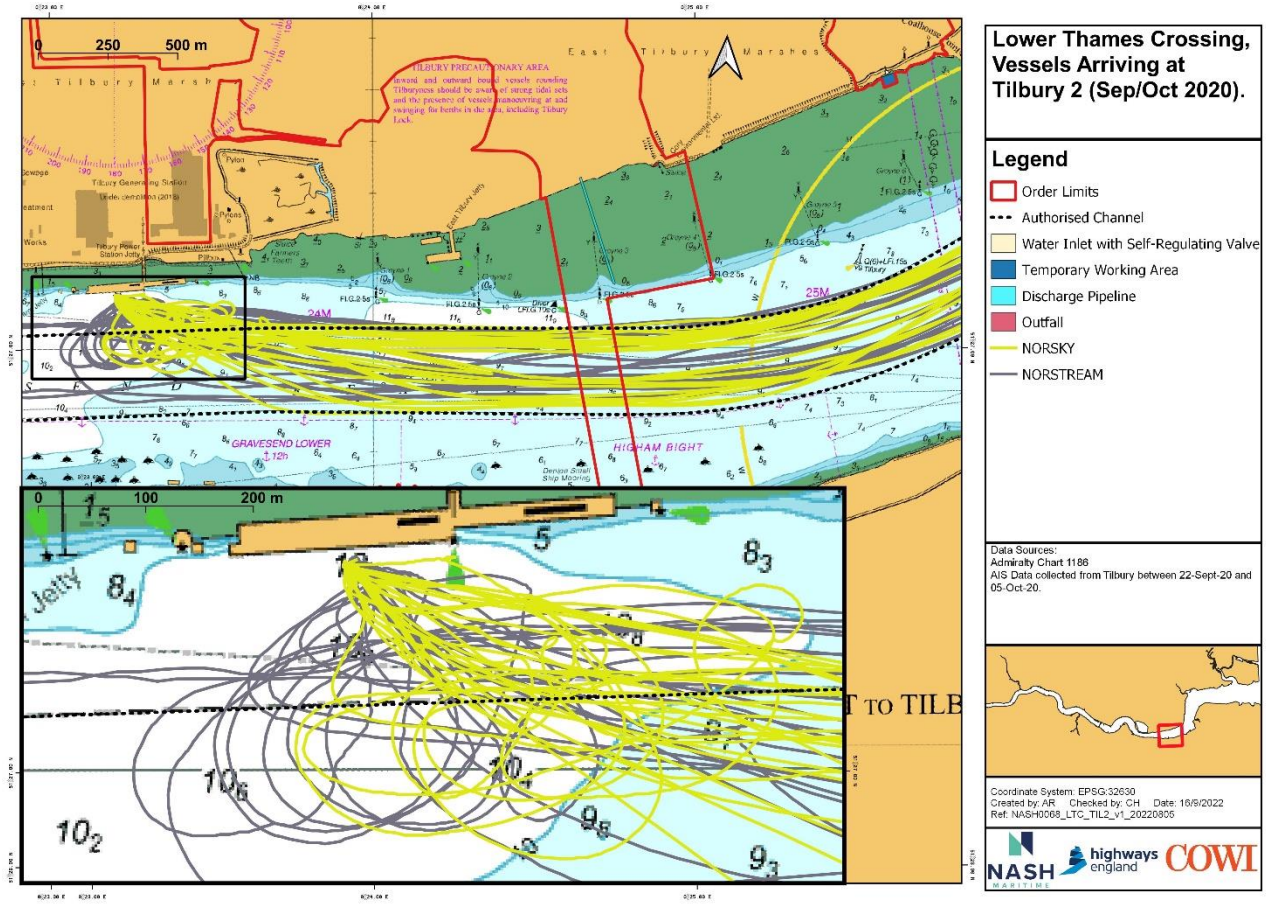
4.3.7 Seagoing vessel tracks show (as expected) most activity for these larger, deeper draught vessels within the authorised channel (Plate 4.3) with a few visiting Clubs jetty on the southern side of the river to the west of the Order Limits.

Plate 4.3 Seagoing vessel tracks 2019



4.3.8 The data in Plate 4.3 excludes seagoing vessels visiting the Tilbury2 facility, as this was not open in 2019. Therefore, additional AIS data was procured from PoTLL for 2020 (22 September to 5 October) to examine the tracks of these vessels. Plate 4.4 illustrates the vessel tracks, showing that within the Order Limits, the vessels remain largely within the authorised channel on transit. Furthermore, the vessels are seen completing manoeuvres on/off the Tilbury2 jetties at least 800m to the west of the Order Limits within the river. The 2020 data only shows use of the upstream roll-on/roll-off (Ro-Ro) berth at Tilbury2. It is expected that the downstream berth usage will increase for Ro-Ro vessels and those using the Construction Materials and Aggregates Terminal (CMAT) berth. Nevertheless (as noted in the minutes of the workshop with PLA/PoTLL, 10 May 2021 (Appendix B)), the PoTLL Marine Asset Manager, considered that the approaches/departures shown in the data (including the swinging on/off the berth) are spatially representative of how movements will occur in the future across Tilbury2.

Plate 4.4 Seagoing vessels at Tilbury2 in 2020



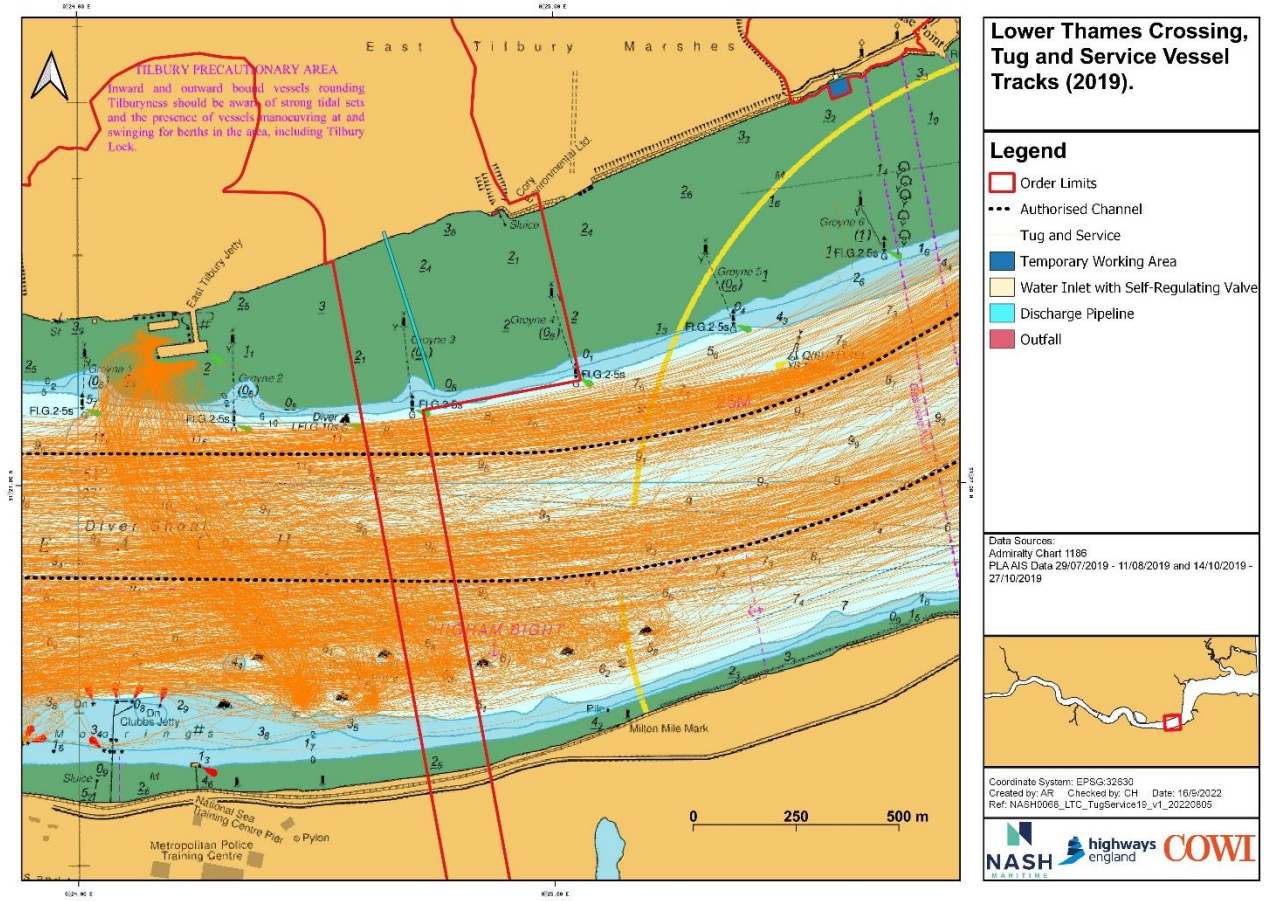
Tug and service vessels

4.3.9 Tug and service vessels make extensive use of the authorised channel but are also seen to navigate outside of the authorised channel both to the north and south of the river, as seen in Plate 4.5. To the north, none of the tracks encroach inshore of the east–west Order Limits near the temporary pipeline and diffuser (between groynes three and four). The tracks also pass well clear of the temporary works area (north of groyne six). The tracks also show the use of the East Tilbury jetty and mooring buoys within the Higham Bight anchorage and Denton moorings to the south of the river. As noted above, much of this activity is related to the Thames Tideway project. Information from the PLA (email 11 June 2021) confirmed that Thames Tideway usage of the mooring is continued until August 2022 and that the other Denton moorings have a variety of operators licensed to use the moorings, as summarised in Table 4.1.

Table 4.1 Vessels using Denton moorings

Mooring	User/licensee	Typical vessel type	Typical maximum deadweight tonnage (t)
PLA Denton Swing TTT No. 33	Thames Tideway	Barge (max 4, 2 loaded)	5,000
PLA Denton Swing TTT No. 33	Thames Tideway	Barge (max 4, 2 loaded)	5,000
PLA Denton Swing TTT No. 33	Thames Tideway	Barge (max 4, 2 loaded)	5,000
PLA Denton Small Ship No. 8	GPS Marine	Barge	<4,000
PLA Denton No. 2 Petroleum	PLA craft	Harbour/marine service vessels	<1,000
PLA Denton No. 2 Small Boat	Thameside Marine Services	Barge (max 2 at one time)	<2,000
PLA Denton No. 1 Swing	Briggs Marine	Barge (Forth Atlas + 1 other)	2,000
New (red circle on chart)	Boluda Towage	Tug (max 2 at one time)	<1,000

Plate 4.5 Tug and service vessel tracks 2019



Inland freight and passenger vessels

4.3.10 Inland freight vessel tracks (Plate 4.6) show vessels navigating mainly at the edges/outside the authorised channel with a number of vessel tracks using moorings within the Higham Bight anchorage. None of the tracks encroach inshore of the east–west Order Limits near the temporary pipeline and diffuser (between groynes three and four) or near the temporary works area (north of groyne six).

4.3.11 There are very few inland passenger vessels navigating in this part of the River Thames, as evidenced by the very low number of vessel tracks in Plate 4.7. Most of the vessels do, however, pass close to (within 50–100m), but do not cross inshore of, the east–west Order Limits near the pipeline (between groynes three and four). The tracks pass well clear of the temporary works area and south of groyne six.

Plate 4.6 Inland freight/cargo vessel tracks 2019

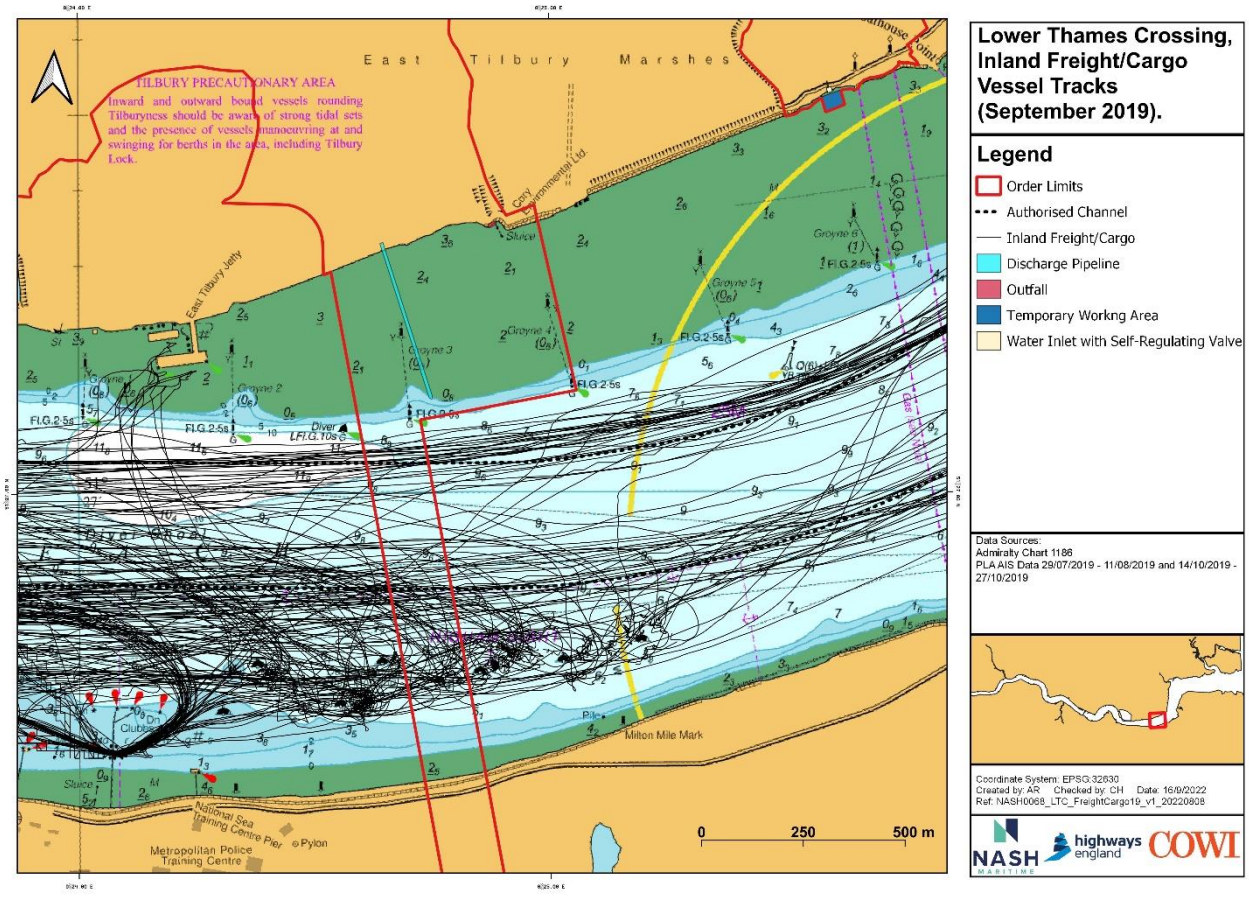
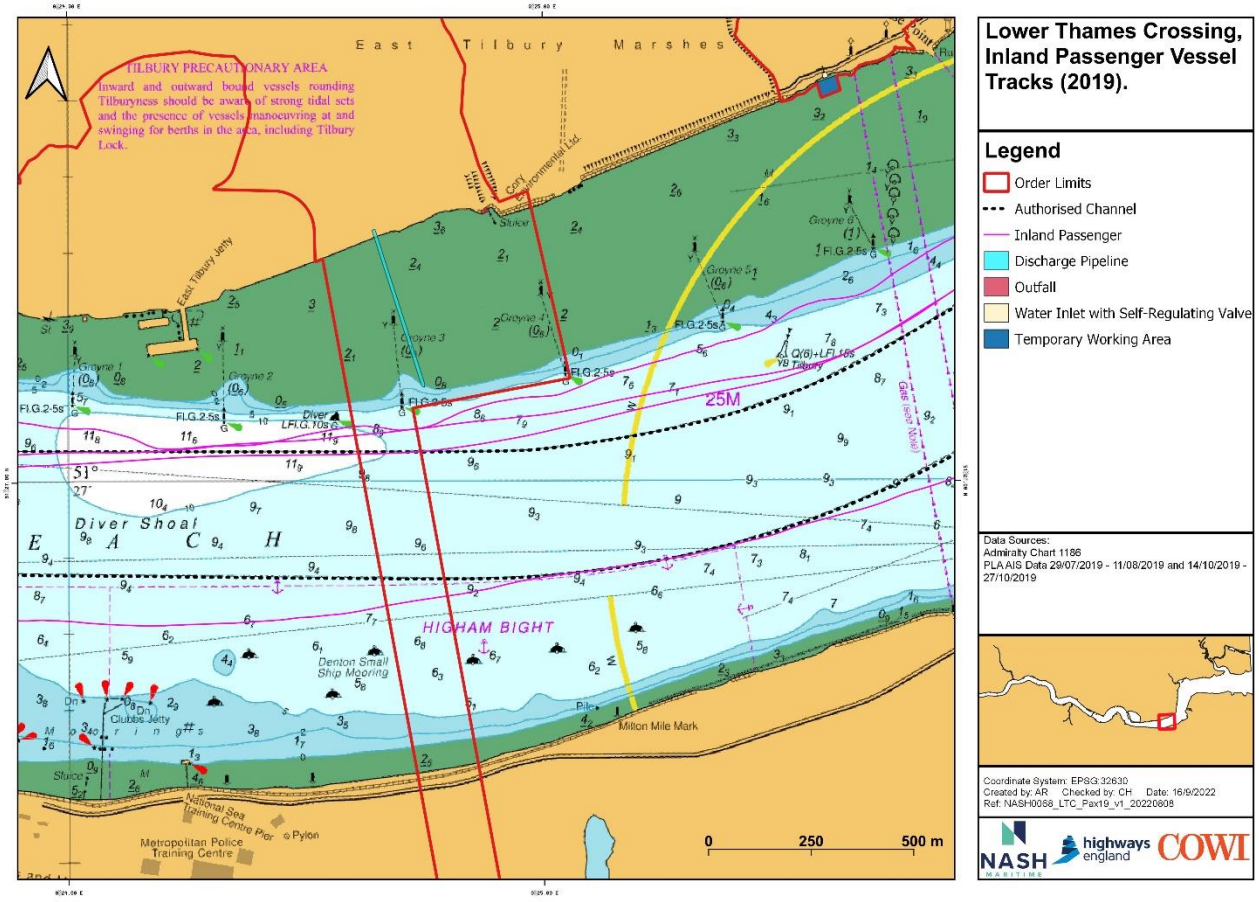


Plate 4.7 Inland passenger vessel track 2019

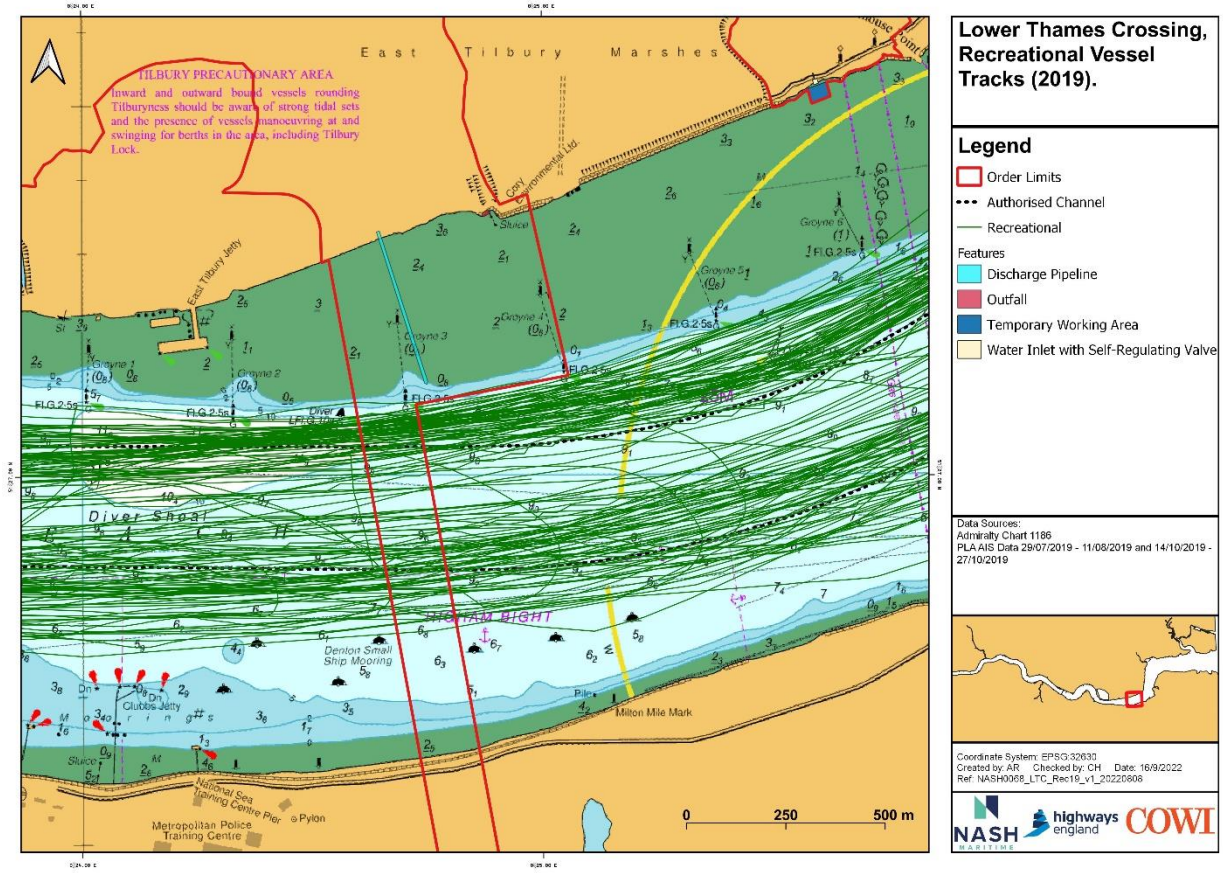


Recreational vessels

4.3.12 Recreational vessel tracks in Plate 4.8 show the vessels navigating at the margins of the authorised channel, with a high density of vessel tracks passing close to, but not crossing inshore of, the east–west Order Limits near the pipeline (between groynes three and four). All recreational vessel tracks pass south of groyne six and well clear of the temporary works area.

4.3.13 The vessel tracks represent larger recreational vessels (typically yachts and motor vessels) fitted with AIS transmitters. Other vessels without AIS and smaller vessels (such as sailing dinghies, small powered craft, rowing craft and kayakers) may also be using this area, but are not recorded within the data, and so this vessel category will typically be underrepresented in the data. Engagement with local stakeholders, including the PLA and local recreational user clubs, has confirmed that some use the areas within the Order Limits for navigation to/from their home base and in the course of racing events. This may occasionally include navigating between groynes three and four, subject to suitable water depths being available.

Plate 4.8 Recreational vessel tracks 2019



4.4 PLA recorded incidents

4.4.1 Marine incidents recorded by the PLA within the study area over the last 11 years (2010–2020) are categorised as follows:

a. Breach of byelaws/regulations

b. Collision

c. Contact

d. Grounding

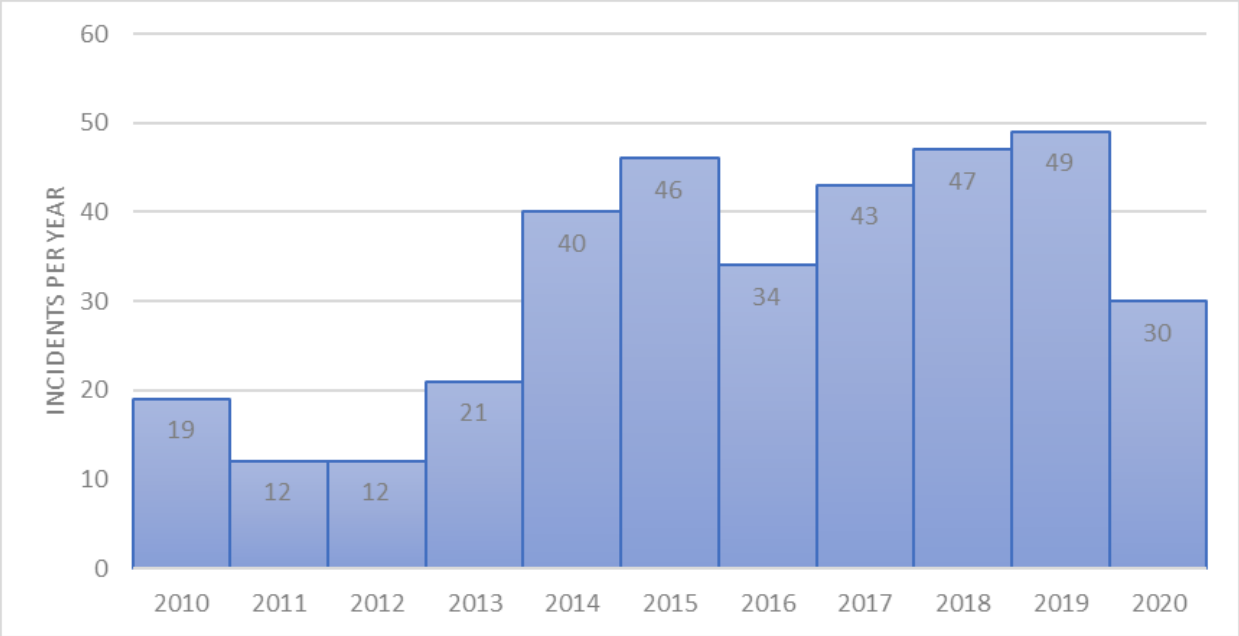
e. Machinery deficiency

f. Wash/draw off

g. Other/near miss

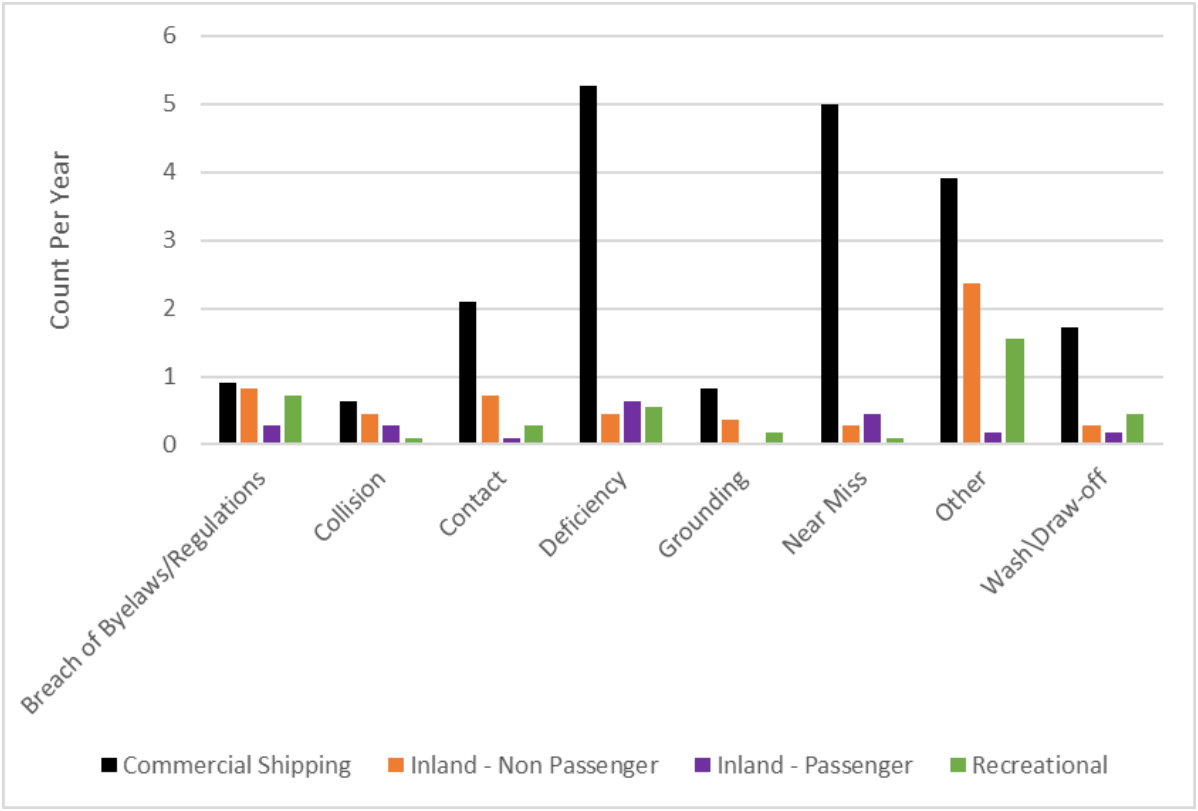
4.4.2 The data shows that all categories occurred within the period with a total of 353 incidents, giving an average of about 30 per year (it should be noted that the step between 2013 and 2014 is understood to be attributable to a change in reporting of incidents rather than a change in trend). Plate 4.9 shows that the number of incidents peaked at 49 in 2019. The substantial drop in 2020 is at least in part due to the lower traffic volumes associated with the impact of COVID-19.

Plate 4.9 PLA recorded incidents 2010–2020 by year



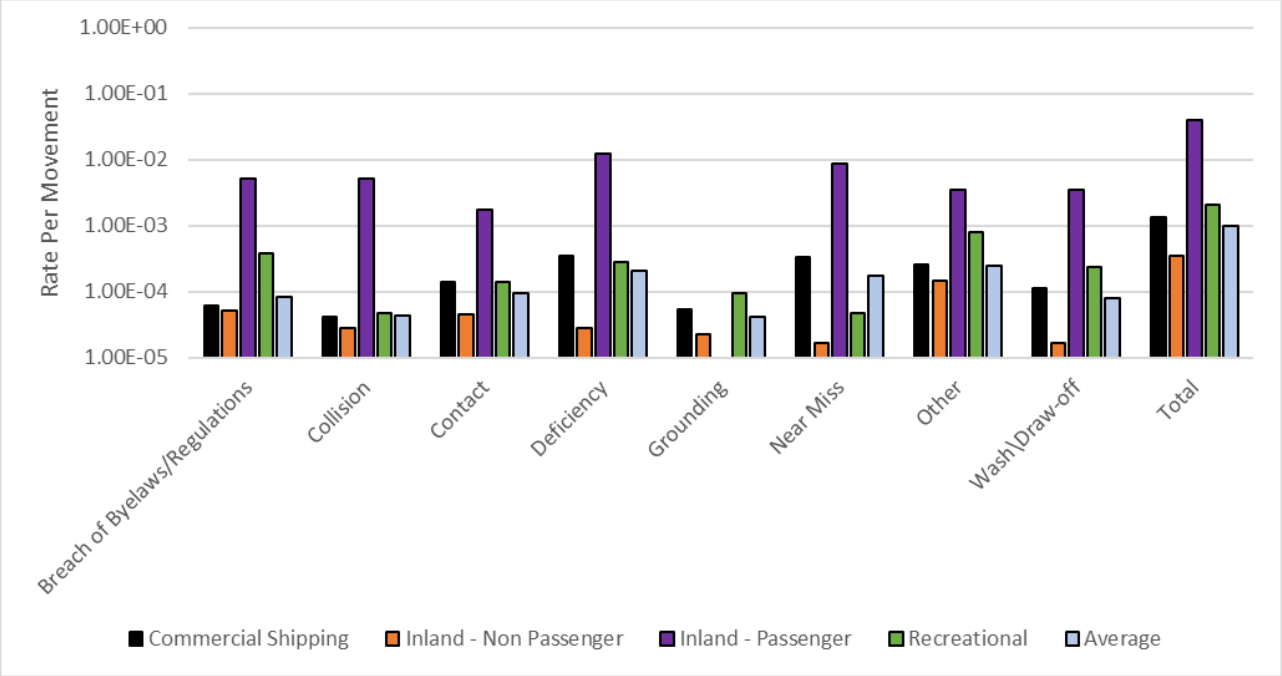
4.4.3 The split between incident type and vessel type is illustrated in Plate 4.10. It shows most incidents relate to commercial shipping, with most of these being machinery deficiency, near miss or 'other' incidents.

Plate 4.10 PLA recorded incidents 2010–2020 by incident and vessel type



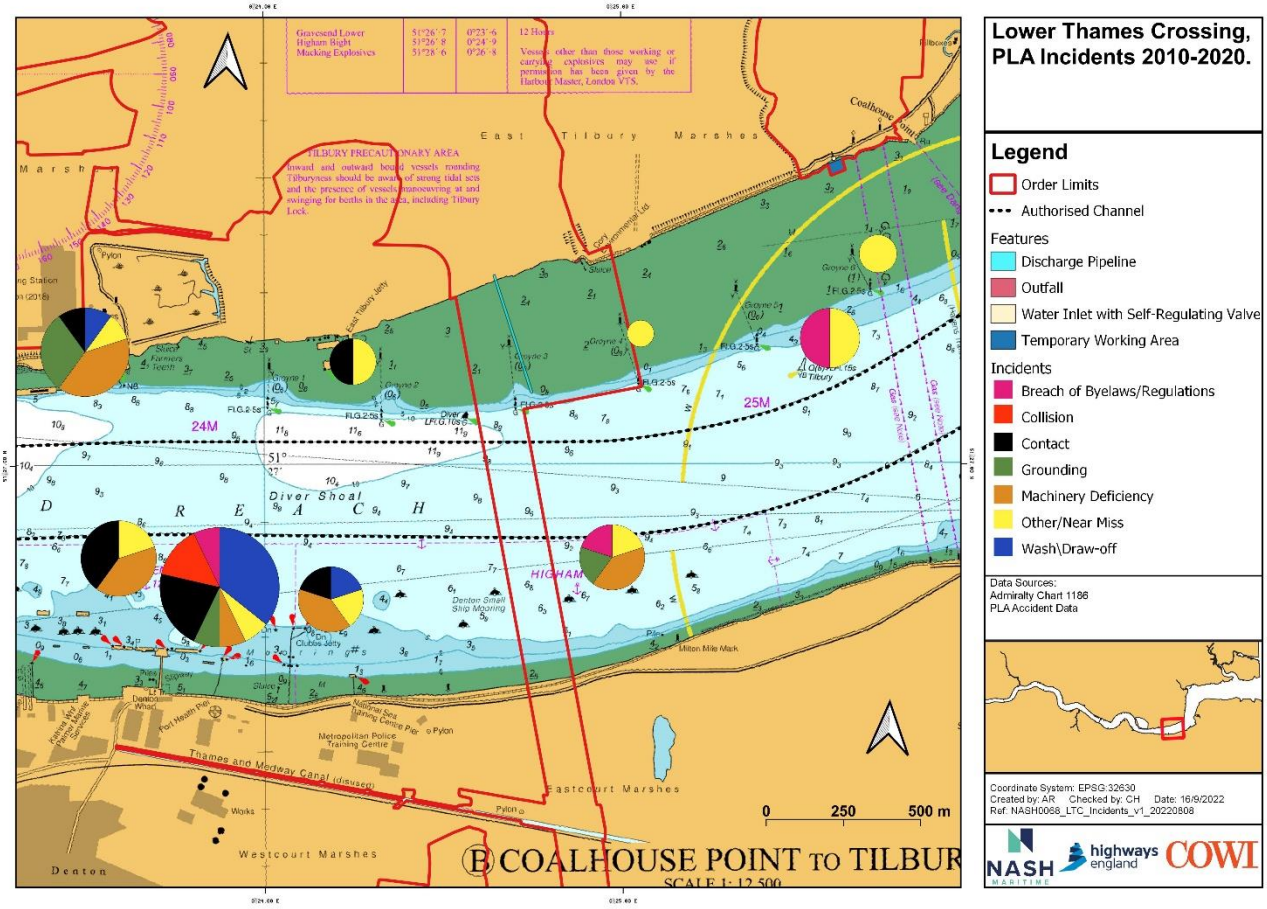
4.4.4 The higher number of incidents for commercial shipping compared with other categories is not unexpected, given the large number of commercial vessels transiting the study area. Analysis of the number of incidents per vessel movement (see Plate 4.11) shows that inland passenger vessels have the highest incident rate for all incidents, except grounding.

Plate 4.11 PLA recorded incidents 2010–2020 – frequency per vessel movement



4.4.5 Analysis of the incidents by location (Plate 4.12) shows that most incidents occurred off the Denton wharf on the south side of the river and all were outside the authorised channel. Two incidents occurred at/close to East Tilbury jetty (contact and other/near miss) and one (other/near miss) near groyne four on the Order Limits.

Plate 4.12 PLA recorded incidents 2010–2020 by incident type and location



4.4.6 Incidents of particular relevance due to proximity to the Order Limits and/or due to the nature of the incident type, include the following:

a. **MAR-2013-000262** – 'CMA CGM JADE (261m * 8.8m) overtook the THOR ENERGY (185m * 10.6m), both vessels were outbound in the vicinity of the Divers Buoy. HW Tilbury 2058. CMA CGM JADE was logged doing 14.6kt over the ground with THOR ENERGY making 9.6kt. As the vessels came into close proximity, the THOR ENERGY took a substantial sheer to port due to the interaction, whilst the CMA CGM JADE took a sheer to starboard. The pilot on THOR ENERGY maintained hard to starboard and full ahead for a considerable time to recover the situation whilst the CMA CGM JADE ended up outside the south side of the channel at Higham Bight.'

b. **MAR-2013-000289** – 'The tug GPS INDIA was towing barges between Denton Buoys and the Goshem's Farm jetty. The tug had already taken two barges from the south side to the north side when, on his third run north, he became disoriented in the fog and got swept down with the tide. In an effort to avoid one of the groynes, the barge ran aground on the north shore close to the east of East Tilbury jetty. The tug was undamaged, but there was significant damage to the barge. The barge was later refloated and removed on the rising tide. The barge was repaired at Goshem's Farm jetty and was inspected by PLA Marine Surveyors before being allowed to work again. Damage was confirmed at £120,000.'

c. **MAR-2014-000261** – ‘At 17:55 the Fast RIB TWIST requested lifeboat assistance following twin engine failure with nine people on board. At 18:02 the Gravesend lifeboat launched. At 18.08 the TWIST was under tow by the lifeboat. At 18.35 the TWIST was secured to Town Pier. Upon inspection, the following was found. Port Engine: Electric Fuel Pump seized which allowed the engine rack to lose pressure, subsequently the engine stalled. Starboard Engine: the engine lost cooling water whilst attempting to return on a single engine. It was found that the bearing to the water pump collapsed which caused the fan belt to then mis-align. All repairs have been carried out.’

d. **MAR-2015-000150** – ‘The motor cruiser LUCILLE was outward bound in Gravesend Reach, and upon passing Royal Terrace Pier, cut across the river towards the north side, intending to pass around Coalhouse Point on the north side. This course led her to pass over at least one of the groynes on the north side before hitting a second in the area of the Tilbury Buoy, which opened up one of the keels of the vessel. She immediately took on water and the owner and his wife were very lucky to be rescued by the Gravesend Lifeboat as the vessel began to sink. Assisted by the Harbour Service, pumps were deployed and the vessel successfully towed to Denton Wharf, where she subsequently sank alongside the main jetty. The vessel was lifted out onto the jetty later that evening by Marine Services. The owner was interviewed by the Deputy Harbour Master the following day.’

e. **MAR-2017-000039** – ‘Workboat Shakedog towing a jack up rig, came into contact with the yellow inner groyne marker no. 2. Following the lifting of the jack up rig legs the master began to transit to the next required location, however it soon became clear that he was unable to manoeuvre and one or more of the legs were caught in the mud. The vessel and tow made contact with the groyne marker as a consequence. Both parties involved have been advised to ensure that communications are improved upon when carrying out this type of operation and the master was reminded of his obligation to be 100% sure of the draft of the object to be towed.’

f. **INC-2020-06-28-4317 SCUDA** – ‘Vessel ran aground on groynes at Diver Buoy.’

5 Future vessel traffic

5.1.1 In this Chapter, consideration is given to the potential changes in traffic in the study area which might result from general increases in traffic on the River Thames driven by factors including port strategy, wider economic trends, environmental goals, specific projects previously identified (which may make use of the River Thames for transport) together with known and planned developments at Tilbury and the Project related vessels .

5.2 Future vessel traffic on the River Thames

5.2.1 The Thames Vision 2035 (PLA, 2016) was launched by the PLA in 2016 and includes goals to:

a. Handle 60–80 million tonnes of cargo each year within the Port of London

b. Double inland waterways freight carried on the river from 2 million to 4 million tonnes per year

c. Double the number of people travelling by river to reach 20 million trips per year

d. Increase participation in sport and recreational activities on and alongside the water

5.2.2 The Port of London Economic Impact Study (PLA, 2020) showed that the port handled 54 million tonnes of freight in 2019 and handled 9.8 million passenger journeys during April 2018 to March 2019 (9.2 million for April 2019 to Feb 2020; March 2020 data is not available and may be impacted by COVID-19). This study did not report on inland freight or recreational use of the River Thames.

5.2.3 The Thames Vision Progress Review 2016–2020 (PLA, 2021d) noted the 2019 peak in port trade at 54 million tonnes and 3.4 million tonnes of (non-project) inland waterways freight. It also reported around 10 million passenger trips per year from 2015 to 2019 and various initiatives which had led to giving more people access to the River Thames for recreation.

5.2.4 The Future Trade through the Port of London, Alternative Decarbonisation and Growth Pathways (Oxford Economics, 2021) report published in May 2021 forecasts (under its central/base case scenario) a total of 77 million tonnes of cargo passing through the Port of London by 2050. This is driven by a big increase in inter-port trade in unitised cargo and forest products (timber for construction) offset somewhat by a decrease in liquid bulks (petroleum products) by 2050. Intra-port trade (cargo moving between terminals on the River Thames and cargo from Medway and Brightlingsea) is forecast to remain static out to 2050.

5.2.5 All of the Thames Vision 2035 goals and the Future Trade through the Port of London forecasts will add to the river traffic but are unlikely to materially change the type of vessels transiting the study area or their typical use of that area. The projected increase in vessels carrying unitised cargo and decrease in liquid bulk vessels will likely mainly impact on terminals downstream of the study area and will thus not impact the Project navigation risks.

5.3 Future vessel traffic from other projects

5.3.1 Potentially relevant interfacing projects were identified in the pNRA Specification (see Appendix A) following a presentation to and discussion with the PLA. During the risk assessment workshop help in May 2021 (see Appendix B) it was agreed that these projects: Thames Tideway, Thurrock Flexible Generation Plant, Silvertown Tunnel and London Resort and further developments at Tilbury (see 5.3) are not likely to impact on the baseline traffic movements illustrated in the 2019/2020 AIS data to an extent which is likely to be relevant for the Project. Following the withdrawal of the London Resort it is National Highway's understanding that the proposals for use of the river by the London Resort project are undergoing change. At the current time, no further information has been made available for consideration in this document.

5.3.2 Whilst movement numbers may decrease or increase in the future, the vessel types/mix is likely to be comparable. No significant change in 'how' vessel traffic spatially uses the Project area is expected. There is therefore no cumulative impact from these projects on the Project.

5.4 Projected future traffic to Tilbury2, CMAT and Thames Freeport

5.4.1 PoTLL expects the use of Tilbury2 Ro-Ro and CMAT facilities to continue and to grow in future with vessel types being similar to those currently using the terminal.

5.4.2 PoTLL is planning future expansion, including to support the recently announced Thames Freeport. In relation to potential impact on the Project, PoTLL confirmed in a meeting on 10 May 2021 (Appendix B)) that:

a. Whilst future developments may spread to the east on land/in the river, they will go no further east than groyne one.

b. Although marine usage of these future facilities (design and vessel type/size etc.) is yet to be defined, PoTLL consider that they will approach/depart berths in a similar way to that shown in the Q4 2020 data.

c. PoTLL envisage that future project plans will be well clear of any interface issue with the Project and foresees no material impact in relation to the works.

5.5 Project vessel traffic

5.5.1 Project vessel traffic would comprise the following:

a. Tunnel site investigation vessels – these are excluded from this pNRA but will be considered in the context of the NRA for SI survey as noted in Section 2.2.

b. Temporary works site investigation vessels – likely to comprise small inshore survey vessel and/or barge with spudcans or an anchor spread for mooring and possible safety boat. These would be present for the survey works associated with the pipeline to be installed between groynes three and four.

c. Temporary works construction vessels for the construction of the pipeline – likely to comprise a dumb barge with spud legs or anchors on winches with a 30–50 tonne 360 excavator and multicat with 5 tonne lifting capacity to set anchors. This would perform excavation of a 2m wide pipeline trench, sheet piling along the trench (driven to or cut off at riverbed), installation of the pipeline in the trench and backfilling. The piling barge would be supplied by a feeder barge carrying sheet piles and a headwall/diffuser unit to be installed at the offshore end of the pipeline. The headwall/diffuser may require a minor cofferdam for installation and monopiles for support. Construction is estimated to take up to 8–12 weeks, with all intertidal work carried out around periods of low water.

d. Temporary works construction vessels for the construction of the temporary works area– likely to comprise a dumb barge with spud legs or anchors on winches, with a 30 to 50 tonne excavator, a supply barge and a multi cat that has a 5-tonne lifting capacity to set anchors as required.

e. Permanent works construction vessels for the construction of the self-regulating Water Inlet with self-regulating valve – likely to comprise a dumb barge/ Jack up barge or pontoon and supply barge.

f. Project related vessels considered in this pNRA are limited in number (likely to be less than 10 in total) and would be operational for limited periods. There would therefore be no discernible cumulative impact on overall vessel numbers in the study area, which (as noted in Chapter 4) sees over 900 vessel transits per month in some sections of the authorised channel.

g. Material supply vessels to support the tunnel and other civils construction. These may comprise a variety of vessels delivering bulk materials (e.g. sand, aggregates) and/or precast tunnel segments. These marine imports would be to established facilities; therefore, these movements would be included under existing navigational risk assessments for PLA and any other SHA (e.g. PoTLL if movements enter their limits). On this basis, material supply vessels for the Project are excluded from this pNRA. As noted above, this has been agreed with the PLA and PoTLL.

6 Stakeholder consultation

6.1 Previous consultation

6.1.1 Consultation was held with the PLA and PoTLL in January and March 2021. This helped to inform and refine the development of the pNRA Specification (Appendix A), including requirements for wider stakeholder consultation which was undertaken during the pNRA. Details of this consultation are included within the pNRA Specification document in Appendix A.

6.2 Technical Engagement on pNRA

6.2.1 A letter to the identified consultees (see Table 6.1) inviting them to discuss the Project and to understand any issues/concerns they might have regarding navigation safety and other potential marine impacts.

Table 6.1 Consultee list

Consultee organisation	Contact
Port of London Authority	Senior Harbour Master
Port of Tilbury London Ltd	Asset Manager Marine
Port Health Pier	Port health department
Gravesend Sailing Club	Club secretary
Gravesend Rowing Club	Club secretary
Thurrock Yacht Club	Club secretary
National Maritime Training Centre (North Kent College	NTMC Manager
Gravesend Embankment Marina (Lock Basin)	enquiries

6.2.2 The PLA and PoTLL joined the NRA workshop on 10 May 2021, described in detail in Chapter 9.

6.2.3 Of the other stakeholders:

a. The National Maritime Training Centre responded to note that most of their activities took place on the southern shores of the River Thames and thus would be largely unaffected by the construction operations or increased river traffic.

b. Gravesend Sailing Club and Thurrock Yacht Club representatives joined a further engagement workshop on 13 May 2021 at which NASH Maritime presented the results of the NRA and discussed their issues/concerns. Minutes of this meeting are presented in Appendix C. The consultees noted that previous developments on the north bank of the River Thames had affected sedimentation at/near their facilities, and they were keen to confirm that no changes were expected as a result of the Project. The consultees were also encouraged to consider completing the ‘keep in touch’ page for the Project in order to receive updates on the Project timetable and scope.

c. The MMO was requested to provide comments, but confirmed it had none and that it was a matter for the relevant SHAs.

d. None of the other identified stakeholders responded.

6.3 Further technical engagement on the water inlet with self-regulating valve

6.3.1 Further consultation was held with the PLA during August 2022 to determine if the addition of the temporary works area impacted the navigational risk profile and subsequently the hazard risk scoring. NASH Maritime invited written representation to ascertain whether the PLA agreed that the addition of the temporary works area had no material impact on the hazards identified and assigned risk scores.

6.3.2 The PLA Senior Harbour Master responded via email on 19 August 2022 stating, that on the basis of the proposed design and construction methodology (as outlined in HE540039-LTC-EWE-S07-REP-ENV-00001) the PLA are satisfied that the existing pNRA sufficiently covers the inclusion of the temporary works area in the pNRA scope.

7 Navigational risk assessment methodology

7.1 Tunnel pre-construction phase

7.1.1 Further ground investigations within the River Thames would be required to support the tunnel design. A pNRA for the previous similar investigations was agreed with the PLA in 2019 (National Highways, 2019). The PLA agreed that the 2019 pNRA remained a valid basis and the risk controls agreed from this work would be anticipated to be taken forward for any further work[2].

7.2 Risk assessment for temporary works in the river

Approach

7.2.1 The formal assessment of risk for this phase comprises:

a. Review of existing vessel traffic and navigation and projections for future traffic in the area of the Project

b. Hazard identification and analysis, including consultation with stakeholders to identify and understand navigation safety issues

c. Formal NRA and identification of risk controls using the PLA methodology

PLA risk assessment methodology

7.2.2 As detailed in the pNRA Specification (Appendix A), the International Maritime Organization Formal Safety Assessment methodology was dovetailed with the PLA risk matrix (Table 7.1) in accordance with the PLA risk assessment methodology (PLA, 2021a).

Table 7.1 PLA risk matrix

Risk score					
Almost certain	5	10	15	20	25
Likely	4	8	12	16	20
Possible	3	6	9	12	15
Unlikely	2	4	6	8	10
Rare	1	2	3	4	5
Likelihood / severity	Minor	Moderate	Serious	Very serious	Severe

7.3 Protection zones and tunnel operation

7.3.1 While the protection zones have been scoped out of the formal final NRA as described in the pNRA Specification (Appendix A), this report considers two pertinent navigation aspects.

[2] Minutes of risk assessment workshop 10 May 2021 (see Appendix B)

Anchor seabed penetration within the river restriction zones

7.3.2 Vessels up to 100m length overall (LOA) are currently permitted (by PLA) to anchor within the Higham Bight anchorage. This would be crossed by the two protection zones under which the tunnel would pass. An anchor penetration depth assessment was carried out for vessels in the Higham Bight anchorage to determine the maximum depth of anchor penetration. This is provided to inform the detailed design stage of the tunnel.

7.3.3 Vessels up to 333m LOA, 124,435 DWT (Cap Sans class) transit (or are forecast to transit) to Northfleet Hope Container Terminal via the River Thames over the protection zones. These vessels may need to deploy their anchor(s) within the protection zones in an emergency situation (e.g. loss of engine or steering). The Project carried out a review of incident data, identified scenarios where this has occurred and carried out a simple anchor burial depth assessment for this maximum size vessel and some similar but smaller vessels to inform the detailed design stage on the tunnel.

7.3.4 The anchor penetration assessment used the cable burial risk assessment methodology published by the Carbon Trust (2015), DNVGL recommended practice for risk assessment of pipeline protection (DNVGL, 2017), and two research papers (Doan *et al.*, 2016; Zhu *et al.*, 2019).

Explosives licence at Higham Bight location and usage

7.3.5 PLA provided copies of the explosives licence at Higham Bight (Appendix D). This licence (issued under Part IX of the Dangerous Substances in Harbour Areas Regulations 1987) permits explosives to be brought to, carried and handled within the Higham Bight anchorage area. The licence sets limits on the distance from the vessel within which certain activities are proscribed. While the PLA provided records of low usage of Higham Bight anchorage from July 2019 to early May 2021 (22 vessels), these records did not specify whether anchoring vessels were carrying explosives or not. The Project would disapply within the draft DCO the explosives licence at Higham Bight such that it ceases to have effect over any area in, on, under or over the part of the River Thames within the Order Limits to ensure the safety of the tunnel infrastructure in construction and operation. National Highways continues to engage with the Health and Safety Executive, the body which granted the consent, and the PLA on this issue. The existing licence therefore proposes no navigationally relevant risks.

8 Navigational hazard identification and analysis

8.1 Hazards for temporary works in the river

Hazard identification

8.1.1 The hazards identified in relation to the temporary works were developed by considering four hazard characteristics: Project phase, hazard type, vessel type and hazard area, as shown in Table 8.1. A wider range of hazard types were considered, including for example, swamping, wash and capsizing, but were not considered material to identifying risk controls that would not already be covered by the four hazard types shown in Table 8.1. The hazard list was agreed with the PLA as an appropriate list through which to identify suitability of existing and possible additional control measures, in accordance with PLA methodology.

Table 8.1 Hazard characteristics

Phase o.	**Project hase**	**Description**
P0	Pre-Construction	In-river site investigations for tunnel [2019 SI pNRA risk assessment and risk controls will apply/be reviewed, and implemented where appropriate]
P1	Pre-Construction	SI activities for pipeline and diffuser
P2	Construction	Temporary in-river works (pipeline and diffuser)
P3	Operations	Permanent works protection zones 1 & 2 [scoped out in pNRA specification report for the reasons set out above]
Area o.	**Hazard rea**	**Description**
A1	Tunnel Alignment	Area of the river above the tunnel where further site investigation is required prior to construction.
A2	Tunnel Protection Zones	In-river protection zones surrounding the tunnel alignment across the river
A3	Northern pipeline/diffuser area	Area of and around the northern temporary pipeline/diffuser required for construction and installation
A4	River outside other defined areas	Areas used by project vessels, but outside areas A1–A3
A5	Temporary works area	Area of and around the temporary works area required for construction and installation of coffer dam and Water Inlet with self-regulating valve
Haz. o.	**Hazard ype**	**Description**
H1	Contact	Vessel striking a fixed structure/moored vessel
H2	Collision	Vessel striking another vessel
H3	Grounding	Vessel striking the river bed
H4	Breakout	Vessel coming adrift from moorings

No.	Vessel type	Notes
V1	Project vessels (inc. SI and construction vessels)	SI, construction vessels
V2	Inland freight / cargo	-
V3	Inland passenger vessels	-
V4	Recreational vessels	-
V5	Seagoing commercial vessels	Vessels subject to compulsory pilotage (>80m, >50m specified vessels) - 'piloted vessel'
V6	Seagoing passenger vessels	Vessels subject to compulsory pilotage (>80m, >50m specified vessels) - 'piloted vessel'
V7	Tug & service vessels	(non-project)

8.1.2 Only Project phases P1 and P2 were considered in this analysis for the reasons provided above. Four hazard types (contact, collision, grounding and breakout) and five areas within which the hazards may occur (tunnel alignment, tunnel protection zone, pipeline/diffuser construction/installation area, the rest of the river and the temporary works area) were considered. Seven vessel types were used to further define the hazards.

8.1.3 Combining the above characteristics with the Project activities, the current vessel disposition (from AIS data analysis) and previous incidents in the area, 18 unique hazards were identified, as illustrated in Table 8.2.

Table 8.2 Hazard identification

Hazard ID	Hazards	Applicable phase(s)	Applicable area(s)	Hazard type	Vessel type
Haz ID #:1	Contact/grounding of pipeline/outfall/ temporary works area SI vessel with existing structures	P1	A3, A4, A5	H1,H3	V1
Haz ID #:2	Contact with pipeline/outfall / temporary works area SI vessel (when moored) by passing vessels (All types).	P1	A3, A5	H1	V1 (V2–V7)
Haz ID #:3	Collision of pipeline/outfall / temporary works area SI vessel with other vessels (seagoing commercial or passenger) when arriving, manoeuvring and departing investigation sites.	P1	A2, A4	H2	V1 (V5,V6)
Haz ID #:4	Collision of pipeline/outfall /temporary works area SI vessel with other vessels (all other types)) when arriving, manoeuvring and departing investigation sites.	P1	A2, A4, A5	H2	V1 (V2,V3,V4,V7)

Hazard ID	Hazards	Applicable phase(s)	Applicable area(s)	Hazard type	Vessel type
Haz ID #:5	Breakout of pipeline/outfall/ temporary works area SI vessels when anchored/moored on site.	P1	A3, A5	H4	V1
Haz ID #:6	Collision of Project pipeline/outfall / temporary works area construction vessels with passing seagoing commercial and passenger vessels	P2	A3, A5	H2	V1 (V5,V6)
Haz ID #:7	Collision of Project pipeline/outfall / temporary works area construction vessels with passing recreational vessels.	P2	A3, A5	H2	V1(V4)
Haz ID #:8	Collision of Project pipeline/outfall / temporary works area construction vessels with passing tug and service, inland freight/cargo and inland passenger	P2	A3, A5	H2	V1(V2)
Haz ID #:9	Collision between any 3rd party vessels caused as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on site.	P2	A3, A5	H2	V2–V7 (V2–V7)
Haz ID #:10	Grounding of Project pipeline/outfall / temporary works area construction vessels during construction.	P2	A3, A5	H3	V1
Haz ID #:11	Grounding of non project vessels as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on site during construction (All types).	P2	A3, A5	H3	V2–V7
Haz ID #:12	Breakout of Project pipeline/outfall / temporary works area construction vessels during construction when anchored/moored on site.	P2	A3, A5	H4	V1

Hazard ID	Hazards	Applicable phase(s)	Applicable area(s)	Hazard type	Vessel type
Haz ID #:13	Contact/grounding of Project pipeline/outfall / temporary works areal construction vessels with existing structures	P2	A3, A4, A5	H1,H3	V1
Haz ID #:14	Collision of Project pipeline/outfall/ temporary works area construction vessels with passing vessels outside the defined construction area	P2	A2,A4	H2	V1(V2–V7)
Haz ID #:15	Collision between any 3rd party vessel caused as a result of avoiding Project pipeline/outfall construction / temporary works area vessels transiting to/from site.	P2	A2,A4	H2	V2–V7 (V2–V7)
Haz ID #:16	Grounding of Project pipeline/outfall construction / temporary works area vessels whilst on passage to site outside the defined construction area.	P2	A2,A4	H3	V1
Haz ID #:17	Grounding of non project vessels as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on passage (All types).	P2	A2,A4	H3	V2–V7
Haz ID #:18	Grounding/snagging of diffuser by passing vessel (once pipeline/diffuser installed, while tunnel construction continues)	P2	A3	H3	V2–V7

Hazard analysis

8.1.4 For each hazard identified, a general disposition was developed to further describe the potential cause and nature of the hazard, as an aid to carrying out the risk assessment. The most likely outcome (consequence) of the hazard and a reasonable worst-case outcome were also developed for each hazard, again to assist in the risk assessment. Details of the disposition and outcomes are presented in Appendix E.

Risk controls

8.1.5 Vessel traffic in the study area is managed by the PLA *inter alia* through a set of existing risk control measures. The existing measures and potential additional measures, all shown in Table 8.3, were reviewed and discussed with the PLA during the risk assessment workshop (10 May 2021) to agree the basis for assessing the baseline risk for the Project activities.

Table 8.3 Risk controls

ID	Title	Detail
Embedded risk controls: risk controls that are already in place/assumed to be in place		
E1	Charting	PLA charts show existing hazards and would be updated to show the location of the pipeline and diffuser, any depth alterations as a result of the construction of the pipeline and diffuser and any aids to navigation.
E2	Aids to navigation	Appropriate aids to navigation exist on existing structures and would need to be installed based on the final diffuser design and location and could include, for example, day marks on the diffuser in accordance with PLA and Trinity House guidance.
E3	Navigate with due care and attention	The requirement to navigate with due care and attention by vessels navigating on the tidal River Thames has some bearing on temporary works SI and pipeline construction vessels whilst moored. This is detailed in section 108 of the Port of London Act 1968 in terms of 'due care and attention', as well as PLA Byelaw 57 which specifically addresses wash and drawoff. This control does not mandate the requirement for permanent impacts on passing vessels.
E4	SI vessel and pipeline construction vessel(s) Vessel Passage Plan and Risk Assessment Method Statements (RAMS)	A detailed passage plan (in accordance with PLA General Directions (PLA, 2021b)) for the SI and pipeline construction vessels is to be approved by the PLA (and any other SHA area it passes through) and developed in conjunction with the PLA Harbourmaster and pilots. The passage plan should include identification of specific procedures including holding procedures, safe tidal operating windows for arrival, departure and SI/construction activities, emergency response procedures and should identify navigational constraints. Metocean limitations may need to be agreed as part of the safe operating procedures. Limits for the passage and temporary works SI/construction activities should be reviewed in respect of limiting wind speed, wave heights and visibility.
E5	Pilotage	The SI and construction vessels may be subject to compulsory pilotage in PLA waters in accordance with PLA Pilotage Directions. Compulsory pilotage is required for a vessel of 80m LOA (when operating as a motorised barge) and compulsory pilotage is required for tug and tow if the combined length of the tug and tow is over 90m.

ID	Title	Detail
Additional risk control – accepted		
A1	Notice to Mariners (NTM)	PLA and PoTLL Notices to Mariners would be issued identifying the details of the temporary works SI operations and pipeline/diffuser construction including outline passage plan, holding/layby areas, operational procedures, transit times and operational dates, and details of any additional controls should be published and regularly updated.
A2	Marine Operations Plan, stakeholder engagement and coordination	A Marine Operations Plan would be developed for temporary works SI and construction operations. The PLA should be party to and consulted on any arrangements made as a result of the Marine Operations Plan as SHA for the area.
A3	Safety boat	Provision of a safety boat where necessary (as determined through contractor RAMS) to provide safety cover and back up to temporary works SI/construction operation
Additional risk controls – rejected		
A4	Speed Reduction	Covered by risk control E3
A5	Waiting/layby moorings	Not required within the Project scope covered by this pNRA

Note: The risk controls above are legally secured within the protective provisions for the PLA of the draft DCO. In particular, the protective provisions require that 'plans' which include NRAs are submitted to the PLA. The protective provisions further require that the NRA must be in accordance this pNRA and incorporates the risk controls identified above unless otherwise agreed by the PLA.

8.1.6 The following points were noted regarding the existing risk controls:

a. Risk Control E1: Charting – agreed.

b. Risk Control E2: Aids to navigation – Noted it is intended to place a special mark on the diffuser outfall head – agreed.

c. Risk Control E3: Navigate with due care and attention – Discussed the sensitivity of site to wash (during SI and construction of the pipeline and diffuser). Agreed this would be managed by the existing Vessel Traffic Service (VTS) under a 'pass with precaution' through a PLA Temporary NTM rather than any speed easement requirement/mandate.

d. Risk Control E4: Vessel Passage Plan and RAMS – Passage plans and RAMS would be developed for the temporary work SI works and construction which would include definition of metocean limits as good practise measure of a competent contractor (noting limits on visibility, wind speed and wave height were determined for the SI works in 2019). Agreed.

e. Risk Control E5: Pilotage – unlikely to be required for proposed Project vessels but it is agreed that the PLA Pilotage Directions would apply.

8.1.7 The following were noted regarding the potential additional risk controls:

a. Additional Risk Control A1: NTM – The PLA noted this is not a mandated requirement and so it is correctly defined as an additional risk control. The group agreed it is likely to be taken forward given it is good practice and it provides a means to implement Embedded Risk Control E3.

b. Additional Risk Control A2: Marine Operations Plan, stakeholder engagement and coordination – agreed this additional control should be implemented.

c. Additional Risk Control A3: Safety boat – Noted that this is in any case likely to be included in the contractor RAMS for the duration of the site investigations and construction of pipeline/diffuser.

d. Additional Risk Control A4: Speed reduction – Was discussed but considered to be covered by Embedded Risk Control E3. It was therefore removed from the list of additional controls.

e. Additional Risk Control A5: Waiting/Layby moorings – Was discussed and agreed not to be required within Project Phases one and two. It was therefore removed from the list of additional controls.

8.1.8 During the risk assessment workshop, it was agreed that, subject to the inherent risk assessment, the above risk controls were appropriate and no further risk controls were identified at this stage.

8.2 Hazards for permanent works

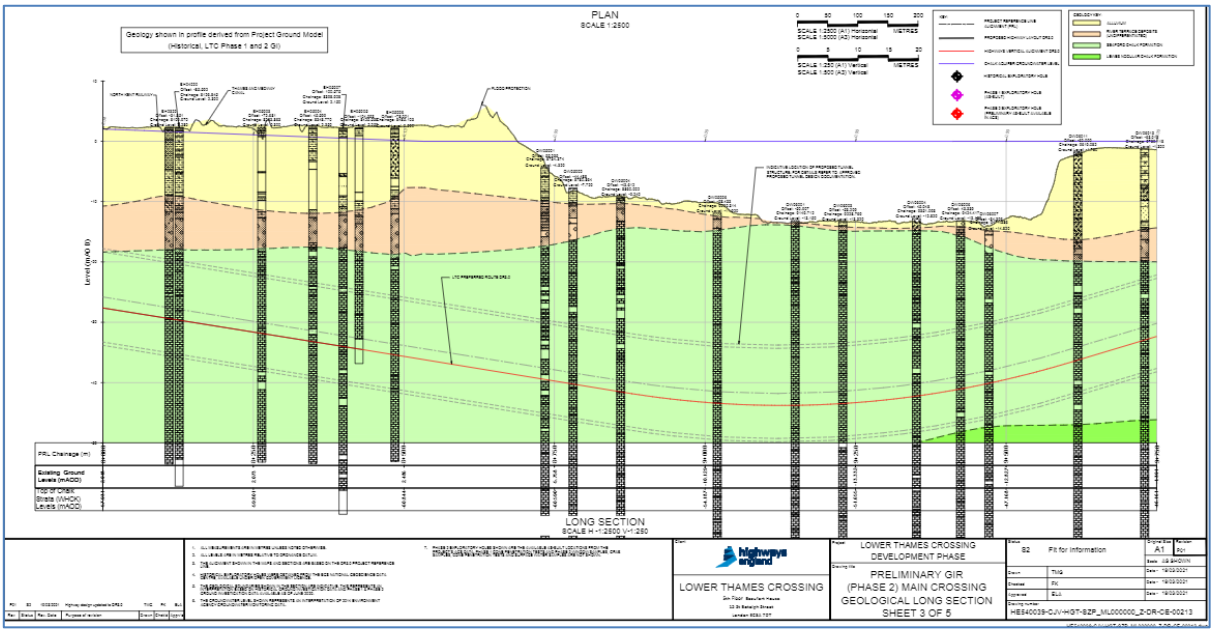
Anchor seabed penetration within the protection zones

8.2.1 PLA records show that only 22 vessels used the Higham Bight anchorage from July 2019 to early May 2021. Celtic Voyager and Arklow Rouge were selected as larger vessels within the data provided on a precautionary basis, as examples of these vessels for the anchor penetration assessment. To assess the probability of an anchor dragging across the tunnel route, it was assumed that the vessels were at anchor for 24 hours and that each vessel visited 10 times per year.

8.2.2 To assess the risks of emergency anchor deployment in the main channel, examples of the three largest vessels currently navigating or likely to navigate across the tunnel route on a regular basis were considered, using information supplied by PoTLL. Thus, the MSC Florentina was assessed as visiting weekly, the Yeoman Bridge visiting bi-weekly and a Cap Sans class vessel visiting monthly.

8.2.3 A preliminary geological interpretive long section (Plate 8.1) from boreholes across the river has been reviewed. This review of this section and the borehole showed that the surficial sediment within the Higham Bight anchorage ranged from very soft clay to fine-to-coarse sand, within the first 5m below the seabed. Within the authorised channel, the first 1–2m below the seabed ranged from fine-to-medium sand to chalk and below 3m often showed chalk. Anchor penetration depth is a function of the bed material. Taking a precautionary approach, the anchor penetration depth was assessed assuming the predominant bed material was soft clay, and the assessment was repeated assuming a predominantly sand bed material.

Plate 8.1 Geological interpretation long section across the river along the tunnel alignment



8.2.4 Results of the anchor penetration assessment in Table 8.4 show a maximum depth of penetration in the Higham Bight anchorage of 2.6m and in the authorised navigation channel of 4.9m. The protection zones ensure that depth of cover to the tunnel is sufficient to protect against accidental impact loading from the anchor penetration presented in Table 8.4.

Table 8.4 Anchor penetration depth assessment

Location	Vessel	DWT	Anchor size (kg) [1]	Fluke length (m) [1]	Penetration depth (m)	
					Sand [1,2]	Soft clay [1,2]
Higham Bight	Arklow Rouge	5000	1509	1.15	0.8	2.6
Higham Bight	Celtic Voyager	4000	1302	1.1	0.8	2.5
Main Channel	MSC Florentina	85,832	7,918	1.95	1.4	4.5
Main Channel	Yeoman Bridge	96,772	8,573	2.00	1.4	4.6
Main Channel	Cap Sans Class	124,435	10,127	2.11	1.5	4.9

[1] Carbon Trust (2016), [2] Zhu et al. (2019)

8.2.5 The risk, or probability, of an anchor dragging across the tunnel route is estimated as 1 in 115 years within the Higham Bight anchorage and 1 in 284 years in the main (authorised) channel (Table 8.5).

Table 8.5 Probability of anchor drag across the tunnel route

Location	Vessel	Probability		
		Freq. (/yr)	Per event [3,4]	Per year
Higham Bight	Arklow Rouge	10	0.0004356	0.004356
Higham Bight	Celtic Voyager	10	0.0004356	0.004356
			Sum	0.008712
			Return/years	115
Main channel	MSC Florentina	52	0.00002	0.00208
Main channel	Yeoman Bridge	24	0.00002	0.00096
Main channel	Cap Sans Class	12	0.00002	0.00048
			Sum	0.00352
			Return/years	284

[3] DNVGL (2017) [4] Doan et al. (2016)

Explosives licence at Higham Bight location and usage

8.2.6 The explosives licence information has been reviewed by the Project in developing the DCO application and Project design. As set out above, National Highways proposes to disapply via the DCO the explosives licence at Higham Bight such that it ceases to have effect over any area in, on, under or over the part of the River Thames within the Order Limits.

8.2.7 Therefore, no specific risk assessment is carried out within this document in relation to the explosive anchorage.

9 Navigational risk assessment

9.1.1 The risk assessment was completed by assessing the consequence (impact/severity) and likelihood (probability) of each hazard (as listed in Table 8.2 using the PLA defined basis/guidance for these, as illustrated in Table 9.1 and Table 9.2. This risk assessment assumes the identified risk controls in chapter 8 are implemented. The Project carried out an initial assessment of consequence and likelihood and presented this in the workshop with the PLA and PoTLL. In the workshop, all participants reviewed and discussed the assessment so that hazards, hazard descriptions and scores could be modified if required. The PLA and PoTLL then carried out a further review of the assessment after the workshop and provided comments (Appendix G) which were incorporated into the final risk assessment table (Table 9.4).

Table 9.1 PLA impact rating guidance

Impact rating guidance (severity)		
Score	**Descriptor**	**Indicative outcome**
1	Minor	• Minor injury but not requiring first aid • Insignificant impact on environment and port operation • Insignificant or no damage to vessel/equipment/structure • Little or no risk to company image • Insignificant port costs: *Guidance: up to £5000*
2	Moderate	• Minor injuries requiring treatment/intervention • Minor impact on environment and port operation with no lasting effects • Vessel/equipment/structure incurs minor damage but remains in service/safe to use; some adjustment to working/operational methods may be required. • Local news coverage and control measures required to manage publicity • Minor cost implications for port: *Guidance between £5000 & £50,000*
3	Serious	• Injuries which require medical intervention, but injured person recovers fully • Limited impact on environment and port operation with short-term or long-term effects. • Vessel/equipment/structure non-operational and in need of repairs • Regional news coverage with potential for reputational damage • Serious cost implications for port: *Guidance between £50,000 & £250,000*
4	Very serious	• Injuries with long-term effect (life changing incident) • Significant impact on environment and Port operation with short-term or long-term effects • Vessel/equipment/structure non-operational and in need of extensive repairs/ dry docking

Impact rating guidance (severity)		
Score	**Descriptor**	**Indicative outcome**
		• National news coverage with significant potential for reputational damage • Very serious cost implications for port: *Guidance between £250,000 & £500,000*
5	Severe	• Fatalities and life-changing injuries • Serious long-term impact on environment and/or permanent damage • Serious long-term impact on port operational effectiveness • Vessel/equipment/structure unsalvageable • International news coverage with severe potential for reputational damage • Severe cost implications for port: *Guidance over £500,000*

Table 9.2 PLA probability guidance

Probability rating guidance (likelihood)		
Score	**Descriptor**	**Indicative outcome**
1	Rare	Very unusual – not common or frequent
2	Unlikely	Not probable or likely to happen
3	Possible	Aim to enhance controls before next review (within 6–12 months)
4	Likely	Enhance controls measures at earliest opportunity
5	Almost certain	Unacceptable stop activity, undertake a formal review of the process/activity

9.1.2 The risk score for each hazard was then determined through simple multiplication of consequence and likelihood and assessed against the PLA risk acceptability matrix (Table 9.3).

Table 9.3 PLA risk acceptability matrix

Risk rating score	Category	Action
1–3	Minor	No further actions but ensure controls are maintained
4–8	Moderate	No further action but ensure controls are maintained
9–14	Serious	Aim to enhance controls before next review (within 6–12 months)
15–19	Very serious	Enhance controls measures at earliest opportunity
20–25	Severe	Unacceptable stop activity, undertake a formal review of the process/activity

9.1.3 As illustrated in the summary results (Table 9.4), all hazards fell into the moderate or low category, thus requiring no further action but to ensure (identified) control measures are maintained. As none of the hazards required further action or risk controls, no residual risk assessment was required to determine the impact of additional risk controls.

Table 9.4 Risk assessment summary

Hazard ID	Hazard	Inherent risk		
		Likelihood	Severity	Score
Haz ID #:5	Breakout of pipeline/outfall/ temporary works area SI vessels when anchored/moored on site.	2	4	8
Haz ID #:3	Collision of pipeline/outfall / temporary works area SI vessel with other vessels (seagoing commercial or passenger) when arriving, manoeuvring and departing investigation sites.	2	4	8
Haz ID #:8	Collision of Project pipeline/outfall / temporary works area construction vessels with passing tug and service, inland freight/cargo and inland passenger	2	4	8
Haz ID #:12	Breakout of Project pipeline/outfall / temporary works area construction vessels during construction when anchored/moored on site.	2	4	8
Haz ID #:14	Collision of Project pipeline/outfall/ temporary works area construction vessels with passing vessels outside the defined construction area	2	4	8
Haz ID #:18	Grounding/snagging of diffuser by passing vessel (once pipeline/diffuser installed, while tunnel construction continues)	2	4	8
Haz ID #:13	Contact/grounding of Project pipeline/outfall / temporary works areal construction vessels with existing structures	2	3	6
Haz ID #:4	Collision of pipeline/outfall /temporary works area SI vessel with other vessels (all other types)) when arriving, manoeuvring and departing investigation sites.	2	3	6
Haz ID #:7	Collision of Project pipeline/outfall / temporary works area construction vessel with passing recreational vessels.	2	3	6

Hazard ID	Hazard	Inherent risk		
		Likelihood	Severity	Score
Haz ID #:2	Contact with pipeline/outfall l / temporary works area SI vessel (when moored) by passing vessels (All types).	3	2	6
Haz ID #:6	Collision of Project pipeline/outfall / temporary works area construction vessels with passing seagoing commercial and passenger vessels	1	4	4
Haz ID #:15	Collision between any 3rd party vessel caused as a result of avoiding Project pipeline/outfall construction / temporary works area vessels transiting to/from site.	1	4	4
Haz ID #:1	Contact/grounding of pipeline/outfall/ temporary works area SI vessel with existing structures	2	2	4
Haz ID #:10	Grounding of Project pipeline/outfall / temporary works area construction vessels during construction.	4	1	4
Haz ID #:9	Collision between any 3rd party vessels caused as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on site.	1	2	2
Haz ID #:11	Grounding of non-project vessels as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on site during construction (All types).	1	2	2
Haz ID #:17	Grounding of non-project vessels as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on passage (All types).	1	2	2
Haz ID #:16	Grounding of Project pipeline/outfall construction / temporary works area vessels whilst on passage to site outside the defined construction area.	1	1	1

10 Study findings

10.1 Conclusions

Tunnel pre-construction

10.1.1 The PLA agreed that the NRA for SI survey developed for previous tunnel related site investigations remained a valid basis in respect of any site investigations for the final NRA. The risk controls agreed from this work would be taken forward for any further tunnel related SIs work of a similar nature in the river.

Temporary works in the river

10.1.2 The formal risk assessment for the temporary works SI and construction activities associated with the temporary outfall and Water Inlet with self-regulating valve or equivalent structure to be installed on the north side of the river between groynes three, four and north of groyne 6 identified 18 navigation safety related hazards. All hazards were found to have an acceptable (consequence/likelihood) risk score, based on the PLA risk assessment methodology and risk acceptability criteria.

10.1.3 These activities thus require no further risk control actions except to ensure the embedded risk controls and the additional risk controls (identified in 8.1.5) are effectively implemented and maintained.

Protection zones

10.1.4 Anchor seabed penetration showed that an anchor may penetrate the seabed within the tunnel related protection zones either through routine or emergency anchoring. Within the Higham Bight designated anchorage, it is estimated that anchor burial depth would not exceed 3m below the seabed, and the risk of anchor drag across the tunnel route was less than 1 in 100 years. Within the main navigation channel, it is estimated that anchor burial depth would not exceed 5m below the seabed, and the risk of anchor drag across the tunnel route was less than 1 in 280 years. The protection zones ensure that depth of cover to the tunnel is sufficient to protect against accidental impact loading in this regard.

10.1.5 The PLA maintains an explosives licence for Higham Bight. This licence (issued under Part IX of the Dangerous Substances in Harbour Areas Regulations 1987) permits explosives to be brought to, carried and handled within the Higham Bight anchorage area. The licence sets limits on the distance from the vessel within which certain activities are proscribed.

10.1.6 The Project is in discussion with the PLA and HSE with the intent of seeking agreement to disapply within the DCO the explosives licence at Higham Bight such that it ceases to have effect over any area in, on, under or over the part of the River Thames within the Order Limits.

10.2 Summary risk statement

10.2.1 This pNRA has considered the impacts of the Project on navigational safety. The results demonstrate that all hazards can be mitigated to acceptable risk levels. However, no matter how much hazards are reduced, both in terms of hazard consequence and likelihood, there still remains a possibility that they will be realised. As such, this pNRA and the associated risk controls that it mandates will be reviewed, in consultation with the PLA, if any aspect of the Project, including additional hazards or the risk controls, change during the Project life.

10.3 Recommendations

Tunnel pre-construction

10.3.1 Further site investigations over the tunnel route in the river should use the 2019 pNRA, developed for previous site investigations, as the basis for an updated navigational risk assessment, including all risk controls as previously established and agreed. The Protective Provisions for the benefit of PLA in the draft DCO contain a requirement for those risk controls to be included in the plans submitted to the PLA.

Temporary works in the river

10.3.2 The sections of this pNRA dealing with the temporary works in the river should be reviewed and updated as necessary when further details of the works are developed and a marine contractor is engaged for the works, or if any details of the works materially change earlier than this. The risk controls noted for these works (Table 8.3) will be implemented and are secured in the Protective Provisions for the benefit of PLA in the draft DCO.

Protection zones

10.3.3 Anchor penetration into the seabed within the protection zones surrounding the tunnel presented in Table 8.4 should be considered within the detailed design of the Project tunnel sections under the river. The protection zones would ensure that depth of cover to the tunnel is sufficient to protect against accidental impact loading in this regard. These protection zones are secured via Article 48 of the draft DCO.

Explosives licence

10.3.4 The Project is in discussion with the PLA and HSE as it will disapply in article 48 of the draft DCO the explosives licence at Higham Bight such that it ceases to have effect over any area in, on, under or over the part of the River Thames within the Order Limits. The HSE has agreed to the dispensation of the explosive license within the Higham Bight

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Glossary

Term	Abbreviation	Explanation
Automatic Information System	**AIS**	Automated system to provide position identification and other information about ships
Aid to navigation	**AtoN**	Any sort of signal, markers or guidance equipment which aids the traveller in navigation, usually nautical or aviation travel. Common types of such aids include lighthouses, buoys, fog signals, and day beacons.
Construction Materials and Aggregates Terminal	**CMAT**	Port Terminal for the import of construction materials and bulk aggregates
Development Consent Order	**DCO**	Means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects (NSIP) under the Planning Act 2008.
High Water	**HW**	Level of water at high tide
Knot	**kt**	Knot (unit of speed equal to nautical mile per hour, approximately 1.15mph)
Length overall	**LOA**	The measurement of the total length of a vessel
Low Water	**LW**	Level of water at low tide
Metre	**m**	Unit of measurement
Maritime and Coastguard Agency	**MCA**	An executive agency of the United Kingdom that responsible for implementing British and international maritime law and safety policy
Mean High Water	**MHW**	The average throughout a year of the heights of two successive high waters during those periods of 24 hours (approximately once a fortnight) when the range of the tide is least.
Nautical Mile	**nm**	A unit of measurement based on the earths longitude and latitude coordinates.
Navigation risk assessment	**NRA**	Risk assessment covering the risk to navigation vessels due to activities within a water way.
Notice to Mariners	**NTM**	Notice containing important navigational information such as chart updates, changes in buoyage, prior warning of activities such as dredging, exclusion zones, harbour closures and byelaws
Preliminary NRA	**pNRA**	Preliminary Navigation Risk Assessment
Port of London Authority	**PLA**	The Port of London Authority (PLA) is a self-funding public trust which governs the Port of London. Its responsibility extends over the Tideway of the River Thames and its continuation (the Kent/Essex strait). It maintains and supervises navigation, and protects the river's environment.
Port of Tilbury London Ltd.	**PoTLL**	The Port of Tilbury is a port on the River Thames at Tilbury in Essex.
Risk Assessment Method Statement	**RAMS**	Standard process for assessing risk associated with an activity and developing a safe method for undertaking that activity.

Term	Abbreviation	Explanation
Ridged Inflatable Boat	**RIB**	Boat with an inflatable rib
Realistic most likely	**RML**	A scenario that is most likely to happen
Roll-on/roll-off	**Ro-Ro**	Ships designed to carry wheeled cargo, such as cars, motorcycles, trucks, semi-trailer trucks, buses, trailers, and railroad cars, that are driven on and off the ship on their own wheels or using a platform vehicle
Realistic worst credible	**RWC**	A realistic negative outcome
Statutory Harbour Authority	**SHA**	Statutory Bodies responsible for the management and running of a harbour. The powers and duties in relation to a harbour are set out in local Acts of Parliament or a Harbour Order under the HA 1964
Site investigation	**SI**	the process of collecting information, assessment of the data and reporting for a specific site
Very High Frequency	**VHF**	Very High Frequency (radio communication)
Vessel Traffic Service	**VTS**	a marine traffic monitoring system established by harbour or port authorities, similar to air traffic control for aircraft.

Appendices

Appendix A Navigational risk assessment specification

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NASH MARITIME

Lower Thames Crossing

Shipping and Navigation Specification

COWI UK LTD

Document No: 20-NASH-0068-0100 | R05-00

20-Aug-2021

PROJECT INFORMATION

PROJECT TITLE	Lower Thames Crossing
REPORT TITLE	Shipping and Navigation Specification
CLIENT	COWI UK LTD
CLIENT ADDRESS	Eastfield Church Street Uttoxeter Staffordshire ST14 8AA

DOCUMENT CONTROL

DOCUMENT No.	20-NASH-0068-0100
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R01-00	12-Mar-2021	Draft	CJH	JJH	EJR
R02-00	19-Mar-2021	Addressing LTC comments	CJH	JJH	EJR
R03-00	12-Apr-2021	Update to reflect revised Order Limits & DML	CJH	JJH	JJH
R04-00	11-Jun-2021	Addressing LTC Legal comments	CJH	JJH	JJH
R05-00	20-Aug-2021	Addressing further LTC comments Updated for compatibility with pNRA	CJH	JJH	JJH

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1. INTRODUCTION

1.1 OVERVIEW

NASH Maritime Ltd have been contracted by COWI[1] to deliver shipping and navigation services including a preliminary Navigational Risk Assessment (pNRA) to support the Highways England Lower Thames Crossing project (the Project). The objective of the pNRA is to assess and quantify the navigation risk posed by the project during its construction and operational phases. The pNRA supports a Development Consent Order[2] (DCO) submission for the Project.

Figure 1 shows the location the Project on the Thames estuary which links the M2 in Kent with the M25 in Essex.

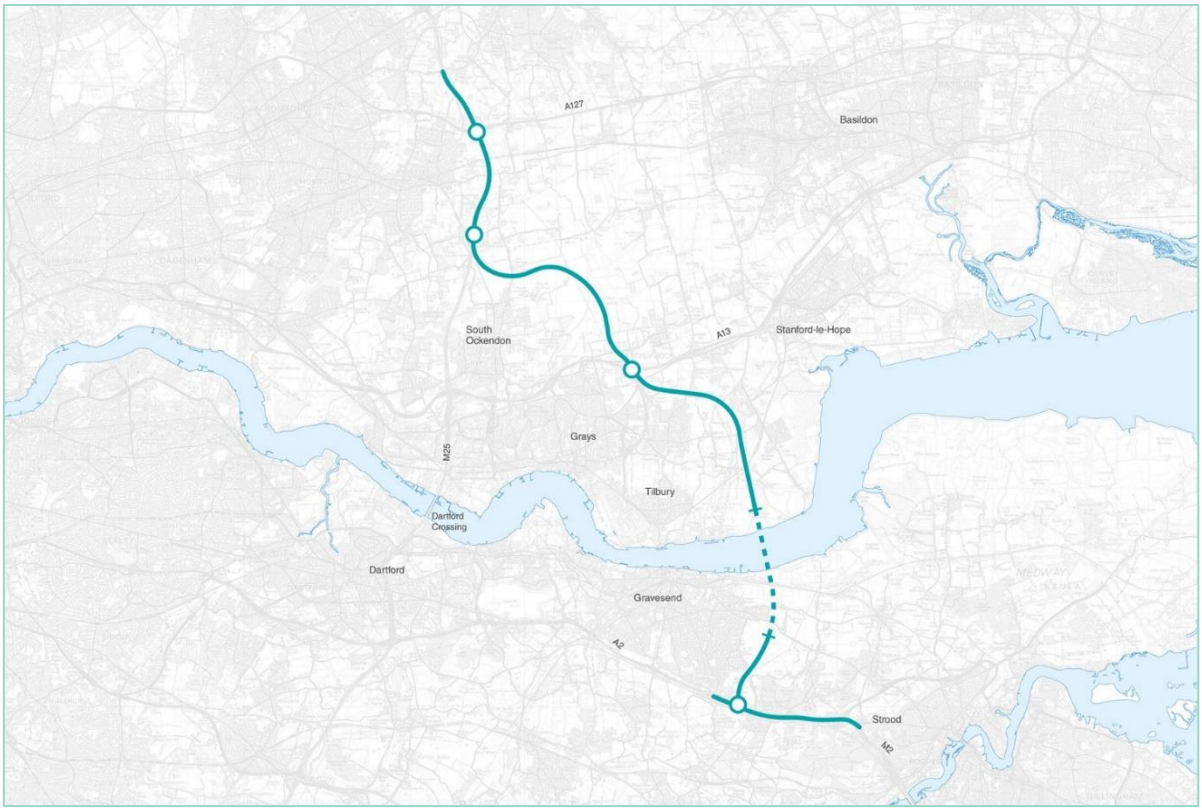

Figure 1: Lower Thames Crossing Project Location.

The Project includes the construction of two 4.25km road tunnels under the Thames located to the east of Gravesend on the south side of the river, and to the west of East Tilbury on the north side. The tunnels will be constructed using tunnel boring machines and pre-cast concrete tunnel segments launched from a large compound (the North Portal) to the north of the River Thames.

[1] COWI A/S is under contract to Highways England through the Lower Thames Crossing Technical Partner Contract in a joint venture with Arcadis Consulting (UK) Limited, Jacobs CH2M Hill United Kingdom (JV Parties)

[2] The A122 (Lower Thames Crossing) Development Consent Order 20[ ]

1.2 EXTENT AND POWERS PROPOSED WITHIN THE DEVELOPMENT CONSENT ORDER AND DEEMED MARINE LICENCE

1.2.1 DCO

The draft DCO seeks to establish the powers necessary to undertake the project. These include powers in relation to construction of temporary and permanent structures, navigation, discharge of water and survey of the river and land. These powers are sought within the Order Limits of the DCO illustrated in **Figure 2** and **Figure 3**.

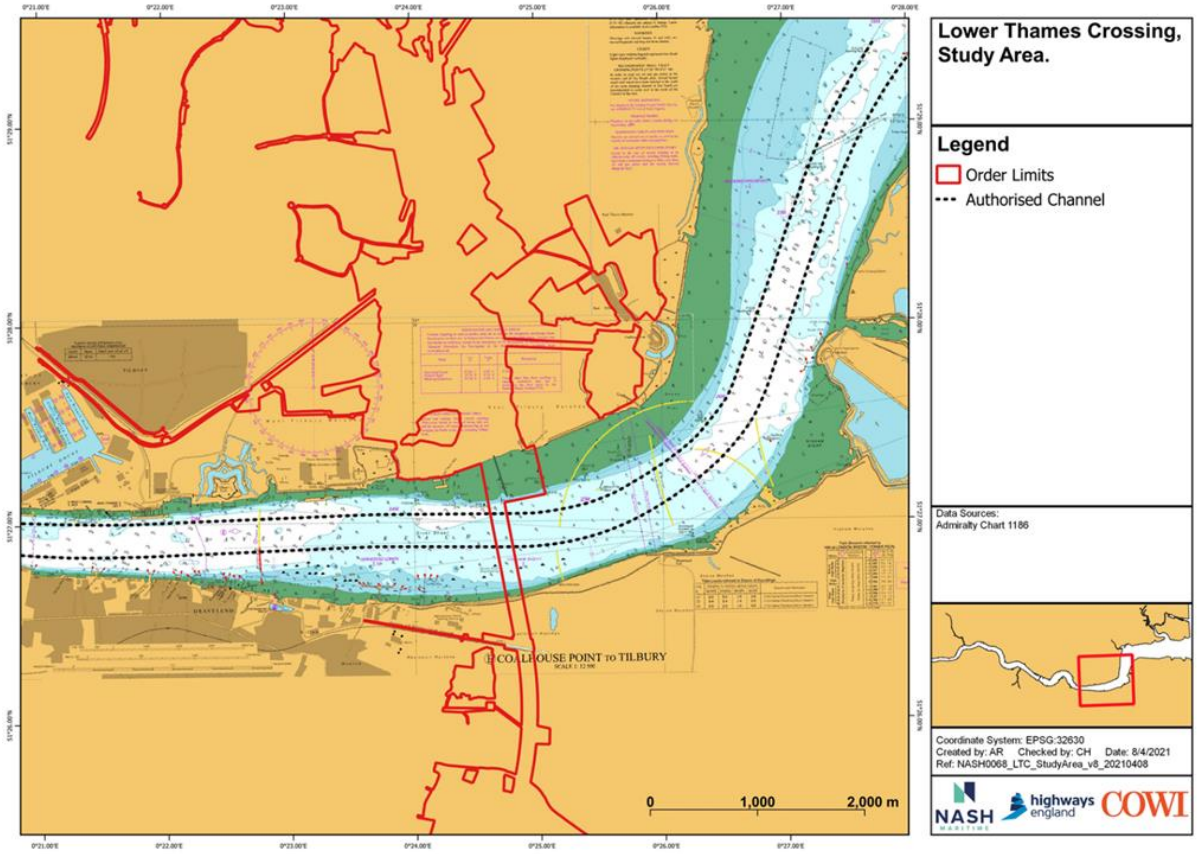

Figure 2: Project Draft DCO Order Limits

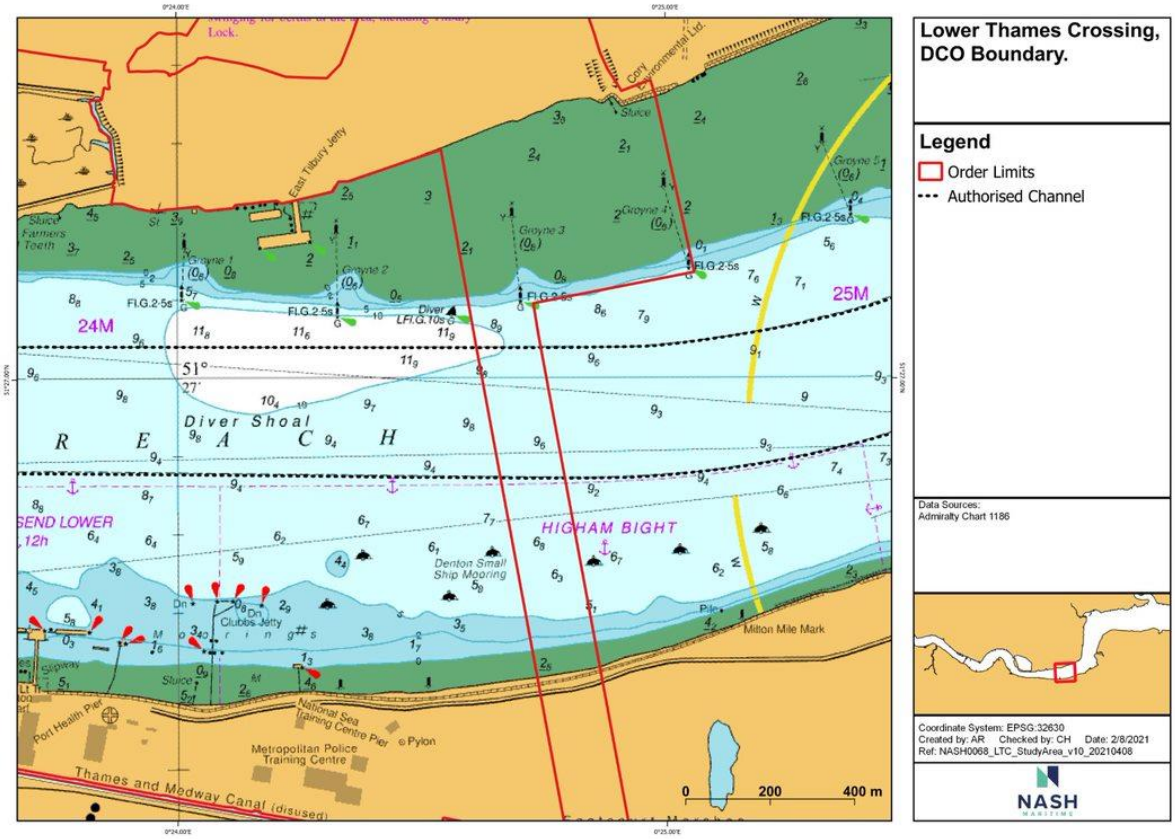

Figure 3: Project Marine Draft DCO Order Limits

Sections of the draft DCO most relevant to shipping and navigation are summarised in Annex A and key items outlined below:

- Part 4 - gives wide ranging powers to potentially impact navigation, discharge water (subject to consent) and survey within the DCO boundaries subject to agreement of the PLA.
- Part 6 - places restrictions on PLA and others to impact the riverbed within the limits of Article 6 and Article 48.
- Part 7 - provides the basis for the application of the Deemed Marine Licence detailed in Article 59.
- Article 35- identifies in a series of drawings, land of which temporary possession may be taken for inter alia: marine works and transportation, and removal areas for tunnel materials.
- Article 58 - provides protective provisions for PLA including mitigation of any impacts on navigation and navigation aids in the Thames.
- Article 59 - provides details of the Deemed Marine License (see **Section 1.2.2** below).

- Article 6 and Article 48 – provides a plan and section (the River Restriction Plan) showing protection zones along the route of the tunnel.

1.2.2 Deemed Marine Licence

The Deemed Marine Licence includes permission to construct or modify certain structures within defined co-ordinate locations for certain periods. These structures include the temporary discharge pipeline (with diffuser) to be installed between groynes 3 and 4 on the northern side of the river and a permanent outfall to be installed on the shoreline at/above mean high water, as illustrated in **Figure 4**.

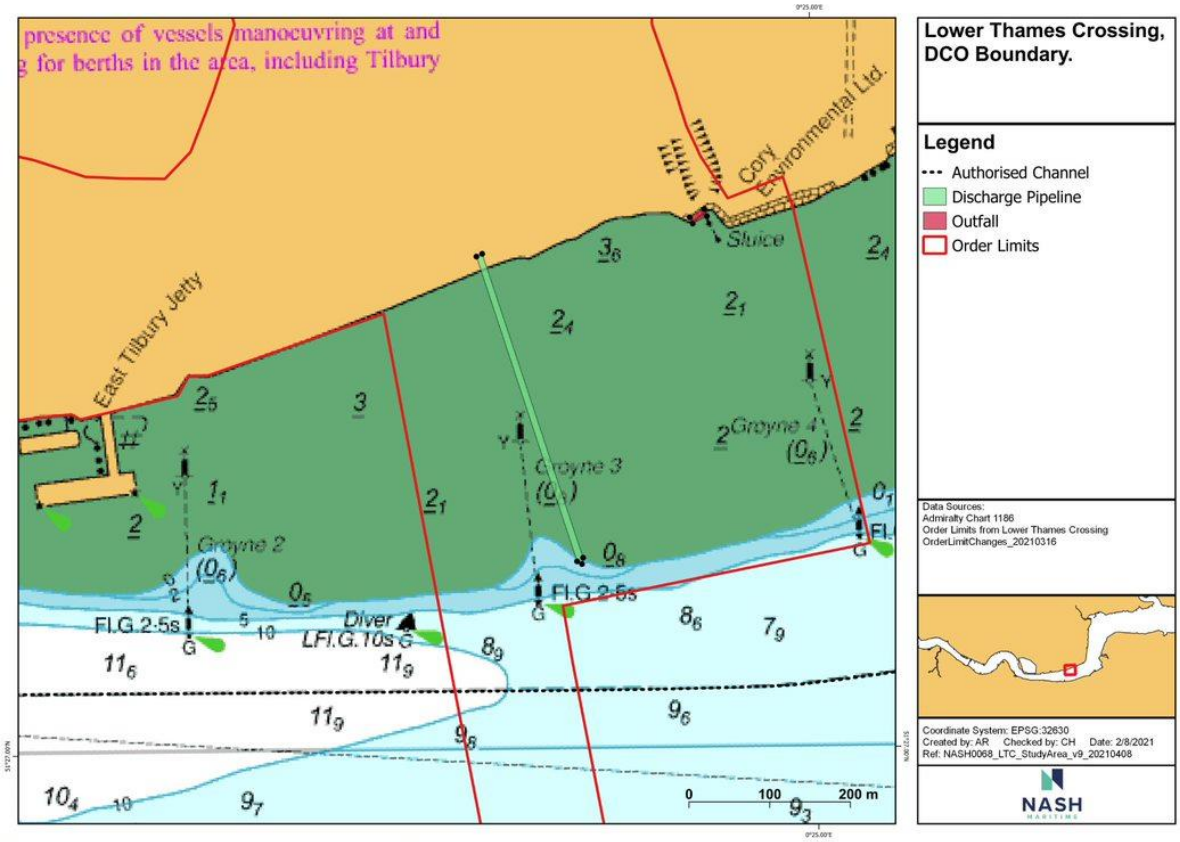

Figure 4: Infrastructure Locations identified in Article 59 of DCO (Deemed Marine Licence).

1.2.3 Protection Zones

Article 48 includes the River Restriction Plan **(Figure 5**) which maps the protection zones around the tunnel where permanent zones will be established to control/proscribe certain activities (dredging, installation of a mooring or other structure , piling activities, designation of any anchorage, excavations, trial holes, boreholes or other investigations; or any other activity which might reasonably be expected to affect the safe operation of the tunnels) which will not be permitted for the lifetime of the tunnel without consent from Highways England. The Project team advised (July 2021) that it is seeking (in discussion with PLA and the Health and Safety Executive) to have the current explosives anchorage licence (no 9/92) for Higham Bight (which

permits PLA to authorise anchoring of vessels carrying explosives within/close to the restriction zones) disapplied for the part of the River Thames within the Order Limits.

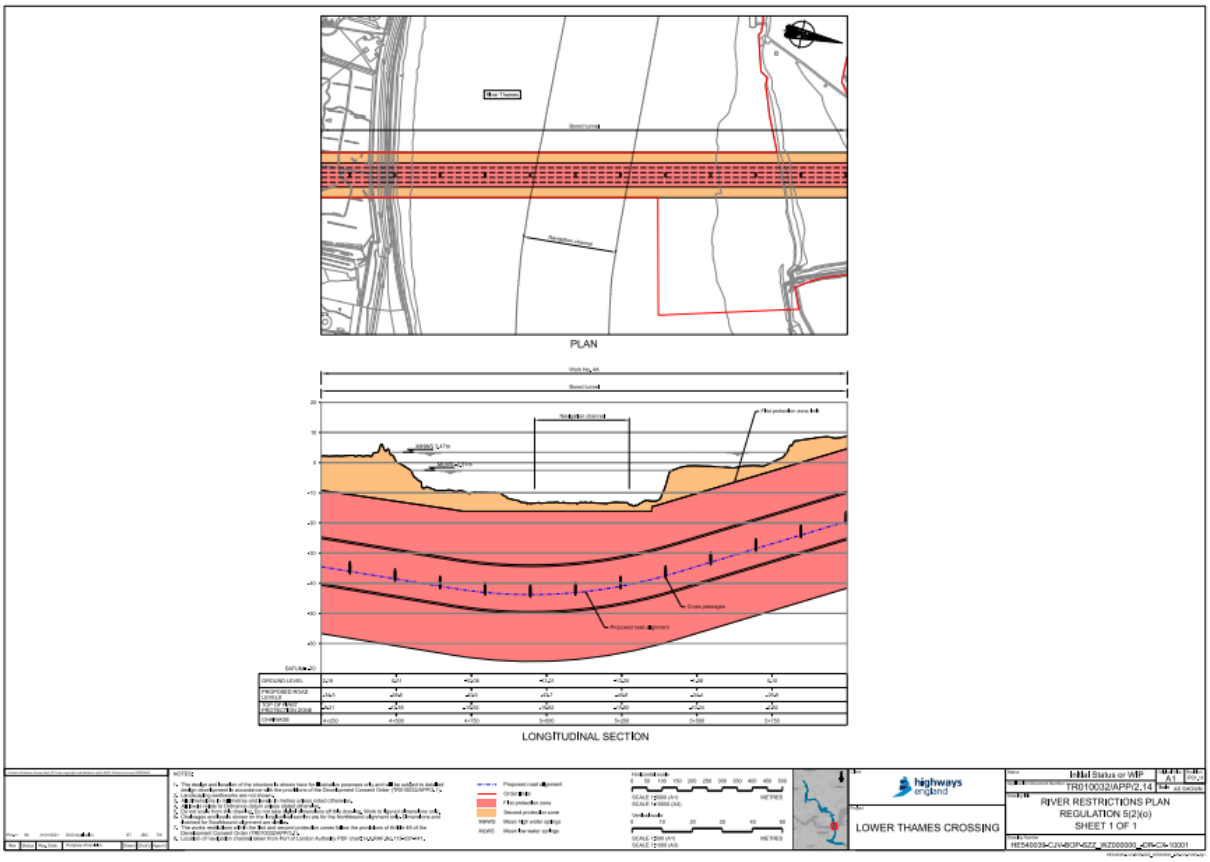

Figure 5: Protection Zones in the River Restrictions Plan.

1.3 DOCUMENT SCOPE AND PURPOSE

This report sets out a specification for the Shipping and Navigation studies required to support the DCO. The specification has been developed in consultation with the key stakeholders: Highways England, the Technical Partner (through COWI), the Statutory Harbour Authority (SHA) - Port of London Authority (PLA) and relevant interested parties identified at this stage including Port of Tilbury London Ltd (PoTLL).

The primary deliverable of the studies, for submission within the DCO Application, will be the pNRA. This document describes the key components of the pNRA including data requirements, study area(s), pNRA methodology, and future consultation, as well as supporting studies which have been identified as requirements to support the pNRA as agreed with the key stakeholders. This document also includes the findings of a preliminary assessment of navigation risk to inform the scope requirements of the pNRA.

1.4 REPORT STRUCTURE

The report sections are as follows:

- **Section 2:** Relevant Legislation Guidance - review of legislation and guidance relevant to the pNRA.
- **Section 3:** Stakeholder Consultation - pNRA consultation to date and future requirements.
- **Section 4:** Baseline Environment – preliminary review of baseline vessel traffic conditions and key identified issues.
- **Section 5:** Proposed Methodology for pNRA
    - Data requirements
    - Locations and study area
    - Risk assessment matrix and methodology
    - Study Execution
- **Section 6:** Summary Scope

2. RELEVANT LEGISLATION AND GUIDANCE

The following section provides details of the legislation and guidance, procedures and practices required to be considered when conducting the pNRA for a development in the marine environment in this project area.

2.1 LEGISLATION

The following legislation is to be considered:

- Harbours, Docks and Piers Clauses Act 1847
- Thames Conservancy Act 1932
- Harbours Act 1964
- Docks and Harbours Act 1966
- Port of London Act 1968
- British Transport Docks Act 1972
- The Thames Barrier Flood Prevention Act 1972
- Transport Act 1981
- Thames Water Authority Land Drainage Byelaws 1981
- International Ship and Port Facility Security Code 2004
- Port of London Thames Byelaws 2012

The PLA has applied for a Harbour Revision Order that may result in some changes to the Port of London Act 1968[3].

2.2 GUIDANCE, PROCEDURES, PRACTICES

The following Marine and Coastguard Agency (MCA) and PLA regulations, codes of practice and guidance as published on the PLA website (www.pla.co.uk) are to be considered:

- Maritime and Coastguard Agency (MCA) Port Marine Safety Code. [4]
- Maritime and Coastguard Agency (MCA) Port Marine Safety Code – "Guide to Good Practice." [5]

[3] https://server1.pla.co.uk/assets/markupofportoflondonact1968-1.pdf
[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918935/port-marine-safety-code.pdf
[5] https://www.gov.uk/government/publications/a-guide-to-good-practice-on-port-marine-operations

- Port of London Marine Safety Management System
- General Directions for Navigation in the Port of London 2021
- Port of London Pilotage Directions 2017 (as amended)
- Code of Practice for Craft Towage Operations on the Thames
- Code of Practice for Rowing & Paddling on the Tidal Thames
- Tidal Thames Recreational Users Guide
- Other codes of practice for mooring, berth operators etc.

3. STAKEHOLDER CONSULTATION AND KEY ISSUES

Consultation with the SHA and port users will be essential in informing the pNRA. The aim of the consultation will be to elicit local stakeholder and regulator knowledge on navigation matters to ensure any potential location specific navigational concerns and impacts, related to the proposed construction and operation at LTC, are identified and can be considered in the pNRA.

3.1 INITIAL STAKEHOLDER CONSULTATION

3.1.1 January 2021 and Early March 2021 consultation

Two early consultation meetings with the PLA and PoTLL were held on 14 January 2021and 10 March 2021 to scope and review the key potential issues and form the basis of the required assessment. The meetings were held within the context of the DCO application submitted in October 2020[6] and resulted in an agreed focus for the pNRA as detailed in the meeting notes presented in **Annex B**.

3.1.2 Late March 2021 Consultation following changes to DCO limits

A further consultation meeting was held with PLA and PoTLL on 24 March 2021 following changes to the draft Order Limits and to the proposed Deemed Marine Licence conditions developed by the Project in February/March 2021. A presentation by NASH Maritime used in the meeting as the basis for discussion of the changes is presented in **Annex C**.

3.1.3 Key Issues for the Navigation Risk Assessment

The key issues remaining valid from the earlier consultation and agreed in the meeting of 24 March 2021 for inclusion in the pNRA are summarised below.

Three main works form part of the assessment required for the pNRA:

1. Temporary works in river:
    a. Comprising additional over water geotechnical investigations (GI) for the tunnels, similar to those carried out in Phase 2A (see below) but with a focus on tunnel cross passage locations.
    b. pNRA to undertake a review of the NASH Maritime pNRA completed for the Phase 2A GI works[7] and identify need / mandate for the same/similar navigation risk controls.
    c. Works undertaken in the river Thames, or on the foreshore, that are not addressed through the provisions made in the Deemed Marine Licence, will

[6] Lower Thames Crossing 3.1 Draft Development Consent Order, APFP Regulations 5(2)(b) Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Volume 3, October 2020, TR010032/3.1, Version1.0

[7] Lower Thames Crossing Ground Investigations, Navigation Risk Assessment, River Based Works – Phase 2A Overwater GI, HE540039-PCI-GEN-GEN-REP-GEO-00027, Highways England, 10 Oct 2019

require a self-service marine licence. This includes over-water Ground Investigation activities."

2. Construction (of temporary pipeline and diffuser [outfall]) in river:
    a. For discharge of process wastewater and rainwater runoff from the North Portal during construction work and for some time after (to allow for landscaping).
    b. This will likely require a consent from the EA to discharge treated site process or wastewater into the tidal Thames.
    c. The position and location of the drainage infrastructure including the outfall are yet to be fixed but will likely need to extend below the high-water (HW) mark and may need to extend to LAT to meet environmental discharge requirements.
    d. This structure will need to be assessed in the LTC pNRA.
3. Protection zones and tunnel operation:
    a. LTC and PLA are (at time of writing) to agree wording in the DCO regarding activities permitted/excluded within the two protection zones running over the tunnel (Figure 5). The permanent works river restriction protection zones have been scoped out of the formal navigational risk assessment (as agreed with PLA and PoTLL in Meeting 10 May 2021, see Annex B). This is because restrictions proposed under Article 48 do not give rise to any navigational risk, as they control works and activities, rather than the free movement of vessels in the navigable river. This has been agreed with the PLA, and on that basis, they are not considered further. However, three pertinent navigation aspects should be considered in the pNRA:
        i. The location and impact of a "no anchoring zone" within the protection zones and the potential impact the existing Higham Bight anchorage.
        ii. Anchor seabed penetration within the protection zones.
        iii. Explosives anchorage location and usage as currently licensed within or close to the protection zones.

Following changes to the draft DCO Order Limits and DML the import/export of materials (during construction) were excluded from the NRA for the reasons noted below.

a. Contractors will use facilities within the Port of Tilbury for import of tunnel segments or other materials. These activities would fall under PoTLL (or other facilities) normal terms of business/operating requirements and their own risk assessments, so can be excluded from the Project pNRA for the DCO. This was agreed with PLA and PoTLL in Meeting 10 May 2021, see Annex B.
b. All tunnel excavated material will be re-used on the LTC site. Export of tunnel excavated material is therefore excluded from the pNRA]

The following points were also agreed in the consultation meetings:

- The risk assessment methodology proposed by NASH Maritime was acceptable.
- Key issues identified by the Project team were appropriate.

- The Harbour Master (HM) was happy for the pNRA assessment study area to focus on activities within the immediate area around the pipeline and tunnel route. The wider area was being used for situational navigation context.
- AIS data from August and October 2019 (as described in Section 5.1.3) is appropriate for the baseline traffic assessment.
- The pNRA will assume the future baseline vessel movements are similar to 2019 levels, except that additional movements are:
    - To be advised by PoTLL for Port of Tilbury, Tilbury 2 (Ro-Ro berth and CMAT Jetty) and a possible future Tilbury jetty east of Tilbury 2. [post meeting note – estimates provided by PoTLL]
    - To consider potential additional/changes in traffic from the following developments, based on publicly available information:
        - Thames Tideway.
        - Thurrock Flexible Generation Plant.
        - Silvertown Tunnel.
        - London Resort.
- The pNRA will consider navigational safety only and will not include identification or assessment of any commercial impacts.
- The study area outlined is appropriate, see **Figure 13.**
- To support further consultation meeting in line with the project schedule indicative dates.

3.2 NRA STAKEHOLDER CONSULTATION

The following organisations are to be consulted during the pNRA:

Table 1: List of Consultees

Consultee Organisation	Contact Role Holder / Contact
Port of London Authority	Senior Harbour Master
Port of Tilbury London Ltd	Asset Manager Marine
Port Health Pier	Port health department
Gravesend Sailing Club	Club Secretary
Gravesend Rowing Club	Club Secretary
Thurrock Yacht Club	Club Secretary
National Sea Training Centre	NTMC Manager
Gravesend Embankment Marina (Lock Basin)	enquiries

4. BASELINE ENVIRONMENT

4.1 NAVIGATION OVERVIEW

The Project is situated in Gravesend Reach on the River Thames which is used by a wide variety of vessel types including general cargo vessels, tankers, ro-ro vessels, and less regular users such as cruise ships and naval vessels. There is also a pilot boarding area located in the western extent of the study area, with vessels approaching, slowing and manoeuvring to board and land pilots from a dedicated pilot launch service.

The Port of Tilbury is located to the western extent of the reach and is a major multi-modal port with several berths within the impounded dock and additional river berths, including the London International Cruise Terminal. Additional river berths opened at Tilbury2 to the immediate west of the LTC project site in 2020 at the site of the former Tilbury Power Station. The primary marine components of Tilbury 2 are a Construction Materials and Aggregates Terminal (CMAT) for handling and processing bulk construction materials and a ro-ro terminal for import and export of containers. This is expected to result in an increase in bulk and general cargo vessels and ro-ro vessels transiting this area which may not be represented in baseline vessel traffic data due to the recency of its opening and also potential impacts due to Covid-19. PoTLL have therefore confirmed to provide a representative traffic profile for consideration within the NRA.

Recreational vessels such as yachts motorboats and rowing boats also operate in Gravesend Reach which has a number of small local yacht and sailing clubs located along its banks.

A defined navigation channel is marked on Admiralty and PLA charts as shown in **Figure 6** and **Figure 7**.

4.2 INFORMATION AND ACTIVITIES

The existing and future baseline vessel traffic/characterisation requires analysis of existing data to facilitate identification and quantification of exposure for navigation hazards.

Relevant information regarding usage of the area will be collated to understand the baseline navigation environment within the study area and will include:

- Review of navigational features and obstructions based on nautical charts and other nautical publications.
- Vessel track data derived from Automatic Information System (AIS[8] data).
- Information on key or critical vessels (vessel specifications, dimensions, passing velocities etc.)

[8] AIS data is vessel position data transmitted by vessels engaged in commercial cargo or passenger operations. AIS data is transmitted periodically (between 1 sec to 6 minutes) by VHF radio, depending on vessel mode of operation (transiting speed, turning, berthed, or anchored etc.), and includes vessel specification termed “static” information (e.g., identification number, size, type, etc.) and “dynamic” information (e.g., speed, heading, position, etc.).

- PLA Operational Protocols and Codes of Practice.

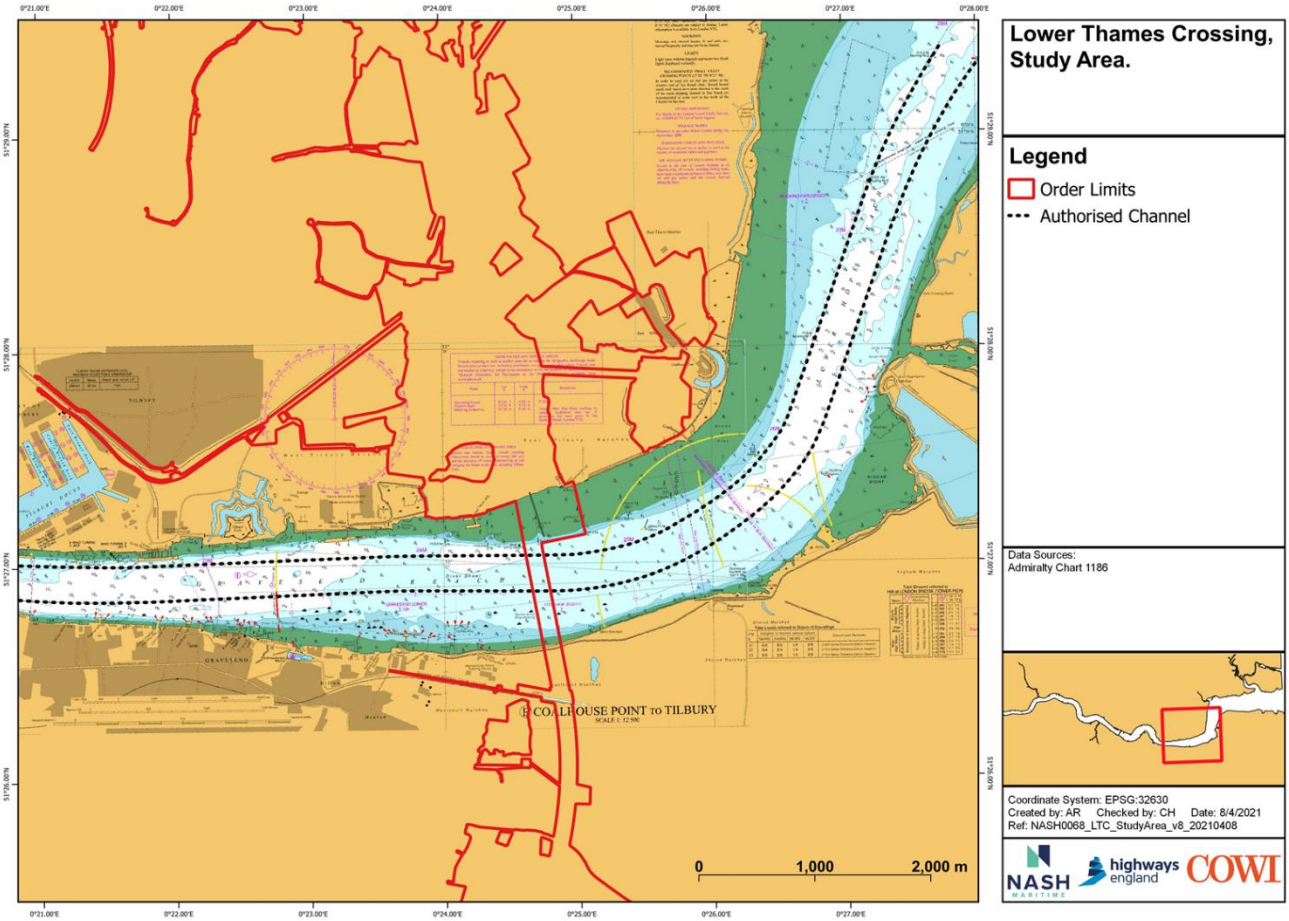

Figure 6: Navigation Features in Gravesend Reach.

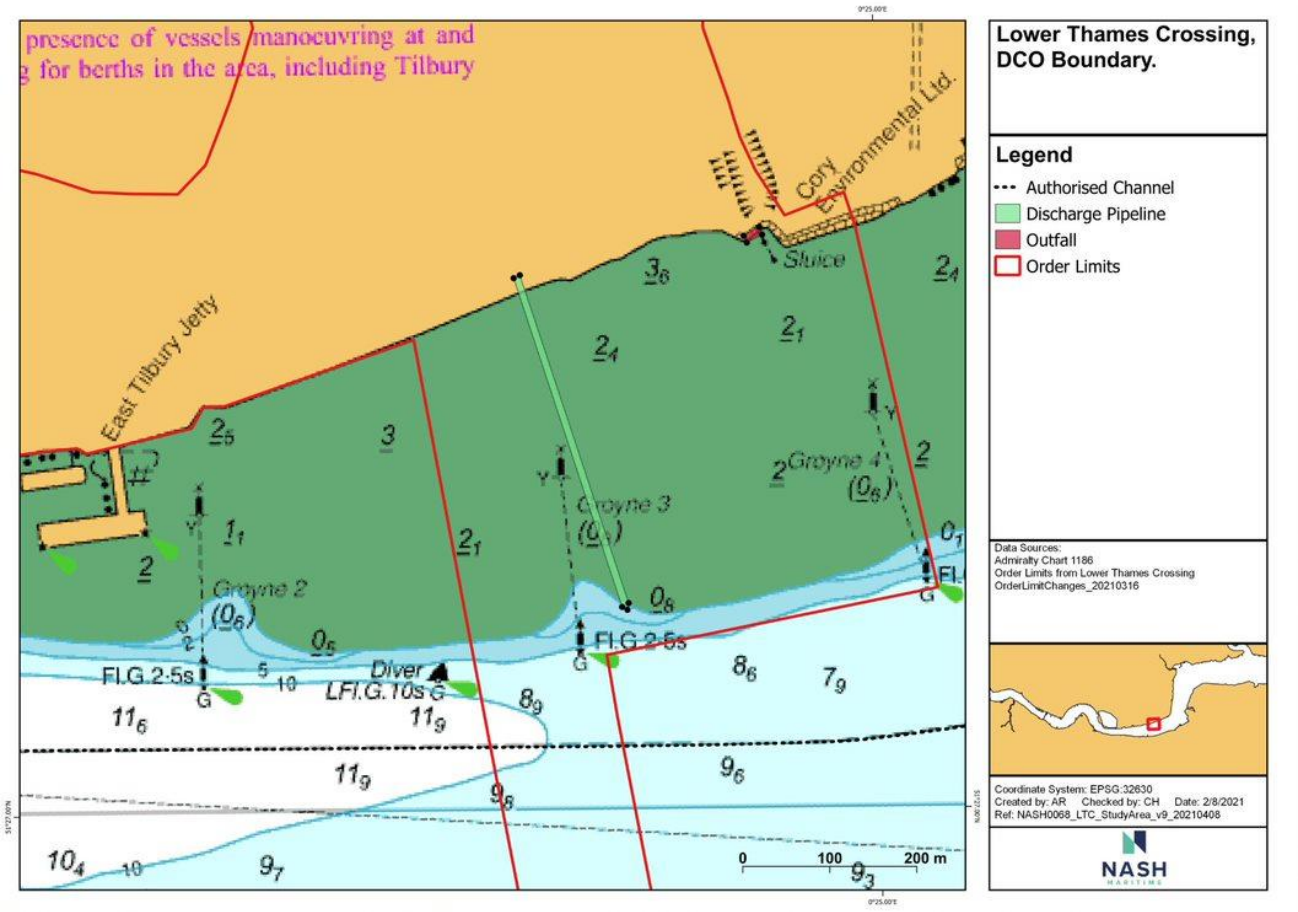

Figure 7: Navigation Features in the Project Vicinity.

- Existing NRA developed for the Project Ground Investigations including identified and implemented risk control measures in place.
- Historical incident data and records to inform likelihood / consequence of hazard occurrence.
- Review of legislation and regulatory documents.

4.3 BASELINE VESSEL TRAFFIC

Figure 8 through to **Figure 12** present initial vessel traffic analysis based on AIS data collected from September 2018 and is shown by selected key vessel types to show the spatial disposition of vessel traffic and allow early interpretation of the baseline traffic around the Project.

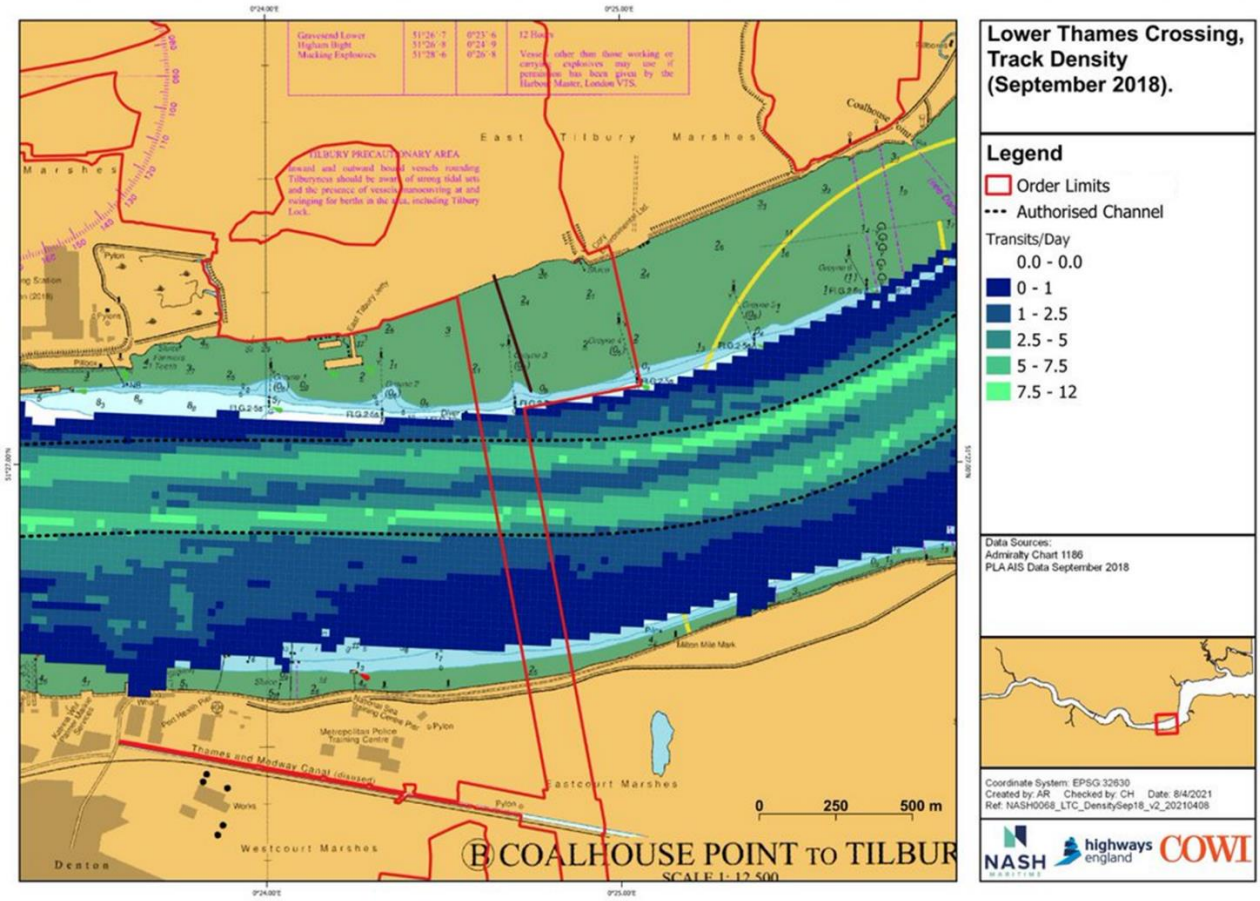

Figure 8: Initial Vessel Traffic Density Plot for Project Area.

The vessel traffic density plot **(Figure 8**) shows the highest traffic density within the authorised channel. There is also some use of the navigable water on the north side of the channel and within the draft DCO Order Limits running roughly east west just north of the authorised channel.

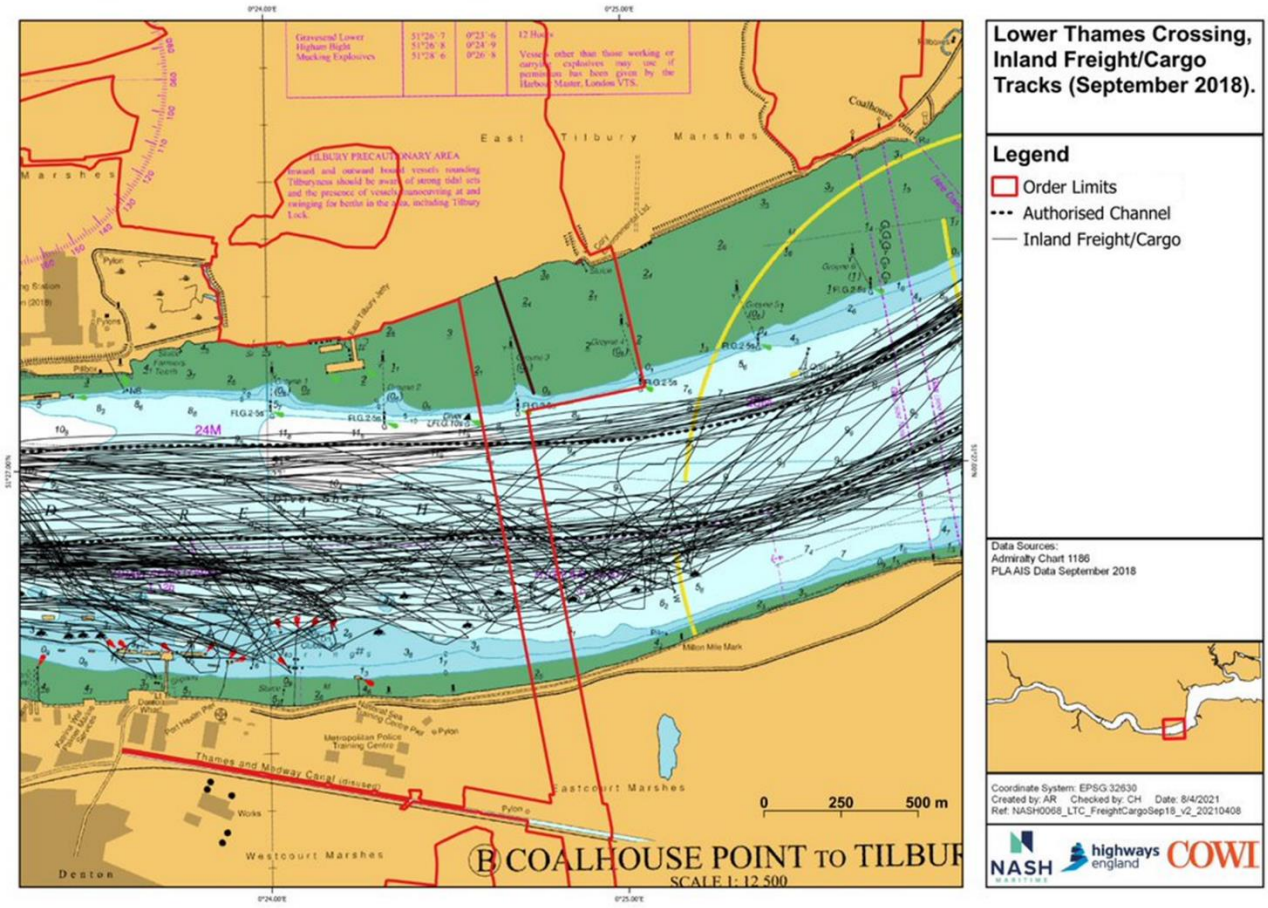

Figure 9: Initial Vessel Traffic: Inland Freight/Cargo – Sep-2018.

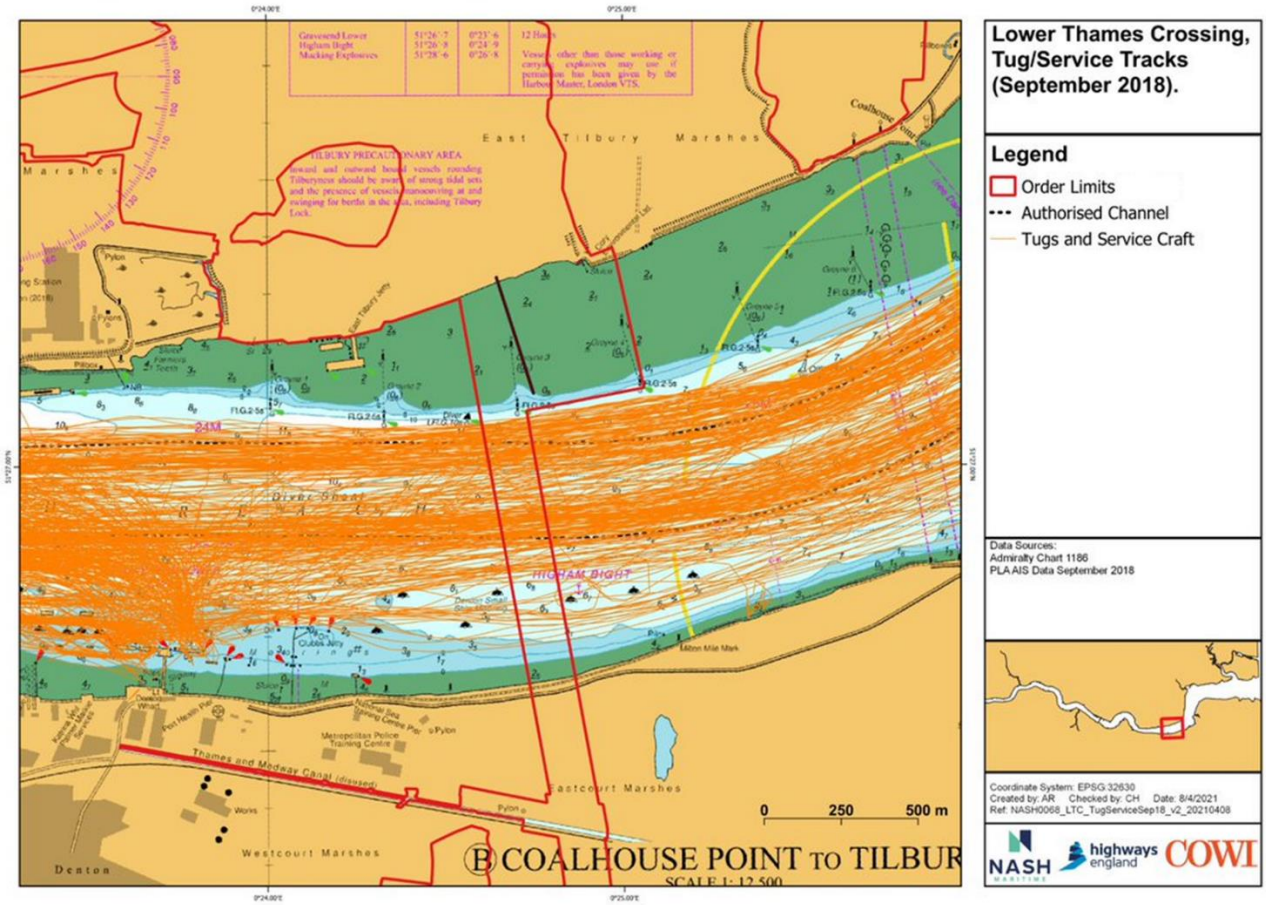

Figure 10: Initial Vessel Traffic: Tug/Service Vessels - Sep-2018.

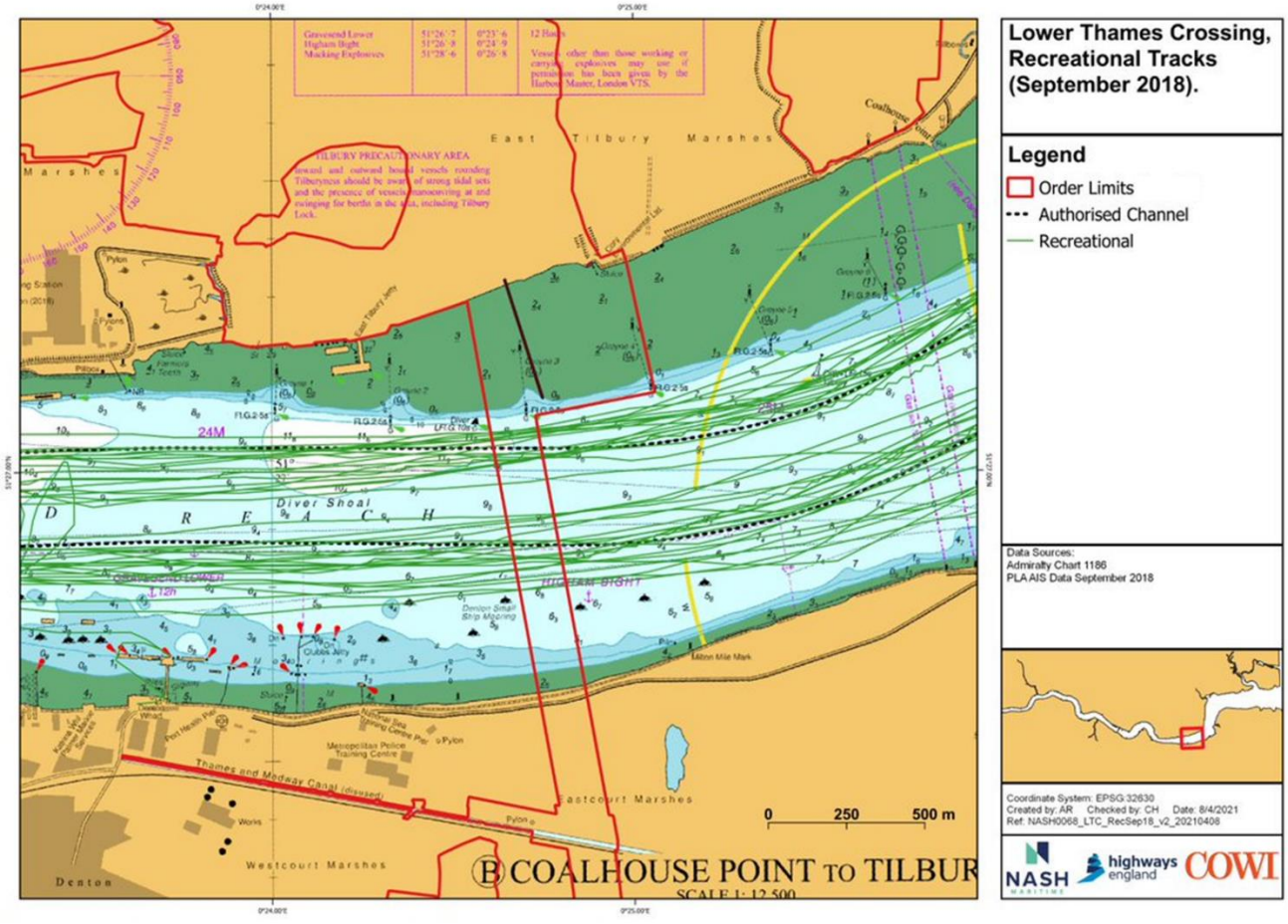

Figure 11: Initial Vessel Traffic: Recreational Traffic– Sep-2018.

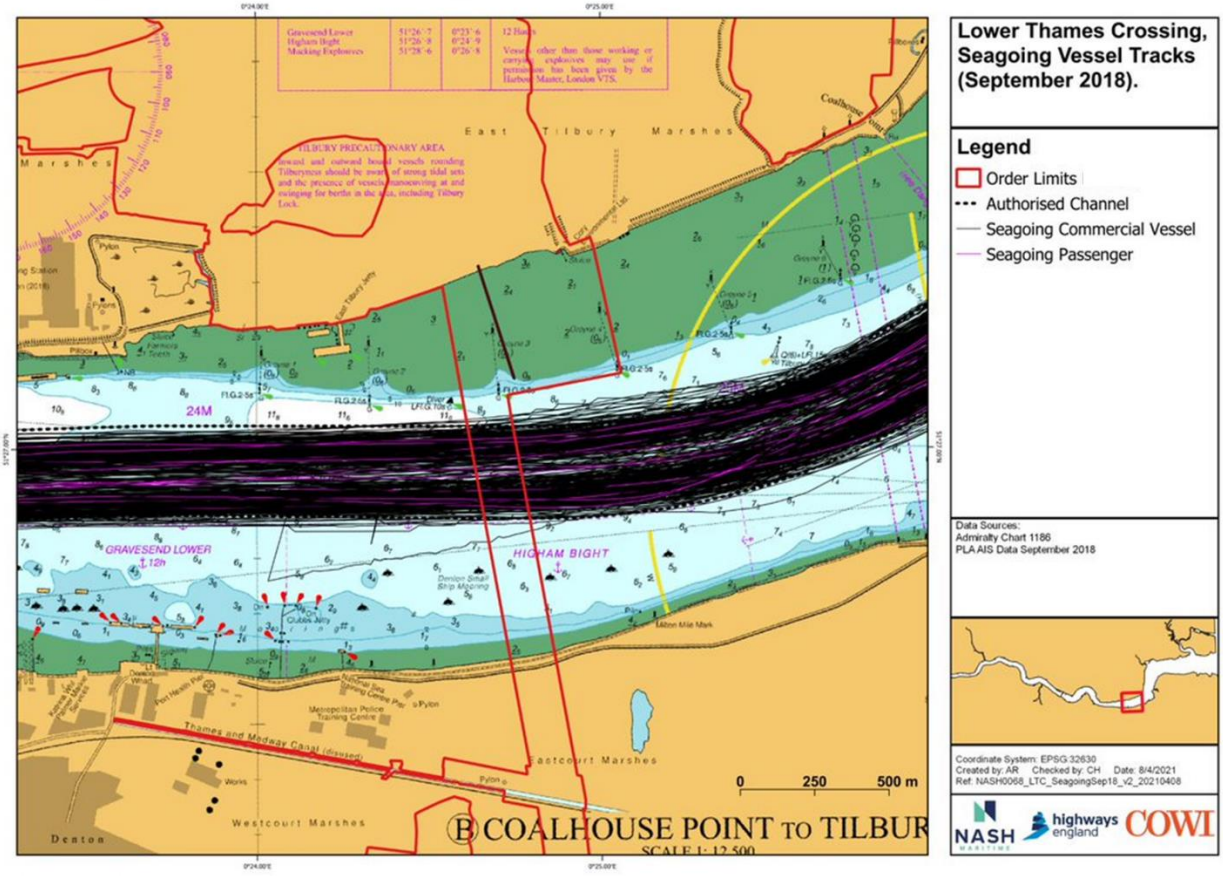

Figure 12: Initial Vessel Traffic: Seagoing Vessels – Sep-2018.

Figure 9 through **Figure 11** show that inland freight/cargo, tugs and service vessels, and recreation vessels all include tracks north of the authorised channel and inside the draft DCO Order Limits. In contrast, **Figure 12** shows that while seagoing vessels (typically larger and with deeper draught than the other classes) operate outside the authorised channel where water depths permit, none of the Sept 2018 tracks crossed the draft DCO Order Limits (except the N-S boundary over the tunnel itself). It is important to note however that the tracks of vessels presented does not take into account the width of the vessels, or the swept path (the water space used by a vessel which is derived from a combination of vessel position, geometry and vessel heading), and vessel domains ("*the surrounding effective waters which the navigator of a ship wants to keep clear of other ships or fixed objects*").

4.4 KEY ISSUES

To inform the Shipping and Navigation Requirements Specification and the pNRA requirements, an initial high level desktop analysis was undertaken and shared during the consultation meetings with the PLA.

4.4.1 Project Phases

The initial analysis and consultation identified the following project activities that need to be assessed.

4.4.1.1 Pre-Construction: Site Investigation Activities for tunnel.

High level assessment limited to outline of works requirement drawing upon the Project Phase 2A GI w20ks NRA[9] (completed by NASH Maritime) to secure key navigation principles of agreement e.g., maintenance of navigation during works within authorised channel.

4.4.1.2 Pre-Construction and Construction: Temporary In-River Works

Preliminary NRA for site investigations for and construction of temporary northern pipeline and diffuser including impact from use of the full extent of Order Limits and navigation relevant DCO definitions.

4.4.1.3 Permanent Works: Design, exclusion and protection zones

Preliminary NRA to address:

- Navigation implications from lateral and vertical permanent protection zones for the tunnel:
    - Explosives Anchorage / No Anchorage zones (inc. relocation options) etc.
    - Any O&M activities/structures
- Permanent northern outfall or other permanent in-river works.

4.4.2 Navigation Concerns – PLA Meetings 10 and 25-Mar-21

From NASH Maritime's desktop review, the PLA's review of earlier work and engagement during this specification development, it has been agreed that the NRA must address the following key navigational issues:

- Impact from project vessels during additional site investigations and during construction of pipeline/outfall.
- Interactions with other (known) planned developments listed in **Section 3.1.3**.

[9] Lower Thames Crossing Ground Investigations, Navigation Risk Assessment, River Based Works – Phase 2A Overwater GI, HE540039-PCI-GEN-GEN-REP-GEO-00027, Highways England, 10 Oct 2019

5. PROPOSED METHODOLOGY

5.1 DATA REQUIREMENTS

The data requirements to support the NRA are provided in this section.

5.1.1 Project Definition and Description

Key elements of the Project relevant to shipping and navigation issues are contained within the documents identified in **Table 2**.

Table 2: Key LTC Project Description Documents.

Title	Document Reference	Rev	Date
Navigational Risk Assessment - Basis Document rev2	n/a	Rev 2	17-Dec-20
Sketch Tunnel Protection Under River Showing River Charts	HE40039-CJV-STU-SZZ-ZZZZZZZZZZ-SK0CT-01065	P01.1	n/a
PLA PoT Meeting Minutes 17 Dec 2020	n/a		
Marine Assessment Report	HE540039-CJV-GEN-GEN-REP-TUN-00031	1.0	04-Nov-19
Marine Transport Assessment	HE540039-CJV-GEN-GEN-STR-CLO-00008	1	04-Nov-19
PLA PoT NRA 14 Jan 2020	n/a	n/a	14-Jan-21
PLA PoT Meeting Minutes 14 Jan 2020	n/a	n/a	14-Jan-21
PLA PoT Meeting Minutes 10 March_2021	PLA PoT Meeting Minutes 10 March_2021		
Norther Outfall Proposals (To Nash Maritime)	n/a	n/a	23-Feb-21
Discharge Route and outfall construction NP	HE540039-CJV-EGN-S07-TNT-ENV-00002	n/a	n/a
3.1 Draft Development Consent Order	TR010032/APP/3.1	1.0	01-Oct-20
DCO Boundary (R2.1)	HE540039_CJV_LDC_DCOBoundary_Ply		30-Mar-21
Order Limit Changes for DCO Submission 2.0	HE540039-CJV-GEN-GEN-DRA-GIS-00203	01	16 Mar 21
LTC Tunnels Project - L1 February 21 Programme	Level 1 Programme - February 21	n/a	25-Feb-21
TBN 21Precast Factory Design	HE540039-CJV-STU-ZZZ-TNT-TUN-20	1	01-Jul-20

20200707 North Discharge Options Environment Agency Response	KT/2020/127094/01-L01 (EA Ref)	n/a	07-Jul-20
320528 LTC North Portal Discharge Assumptions Paper NE response	320528 (EA ref)	n/a	25-Jun-20
Jetty Design and Construction Assumptions Paper	HE540039-CJV-EGN-S07-TNT-ENV-00001	n/a	n/a
2.14 River Restrictions Plan	TR010032/APP/2.14	1	01-Oct-20

5.1.2 DCO Details

Relevant details from the draft DCO are summarised in Section 1.2.

5.1.3 Vessel Traffic Data

AIS data (sourced from PLA VTS) covering the Thames from 500m upstream (west) of QEII bridge to 500m downstream (east) of DP World London Gateway terminal will be used. The data will cover the following periods:

- 14 days duration from Aug-2019 (0000 on Mon-29-Jul – 2359 on Sun-11-Aug inclusive).
- 14 days duration from Oct-2019 (0000 on Mon-14-Oct – 2359 on Sun-27-Oct inclusive).

This has been agreed with PLA and will ensure a baseline traffic dataset which pre-dates any COVID-19 influence and consider seasonal differences. Oct-19 traffic represents a 'peak' winter vessel movement dataset so will be precautionary. Consideration of Tilbury 2 marine operation and vessel traffic, which opened in 2020, will also be undertaken.

5.1.4 Incident Data

Incident data to be obtained from the PLA Incident database and reviewed.

5.1.5 Legislation and Guidance

Relevant legislation and guidance are summarised in **Section 2.2**

5.1.6 Stakeholder Consultation

Previous Stakeholder consultation to be considered is summarised in **Section 3.1**

Additional stakeholder consultation requirements are outlined in **Section 3.2**

5.2 LOCATION AND STUDY AREA

The study area for the NRA is shown in **Figure 13.** The study area covers the river Thames from just west of the draft DCO Order Limits to just east of the draft DCO Order Limits on the northern bank.

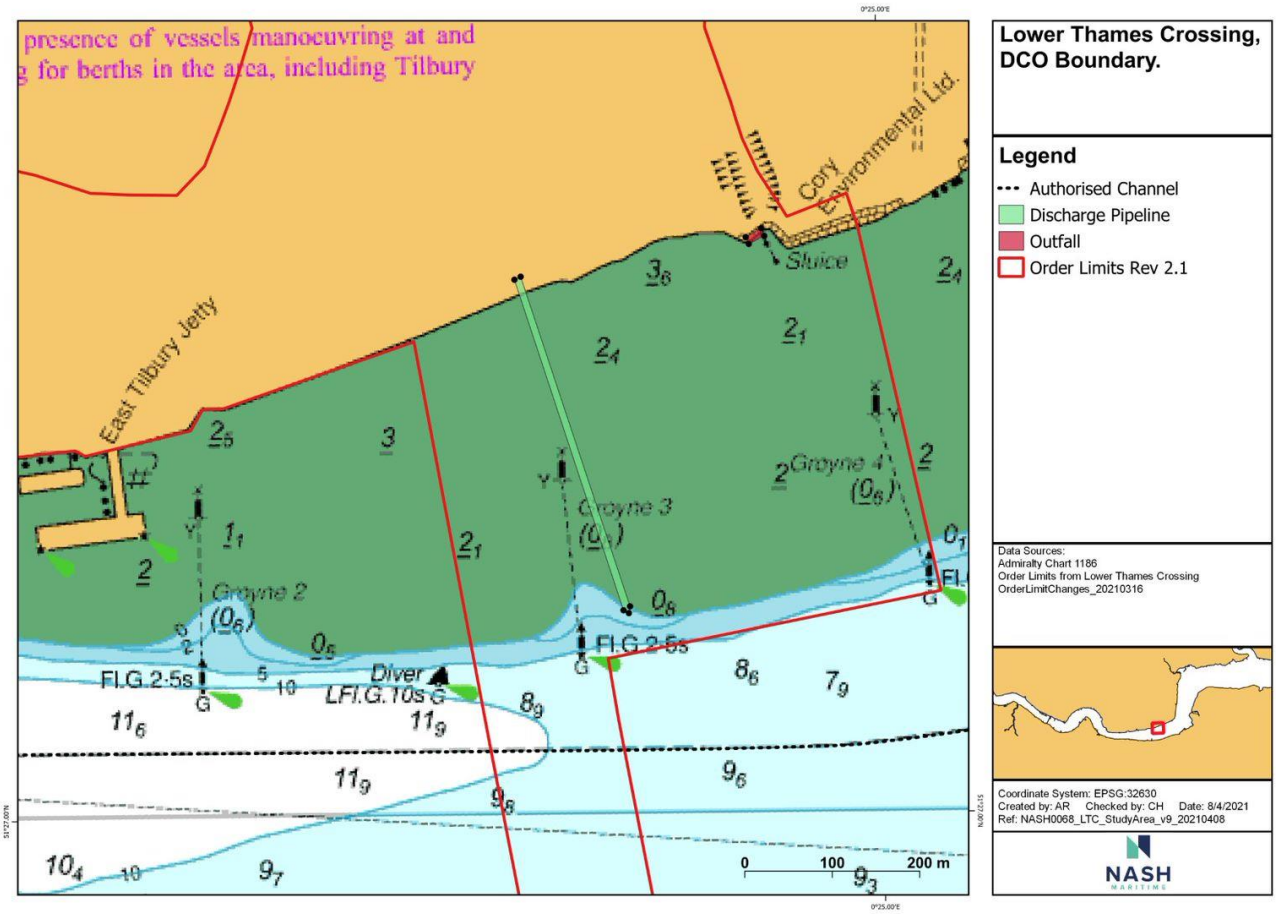

Figure 13: Extent of Study Area.

5.3 RISK ASSESSMENT MATRIX AND METHODOLOGY

The International Maritime Organization Formal Safety Assessment (FSA) methodology (see **Figure 14**) will be utilised and dovetailed with the risk matrix as shown in **Figure 15** in accordance with the PLA risk assessment methodology [10].

The pNRA will collate quantitative vessel traffic analysis, with the qualitative input derived from consultation and the expertise of project personnel to; undertake hazard identification, hazard risk scoring, and identification of appropriate risk control measures. Hazard categories may be split by:

[10] PLA Navigational Risk Assessment - Guidance to Operators and Owners. See: https://www.pla.co.uk/Safety/SMS/Navigational-Risk-Assessment-Guidance-to-Operators-and-Owners (Accessed 11-Mar-2021)

- Vessel types.
- Geographic/Spatial Risk Areas.
- Hazard types – e.g., collision, contact, grounding, breakout.

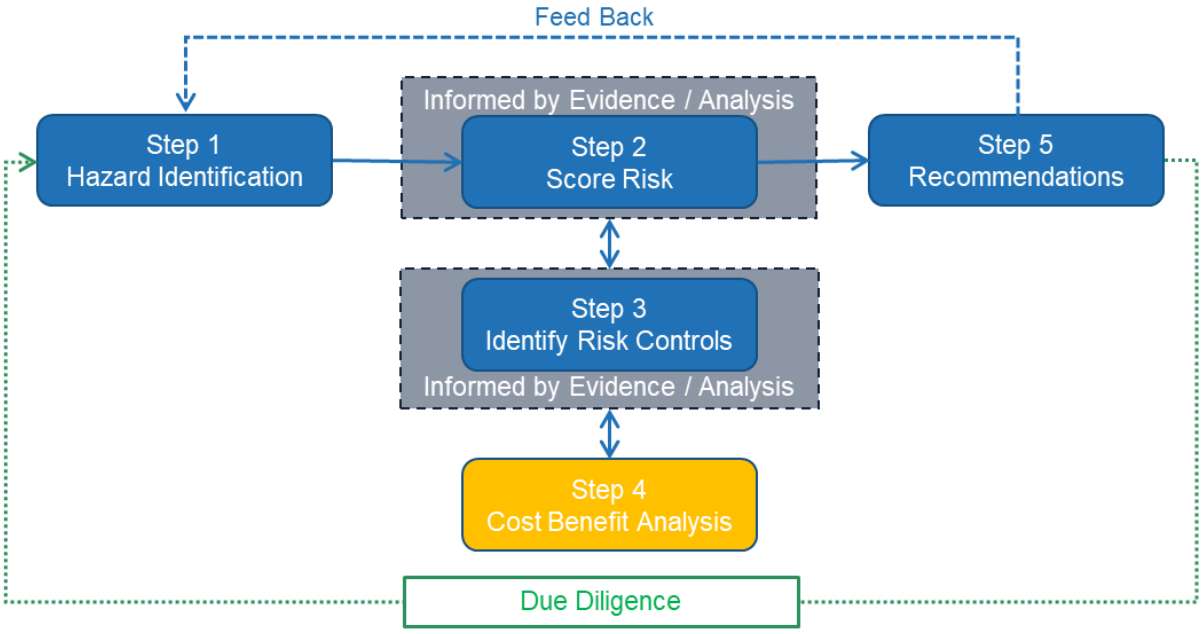

Figure 14: Formal Safety Assessment Process.

Where key or critical hazards are identified, further analysis may be required to provide an evidence basis for the assessment of risk. In many instances, key hazards or concerns are identified based on limited information, especially when there is likely to be a change in vessel traffic activity, and therefore further detailed analysis and interpretation may be used to determine the magnitude of any change or concern.

In order to ascertain the risk of individual hazard occurrence for both hazard likelihood and hazard consequence the "*Risk Assessment Matrix*" will be used (see **Figure 15**). The process of scoring hazard risk is carried out as part of a hazard workshop where hazards are individually assessed against the baseline traffic and incident data, the results of the stakeholder consultation, the expert judgement of the project team, and any detailed key hazard analysis undertaken.

Risk Score					
Almost Certain	5	10	15	20	25
Likely	4	8	12	16	20
Possible	3	6	9	12	15
Unlikely	2	4	6	8	10
Rare	1	2	3	4	5
Likelihood	Minor	Moderate	Serious	Very Serious	Severe

Figure 15: Risk Assessment Matrix.

Where hazards are scored as high risk, risk controls aimed at eliminating the hazard or reducing the risk to acceptable levels will be identified. Hazards scoring within the ALARP zone (As Low as Reasonably Practical) of risk acceptability will also have risk controls identified, and subject to their cost benefit these will be incorporated within the assessment. The process of risk control identification and effectiveness scoring will be documented in a hazard register.

5.4 STUDY EXECUTION

The pNRA will comprise the following tasks:

- **Task 1: Project/Task Management**

  The project team will conduct a full review of the documentation supplied by the Project and any relevant regulatory documents and legislation. Project controls and reporting systems will be put in place to ensure timely delivery of the project.

- **Task 2: Stakeholder Consultation / Hazard Identification and scoring workshop inputs**

  Stakeholder consultation will be vital in informing the NRA and consultation meetings will be held with regulators and stakeholders. As part of the pNRA the following consultation meetings are planned:

  - PLA including all relevant internal stakeholders to be invited by the Harbour Master (e.g., PLA Pilots, specialist HM Recreation).
  - Other organisations (e.g., PoTLL, recreational users (Gravesend Sailing Club and Gravesend Rowing Club) and National Sea Training Centre).

- Hazard Scoring workshop to discuss and score identified hazards, attendees to include:
  - PLA
  - COWI (representing Highways England)
  - Project navigation consultants (NASH Maritime).

- **Task 3: Baseline Vessel Traffic Analysis**

  Vessel traffic analysis will be undertaken from a dataset of vessel activity (derived from collected vessel positions transmitted as part of AIS) covering the study area. The dataset covers August 2019 and October 2019. This data will be processed into a geodatabase enabling the following analysis to be undertaken:

  - Vessel density analysis:
  - Vessel track analysis by vessel type.
  - Gate analysis near the proposed site - Analysis of gate data by vessel type, time of day, speed, etc.
  - Swept path analysis of vessels in order to understand the geometry and sea room extent needed for various manoeuvres.
  - Analysis as necessary to investigate key issues.
  - Analysis of historic incidents using data provided by PLA and the Marine Accident Investigation Board (MAIB).

- **Task 4: Future Vessel Traffic Analysis**

  The project team will then develop and implement a future vessel traffic forecast and movement scenario based on the future baseline vessel traffic movements agreed with PLA, PoTLL.

- **Task 5: Baseline and Construction Risk Assessment**

  Based on the analysis conducted during Task 1, 2, 3 and 4, hazards associated with the project in the study area will be identified in consultation with PLA and the associated risk will be scored as part of a hazard scoring workshop. Appropriate risk controls will be identified, where necessary, to mitigate risk.

- **Task 6: Future Operational Scenario Risk Assessment**

Based on the analysis conducted during Task 3 and 4, hazards associated with the future baseline operation of the LTC will be identified and the associated risk will be scored as part of a hazard scoring workshop. Appropriate risk controls will be identified where necessary to mitigate any unacceptable navigation risk.

- **Task 7: Reporting**

  A Technical Preliminary NRA Report will be produced and will be suitable to be included as an Annex to support the DCO application.

6. SCOPE SUMMARY

The project team will carry out Shipping and Navigation studies and prepare a Preliminary NRA using the methodology outlined in this report. The scope of the preliminary NRA has been developed in consultation with the PLA. **Table 3** summarises the topics to be covered in the pNRA.

Table 3: Summary of Sub-Topics included in pNRA.

Sub- Topic	Scoped In/Out	Rationale for inclusion / exclusion
Full NRA as per requirements of PLA	Scoped In	Included to address concerns raised by PLA in meeting on 14 Jan 2021 and 10 March 2021as amended during meeting on 24 March 2021 following changes to DCO Order Limits and DML details.
Construction Phase	Scoped In	A construction phase is included as part of the NRA as some marine activities and some temporary marine infrastructure works are included in the DCO application.
Operation Phase – excluding drainage, protection zones and explosives anchorage	Scoped out	There will be no increase in vessel movements as a result of the operation.
Operations Phase – permanent drainage	Scoped out	Permanent outfall on the shoreline for surface runoff is not navigationally relevant due to its location in the seawall on the shoreline at/above MHW. This location is not only outside the navigation channel but out of the river in all but very high tides.
Operations Phase – Protection Zones	Scoped out	The river restrictions within the protection zones proposed under Article 48 do not give rise to any navigational risk, as they control works and activities, rather than the free movement of vessels in the navigable river.
Operations Phase – Protection Zones – anchor strike	Scoped in	Anchors may penetrate the seabed within the protection zones so should be considered within the tunnel design
Operations Phase – Protection Zones – explosives anchorage	Scoped in	An existing explosives licence issued by HSE allows for anchoring of vessels carrying explosives in the vicinity of the protection zones. The licence precludes certain activities within certain distances of the vessel.
Use of East Tilbury Jetty	Scoped out	The potential use of East Tilbury Jetty is no longer included within the DCO
Third Party Hazards	Scoped out	Third party hazards are not included because they are assessed as part of the wider Port of London risk assessment administered by PLA.
Commercial Shipping Assessment	Scoped out	Future commercial (rather than navigation safety) impact on commercial shipping as a result of LTC construction and permanent works considered to be unlikely, given the very limited scale of construction activities and permanent features within the navigable river..
Shipping and navigation outside of Study Area	Scoped out	Navigational risk will be assessed within the study area outlined in **Figure 13** as agreed with PLA (see Annex B), this extent is suitable for the relevant assessment of risk .

Annex A
DCO Sections Relevant to Shipping and Navigation

Details from:

Lower Thames Crossing 3.1 Draft Development Consent Order, APFP Regulations 5(2)(b) Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Volume 3, October 2020, TR010032/3.1, Version 1.0

Note to Reader:

LTC is currently revising the DCO details in advance of submitting a Version 2.0 of the application. Relevant changes include:

- DCO Order Limits
- DCO powers
- Deemed Marine Licence

Relevant changes to be addressed in the Preliminary NRA when further details are available.

Section / Title	Article / Para	Relevance / Summary
PART 4 SUPPLEMENTAL POWERS		
Powers in relation to relevant navigations or watercourses	Para 18	Gives wide ranging powers to potentially impact navigation anywhere within the DCO boundaries - providing (Article 58) it is agreed with PLA (see below)
Discharge of Water	Para 19	Gives wide ranging powers to discharge to watercourses - subject to consent
Authority to survey and investigate the land	Para 21	Gives wide ranging powers to survey (including excavations and boreholes) on land and in watercourses within the DCO boundaries
PART 6 OPERATIONS		
River Restrictions in the vicinity of the tunnel	Para 48	Defines the restrictions on the PLA and other users doing anything to/on the riverbed which may impact the tunnel within the river Restriction Zones identified in Schedule 16 without consent from the undertaker [LTC]. Also restricts PLA from issuing river work or dredging licences anywhere within the DCO boundary without consent from LTC.
PART 7 MISCELLANEOUS AND GENERAL		
Deemed Marine Licence	Para 59	Marine licence is deemed to have been issued per Schedule 15 (Article 59) and the conditions therein
SCHEDULE 11 LAND OF WHICH TEMPORARY POSSESSION MAY BE TAKEN Article 35		
		Locations potentially impacting navigation illustrated on multiple drawings including areas where temporary possession may be taken - including marine works, river outfall, existing East Tilbury Jetty and transportation and removal area of materials from tunnelling works in the north portal.
SCHEDULE 14 PROTECTIVE PROVISIONS Article 58		
PART 7 FOR THE PROTECTION OF THE PORT OF LONDON AUTHORITY	Para 82	Requires PLA to approval for any part of the development below high water or affecting navigation on the Thames or any function of the PLA.
	Para 83	Consent to be given in writing by PLA before commencing specified work.
	Para 84	Tunnelling works to ensure navigable channel can be maintained (now and in future) by PLA to a depth of 12.5m Allowing +0.5m overdredge.

	Para 88	Any work which gives rise to sedimentation, scouring, currents or wave action, which would be materially detrimental to traffic in, or the flow or regime of, the river Thames may require LTC to remediate. pNRA does not need to consider the potential for these impacts as LTC project team advised that no planned marine structures (including pipeline/diffuser) will have this type of impact on navigation.
	Para 89	NRA to consider impact of any work on existing Navigation aids
	Para 94	NRA to consider need for additional nav aids
SCHEDULE 15 DEEMED MARINE LICENCE		**Article 59**
PART 2 LICENCSABLE MARINE ACTIVITIES		
	Para 3	Licence allows construction of certain structures within the Thames at certain locations for certain periods
	Para 5 (1)	May include construction, alteration, improvement, maintenance, operation and decommissioning
	Para 5 (1) (a)	Construction of a buried subtidal outfall on northern shore with diffuser on subtidal river slope. Permitted during construction only: to be decommissioned after construction of LTC
	Para 5 (1) (b)	permanent outfall on northern shore discharge at MHWS. Not relevant to NRA
	Para 5 (1) (c)	alterations to (but not extending) existing jetty [East Tilbury Jetty]
	Para 5 (1) (d)	may include operating existing jetty for offloading concrete tunnel segments allows 24 hour working and task lighting
	Para 5 (1) (e)	decommissioning existing jetty only a requirement if the jetty is used by LTC
	Para 5(2)	specific (approximate) co-ordinates provided for each element as below
	Para 5(2) (a)	construction phase outfall
	Para 5(2) (b)	operation phase outfall
	Para 5(2) (c)	existing jetty
PART 4 CONDITIONS *General conditions*		

removal of temporary structures etc.	Para 19.	Requires removal of temporary structures with 30 business days of completing relevant activities
PART 6 CHANGES TO THE DEEMED MARINE LICENCE		
	Para 26	any changes require approval from MMO
SCHEDULE 16 DOCUMENTS TO BE CERTIFIED Article 60		
River Restrictions Plan	Regulation 5(2)(o)	Identifies tunnel route and profile and exclusion/restriction areas relevant to navigation and river operations [details remain under discussion between PLA and LTC]

Annex B
PLA Consultation Minutes

Stakeholder Meeting Minutes Lower Thames Crossing

Meeting with Port of London Authority and Port of Tilbury on 14 January 2021

Navigational Risk Assessment - Scoping

Location: Teleconference

Attendees:

Name	Initials	Organisation
Peter Ward	PW	Commercial Director, Port of Tilbury
Nick Evans	NE	Harbour Master, Port of Tilbury
Lucy Owen	LO	Deputy Director of Planning and Environment, PLA
Cathryn Spain	CS	Senior Harbour Master – Lower, PLA
Mark Towens	MT	Harbour Master (Special Projects), PLA
Silvia To	ST	Stakeholder Engagement, LTC
Kate Orage	KO	Stakeholder Engagement, LTC
Ian Mockett	IM	Marine Advisor, LTC
Bleddyn Bridge	BB	Highways, LTC
Kirstie Goldsmith	KG	Consents, LTC
John Clark-Hughes	JCH	Construction, LTC
Ed Rogers	ER	Consultant, Nash Maritime
Jamie Holmes	JH	Consultant, Nash Maritime

Meeting notes:

Discussion points
Introduction • ST: LTC are developing a NRA as requested by PINs. The focus of this meeting is to discussing scoping of the Navigational Risk Assessment (NRA). Stakeholders advised LTC to engage with specialist consultants and LTC have taken Nash Maritime for the NRA work. • BB: We have so far focused on four main works that form part of the assessment. We would like to go through each area to understand stakeholders' feedback on how much detail is required. Note that LTC is currently at preliminary design phase so it does not have detail on every aspect. Four main works as follows: **Temporary works in river** • IM: LTC anticipate further over-water GIs – a repeat of phase 2 GI but targeted to support detailed design, particularly at the cross-passage location. Cross passages will be 6 or 7, with one or two in the main channel. Scope of work would be part of design and build contract so essentially under remit of contractor and our approach to it would be based on risk assessment previously undertaken, plus detailed NRA for obtaining licenses etc. • LO: will this be done under temporary licence or put into the DCO? The GI will likely come in advance of tunnelling so a licence regime is possible, and then DCO worded accordingly. KG: LTC will consider this. **Action: LTC to consider whether**

over-water GI activity post-consent could be taken as a temporary licensing outside of the DCO.

- JH notes that the NRA undertaken for original GI came up with navigational risk controls that may still be valid for future SI so there are already mitigation provisions authorised within channel that can be bought forward and can be assessed in temporary licence.
- BB: If taken forward and GI done under separate consent, would we still have to cover that work in NRA? MT: If separate licence, NRA can be dealt with through that process and removed from DCO NRA.
- IM invited Tilbury to comment. PW only wants to ensure that these temporary works do not interfere with river navigation – it is understood that PLA will cover this issue. LTC should be aware that since the previous GI was carried out, Tilbury have since opened a new port (Tilbury2) which will ramp up significantly with larger ships and increased shipping movement (Tilbury2 terminal will transport 1 million tonnes a year).

Import/export Material

- IM: current project position is that the bulk of material exported will be used on-site but the use of Ingrebourne Jetty is part of DCO submission to provide flexibility for contractor. It may not actually be used but keen to get a view from stakeholders on what level of detail is needed to describe this. From import view, contractors would potentially use Ingrebourne jetty and provision is made for use of existing Tilbury2 facility. Note that for the jetty – there will be a similar approach to what is already licenced (by Tideway and Flo), and if the contractor uses Tilbury2 facility, that will fall under Tilbury's normal operation. How defined does this all need to be in NRA and to what level (for both jetty and Port use)?
- PW notes that for import, the Port advise use of Tilbury2 as the existing Goshams jetty would not have the capability to import tunnel segments (unless jetty is upgraded). Use of Port facility would also reduce construction traffic. IM/JCH agrees that Tilbury2 has capability, however this cannot be mandated. This topic is being discussed separately in other meetings.
- NE: regarding use of tilbury dock, it is agreed that this would fall under the Port's normal terms of business and not for the NRA. The Port would undertake a risk assessment with the operator unless PLA think otherwise. IM: the project would undertake a risk assessment if the import/export activity via Tilbury2 falls outside it is normal operation – if so, LTC would place obligation on the contractor to ensure further assessment is undertaken.
- MT/CS: For PLA, whether the jetty site is being used or not, the DCO allows potential for its use so the NRA needs to cover this. Consequential volume of traffic needs to be assessed. In terms of use of Tilbury2, this depends on the type of import/export activity – if it is 'business as usual' (i.e. no increase on capacity or vessel size), then it would not require additional assessment in NRA DCO.
- BB: regarding use of jetty, we can only make assumptions at the moment on the level of detail we have. MT: noted - at this stage, you can assess broadly, and detail added later when appropriate. At this stage, we are establishing principle rather than detail such as vessels and barge sizes etc.
- LO: noted that LTC needs to have enough confidence that this will happen realistically - a degree of confidence about what will be done and where.

Construction in-river

- IM: Any construction in-river will be outside of main channel (potentially works to occur in shallow section of Diver Shoals – the key area will be on construction side, north of river.
- JCH: On northern side, LTC are discussing these works with Environment Agency (EA) and Natural England (NE) – the debate for us is whether or not we can discharge water into local ditch network or whether we need to take the outfall directly to the Thames. There are pros and cons for both - environmental bodies prefer discharge to the Thames so if this is assumed as the case, we need to construct out and across the edge of the water. What we envisage for the river is taking pipe out with diffuser head, noting that there will be a large volume of works (major excavation at below ground level) – water needs to be treated to reach EA standards.
- LO: how will NRA feed into Order Limits and the powers being sought? Powers can include more than the area proposed. If the Order Limits are re-drawn accordingly to the works LTC are stating, then this will reduce work at examination. JCH: the distance required to go out into river would be minimum possible, but the area required is driven by EA and NE requirements that will make us fall out into tidal zone and at which point the diffuser would be the lowest tide level.
- KG added that the position of the diffuser head is related to the conversation with EA around Water Framework Directive requirements in terms of level of chemicals in that discharge. If LTC can reduce the area of the Order Limits in this area, we will but this is unlikely to change given that this is what LTC considers the most practicable solution. LTC will keep the dialogue open.
- MT reiterates LO's concern regarding the defined area in north side of river. From an NRA perspective – what needs to be defined is the powers within this area. It is a very large area right up against navigational channel with powers that allow a lot to be done. The NRA will need to include detail, such as its proximity to channel, powers contained currently within the DCO and what can be done within the Order Limits and next to channel. PLA advises that LTC reduces the Order Limits with less work/scope on the NRA for the intended works stated above. If the Order Limits remain, there the scope of NRA will increase.
- MT asked whether the Order Limits on the south side is still present. KG confirmed that LTC intends to remove for DCO resubmission. MT: if removed, no concern.

Permanent works design, exclusion and protection zones

- IM: Is there an expectation for these areas to be included in NRA? MT: This is more complicated. In terms of depth, we are close to an agreed solution. This is probably not an NRA issue – more of a future proofing design consideration of the tunnel. Struggle with how it might be worded in NRA. NE agrees – unsure as to how it might be covered in NRA but the issue itself is a significant risk to the Port given future expansion and associated dredging. The Port do not wish to go through dual licencing (via PLA and Highways England) so need to understand this more.
- RO notes that within the protection zone, dredging activities are allowed without consent. It is other activities such as excavation and piling that needs approval. No works are permitted within the exclusion zone without approval.
- MT: the reference 'no works permitted without approval' needs further discussion as there may be more works to do which have little or no impact. PLA are keen to

know what works require approval or not. **ACTION: LTC to include this as an agenda item at separate meeting with PLA.**

- IM: from NRA point of view, works will be activities driven by either PLA or other river users so no need to include the description of these under NRA, unless you feel that that is useful to have something in there?
- NE: regarding the protection zone, does it include capital dredging? Or is the 'no-consent' requirement only related to maintenance dredging? RO: Maintenance dredging is the term stated – any dredging should also cover capital dreding.
- LO: for PLA, it is about Highways England's powers and providing degree of flexibility. Powers are quite extensive about placing things in river during construction, so NRA needs to reflect powers given rather than what you envisage to do. KG notes that this issue is being considered separately.
- ER: asked about the no anchoring zone and whether this is been discussed. MT: noted that this has not yet been considered closely but needs to be picked up in the NRA. There is also the potential need to move the existing explosives anchorage.

Next steps

- IM asked if there are any other areas LTC needs to consider for the NRA. LTC will continue to ensure stakeholders are consulted.
- **LTC and Nash will draft initial NRA scoping document for stakeholder circulation and review.**
- JCH asked if PLA expects NRA to be part of the DCO. LO – some form of NRA needs to be in the DCO application. As it is quite broad in scope, PLA expect that Protective Provisions are in place and NRA is submitted where appropriate.
- IM asked if a 'preliminary' risk assessment would be appropriate at this stage. LO – at this stage, we are looking to agree scope so hopefully no surprises if scope is followed. Silvertown, similarly, submitted a preliminary NRA so this is not an issue for LTC, in principle.

Stakeholder Meeting Minutes Lower Thames Crossing

Meeting with Port of London Authority and Port of Tilbury on 10 March 2021

Navigational Risk Assessment - Scoping

Location: Teleconference

Attendees:

Name	Initials	Organisation
Peter Ward	PW	Commercial Director, Port of Tilbury
Nick Evans	NE	Harbour Master, Port of Tilbury
Lucy Owen	LO	Deputy Director of Planning and Environment, PLA
Cathryn Spain	CS	Senior Harbour Master – Lower, PLA
Silvia To	ST	Stakeholder Engagement, LTC
Kate Orage	KO	Stakeholder Engagement, LTC
Ian Mockett	IM	Marine Advisor, LTC
Bleddyn Bridge	BB	Highways, LTC
Kirstie Goldsmith	KG	Consents, LTC
John Clark-Hughes	JCH	Construction, LTC
Chris Hutchings	CH	Consultant, Nash Maritime
Ed Rogers	ER	Consultant, Nash Maritime
Jamie Holmes	JH	Consultant, Nash Maritime

Meeting notes:

Purpose of meeting

To discuss and agree on detailed scope of the Navigational Risk Assessment (NRA) and update on tunnel depth discussions.

Discussion points

Tunnel depth update

- LTC has reviewed the tunnel depth and channel width figures provided by PLA (on 15 February). From an engineering perspective, the figures feel comfortable. The mechanism in place to secure this is a discussion via the Draft Order and/or Protective Provisions is ongoing with the PLA.
- LO: positive that these discussions will forward and adds that it would be useful to get updated drawings or plans to reflect conversations. WC stated that drawings are in progress – this will be circulated in due course.
- CH: For the purpose of producing the NRA, are the arrangements in this discussion different to the areas stated in current DCO? KG: this is an evolving discussion – the answer may become clearer following further agreement (6-8 weeks). JH notes that this brings an embedded level of precaution into our assessment.

Navigational Risk Assessment (NRA) – Scoping

- JH presented power point slides covering NRA scope and agenda.
- **ACTION: LTC/NASH will issue specification report to PLA and PoT when available.**
- LO: Is it envisaged that there would be temporary mooring to assist in use of jetty? JCH: We are specifically looking at river transport strategy – one component of that will be looking at temporary mooring so this is still under consideration.
- PW: Will LTC take into account the Port's planned development on RWE's current land as the development will extend near to Ingrebourne's jetty? JH: We will need to take this back and consider. It would help to understand the extend of the Port's expansion plans.
- JCH: discharge pipe is likely to be in the region between groynes 3 and 4 but cannot confirm yet – still awaiting information from the Environment Agency.
- LO: The DML is specific on coordinates but the Order Limits in the river is appears more than what is necessary. PW also queried why the Order Limits extends out west of the existing jetty. KG noted that the Order Limits are currently being reviewed.
- LO: in relation to the jetty, would the DCO look to extinguish existing licensable works? This would be an issue as if the case, who is then responsible for it? KG states that the Deemed Marine Licence (DML) intends to take over the existing licence but on a contingent basis – i.e., only if the project uses the jetty. If there is no use, the jetty (and licence) would remain in the hands of its current owner. LO is concerned more about the river works licence, rather than the DML.
- **ACTION: LTC (KG) to check on the river works licence conditions for jetty (specifically in relation to extinguishing existing licensable works)**.
- PW: notes that the existing jetty in the Order Limits are not capable of receiving components such as tunnel segments. LO further queried why LTC is considering spoil by water. JCH: there is no soil exportation – they are being placed on Goshems Farm. LO notes that if this is the case, it needs to be made clear in this document.
- JH: re the study and assessment area, the Order Limits within the river is what we will base the NRA on. Does PLA have views on west and eastern extent of area for risk assessment? CS: It's a long reach so PLA do not see the need to extend the area beyond – you capture all river traffic information you need within the current study zone. JH confirmed that Nash will proceed on the basis of the map presented.
- PW added that the Port can provide their traffic data over a timeline following CMAT and RoRo berth operation. JH noted this would be helpful. Our expansion timeline means that our development would be built before LTC commenced construction. The Port has also been awarded Freeport status so the Government will expect their development plan to go

ahead and for LTC to look at this content. They are concerned about how this would be impacted by LTC. LO added that whilst is it not currently a committed development, if LTC does not assess it now and the Port gets permission and builds out, then it may have an impact on LTC at a later date. KG noted that we will consider this internally with Nash.

- **ACTION: PoT (PW) to provide footprint, movement and timescale associated with planned expansion.**
- **ACTION: LTC/NASH to consider NRA scope in light of PoT's planned expansion.**
- Other actions included are as follows:
- **LTC/NASH to send Site Investigation NRA report to Port of Tilbury.**
- **PLA (CS) to provide further contacts for stakeholder consultation on NRA.**
- **LTC to factor in potential Thames clipper scheme as interfacing project in NRA scope**
- **LTC (ST) to confirm whether NRA will be included in scope of public consultation.**
- **LTC/NASH to hold further session with Tilbury and PLA to run through thoughts on preliminary navigational impact and hazards.**

Notes of Meetings
Lower Thames Crossing (21-NASH-0168)

Client:	**Lower Thames Crossing**
Project:	Lower Thames Crossing
Venue:	Video/telecon (MS Teams)
Date of Meeting:	10-May-21 (10:00-13:00)
Present:	
Port of London Authority (PLA)	Cathryn Spain (CS) | Harbour Master
Port of Tilbury London (PoTL)	Nick Evans (NE) | Asset Manager Marine
Lower Thames Crossing	Ian Mockett (IM) | Senior Market Director
NASH Maritime	Chris Hutchings (CJH) | Project Manager
NASH Maritime	Jamie Holmes (JJH) I Project Director

0. Introductions and Meeting Objectives

CJH commenced the meeting, introduced attendees

CJH and JJH noted that the Specification report for the Preliminary NRA (PNRA) would now be updated and re-issued following comments from Project legal.

The purpose and aim of the meeting as defined in the accompanying slide pack (to be read in conjunction with these minutes) is to confirm the scheme and review the draft PNRA identified hazards and preliminary scoring results together with potential risk controls.

1. Scheme Summary | Order Limits and key marine/navigation features

CJH explained the key project features confirming the updates introduced at previous meeting (24 March 2021), specifically including the revision to the Draft DCO and further definition on marine/navigation aspects of the proposed scheme. Key aspects include:

- Order Limits (red line boundary) reduced and the potential for use of the East Tilbury Jetty is no longer included and not being progressed in the DCO.

Temporary in-river works prior to and during construction of tunnel:

- Features consists of discharge pipeline and outfall between Groyne No's. 3 and 4 on northern shore. Intended to be in place for duration of construction and removed on completion (slide 4/34).
- Overview provided of construction & decommissioning of discharge pipeline and outfall including key activities, plant (where known) and schedule of works (slide 6/34).

Permanent works – on completion of construction of tunnel:

- The relevant navigation interface is noting the tunnel protection zones (slide 4/34)

Use of river during construction of tunnel:

- CJH provided overview of materials during construction works including indicative import/export volumes and material types (slide 5/34)

- Project premise (following the revision to the Draft DCO) is that marine imports/exports will be to established facilities, and CS and NE confirmed PLA and PoTL understanding that these movements would therefore be included under existing navigational risk assessments for PLA and any other SHA (e.g. PoTL if movements enter their limits).
- CS explained that establishment/usage of additional marine facilities for project (if proposed) will necessitate NRA update.

Overview of schedule provided inc. mobilization in Jul-2023 with tunnelling between Jul-2025 to Mar-2027 and completion by Jul-2028.

Project phases for purposes of PNRA are considered as below (slide 7-8/34). Ph0 is scoped out of the PNRA (as previous NRA provides basis for review/update once SI borehole locations are known and SI Contractor develops RAMS) and Ph3 being considered in terms of navigation implications associated with penetration into the protection zones rather than in a risk assessment approach.

- Ph0 – Pre-Construction SI for tunnel (additional boreholes along tunnel route)
- Ph1 – Pre-Construction SI for pipeline and diffuser
- Ph2 – Construction and duration of installation for pipeline and diffuser
- Ph3 – Operations-/-Permanent Works: Protection zones around tunnel and relevant navigation implications

2 Scope of the Preliminary Navigational Risk Assessment

CJH summarized the key points as per the Specification for Phase 0 and Phase 3.

Phase 0: Pre-Construction SI for tunnel (slide 10/34)

- CS agreed that NRA undertaken for SI in 2019 remains valid basis and the risk controls agreed from this work will be anticipated to be taken forward. JJH noted this, and once boreholes are known and contractor develops methodology, the risk assessment should be reviewed/validated.

Phase 3 – Operations-/-Permanent Works: Protection zones around tunnel and relevant navigational implications (slide 11-15/34)

- CJH drew attention to the potential impact of protection zones on usage of the designated anchorage Higham Bight and moorings with respect to the draft DCO definition and some recent project correspondence in relation to permitted activities/exclusions being sought.
- Designated Anchorage:
    - CS noted, following review of circa 2 years POLARIS data prior to meeting, that the anchorage is not heavily used with circa 20 movements recorded in the period. Action A1: CS to provide POLARIS extract/details of usage inc. key vessel parameters where known

- Anchorage is Unrestricted (in terms of mooring duration) and maximum vessel 100m vessel length limit as per: https://www.pla.co.uk/assets/platidetables2021webversion.pdf (accessed 10-May-2021)
- JJH queried status of Explosives Licence and CS confirmed that anchorage is licensed by HSE on this basis, but she had no knowledge of it being used as such over last 2 years. Action A2: CS to forward any relevant details to NASH Maritime
- Denton Small Ship Moorings:
- CS noted that POLARIS records this area as 'Denton Swing' and doesn't itemise down further (e.g. by individual buoy).
- CS noted that any intraport usage and moorings rented by others will not be recorded in POLARIS and so will show underuse relative to reality. JJH noted opportunity extrapolate from project AIS Data although any use/definition by PLA would be helpful to validate this extrapolation.
- Action A3: CS to provide introduction to Barbara Juist from PLA Marine Services for information on any mooring rental/intra-port usage

Discussion held on key risk being seen as potential bed penetration in relation to 1st and 2nd protection zone by planned vessel anchoring (less for those using moorings). NASH to review for routine anchoring vessels (based on PLA data-/-assumptions for maximum 100m vessel length).

NASH to also consider emergency anchoring over the tunnel route (e.g. in authorized channel) as, whilst likelihood may be lower, the vessels will be larger than 100m and therefore have a deeper penetration depth potential.

Action A4: CS to provide information on largest vessel transiting over tunnel route (length and DWT would be helpful).

Action A5: NASH to consider with Project team so that maximum depth penetration potential can be defined from planned and emergency anchoring.

All agreed above approach considered appropriate rather than conventional risk assessment given specific nature of question in relation to Phase 3 of the project. Phase 1 and 2 being considered under conventional risk assessment.

3. Vessel Traffic Data, Analysis and Review

CJH confirmed vessel type groupings and presented AIS data as used (from the pre-agreed windows of 14 days Aug-2019 and 14 days Oct-2019) with breakdown by vessel type together with density and gate analysis (slide 16-23/34) to characterise the baseline.

Discussion held on data and generally considered as an accurate representation.

- Noted use of East Tilbury Jetty is specific to Tideway and activity will complete in due course.

- CJH noted that Tilbury2 wasn't operational in the data window so additional AIS data was collected for use of the Tilbury 2 Ro-Ro (from Q4 2020) to understand spatial usage of the area and whether any risk of potential interface issue with Project.
- Following points discussed on Tilbury2:
- NE noted that upstream Ro-Ro berth currently being used more than downstream Ro-Ro (in shown data)
- NE expects increased usage of both Ro-Ro berths and commencing usage of CMAT berth which will be used by larger vessels than Ro-Ro
- NE considered that approaches/departures in the shown data (inc. swinging) are spatially representative of how movements will occur in the future across Tilbury2
- Vessels will be well clear of any Project interface issue, and no material impact foreseen in relation to the Ph 1 and Ph2 works
- Following points discussed on potential future Tilbury expansion including consideration of recent Free Port status:
- Whilst future developments may spread to the east they will go no further than Groyne No. 1.
- Marine usage of future facilities (design and vessel type/size etc…) is yet to be fully defined but NE provided projections including predicted vessel type covering 2022-2029 (email 12 April 2021) and considers that they will approach/depart berths in similar way to as shown in the Q4 2020 data
- NE confirmed envisages above future project plans will be well clear of any Project interface issue and foresees no material impact in relation to the Ph 1 and Ph2 works

The group reviewed PLA incident data (2010-2020) as shown in slide 24/34 in relation to the area. The incident database was reviewed on screen by the group and specific incidents relevant to the incident area and risk assessment were noted – specifically 5 including:

- 1x near miss (grounding/contact with groyne) of large vessel following engine failure – noting anchor was deployed)
- 2x near miss collision-/-close quarters situation. One with 2 large vessels resulting in 1 leaving authorised channel
- 1x Grounding and contact with groyne of a jack up barge under tow (due to being towed with legs deployed)
- 1x near miss (grounding/contact with groyne) of commercially operated RIB

4. Risk Assessment Methodology

CJH confirmed PLA methodology being adopted for the assessment (slide 25-28/34).

Discussion points raised included:

- Potentially relevant interfacing projects identified as per list (NE confirmed that future PoTL baseline traffic movements had been shared as part of this)
- Whilst movement numbers may decrease/increase over the future baseline, the vessel types/mix is likely to be comparable, and no significant change in 'how' vessel traffic uses the Project area spatially is expected
- JJH explained that the Project team therefore considers the Project to not be sensitive to change in the future baseline of movement numbers, and no material impact is envisaged from variance in movement numbers as the future traffic is not likely to change the spatial use of the study area.

5. Hazard Identification

The group reviewed hazard identification and grouping by hazard type, vessel type, project phase and area were summarised leading to the matrix of 18 identified hazards across Phase 1 and 2 (slide 29 & 32/34).

CJH explained logic of identifying hazards by order hierarchy:

- Project phase
- Area
- Hazard type
- Vessel type

No additional hazards were identified in the workshop.

Embedded risk controls (included within inherent risk assessment) were reviewed (slide 30/34) and discussed. Following points agreed:

- Risk Control E1: Charting - agreed.
- Risk Control E2: Aids to Navigation (AtoNs) - Noted it is intended to place a special mark on the diffuser outfall head – agreed.
- Risk Control E3: Navigate with due care and attention: JJH queried sensitivity of site to wash (during SI and construction of the pipeline and diffuser). Agreed this would be managed by VTS under a 'pass with precaution' through a PLA Temporary NTM rather any speed easement requirement/mandate.
- Risk Control E4: 'Passage Plan and RAMS': It is assumed that passage plans and RAMS will be developed for the SI works and construction which will include definition of metocean limits (noting limits on visibility, wind speed and wave height were determined for the SI works in 2019). Agreed.

Additional risk controls were reviewed:

- Additional Risk Control A1: NTM: CS noted this is not a mandated requirement and so correctly assumed as an additional, and group agreed is likely to be taken forward given good practice and benefits (and a means to implement RC ID E3). Agreed.
- Additional Risk Control A2: Marine Operations Plan, Stakeholder Engagement and Co-ordination: Agreed.
- Additional Risk Control A3: Safety Boat. Noted likely to be included in contractor RAMS for duration of SI and construction of pipeline/diffuser and emphasized here as option.
- Additional Risk Control: Speed reduction: discussed but considered to be covered by RC ID E3. Removed.
- Waiting/Layby moorings: discussed but not thought to be required within project Phases 1&2. Removed.

Group agreed that, subject to the inherent risk assessment, the above risk controls were appropriate, and no further risk controls were identified at this stage.

6. Risk Scoring Workshop

CJH and JJH introduced the workshop section by explaining that preliminary scoring of the inherent scenario (risk of the project with embedded risk controls in place) had been undertaken by the project team in advance of the session, based on data, analysis, expertise and project knowledge. To be validated with stakeholder consultation.

The pre-scored inherent risk table was shared to provide advance context of scoring – noting no hazard being scored greater than 8 (out of 25) and so resulting in the 'Moderate' category and considered acceptable risk.

Discussion on realistic most likely (RML) and realistic worst credible (RWC), with JJH and CJH confirming that RML and RWC were considered qualitatively (with accompanying narrative around the consequence severity across people, property, environment, reputation and port-impact. used as a basis in scoring total with a precautionary basis behind taking the RWC).

The group reviewed the 6 hazards with the top ranking scores (of 8/25) with following comments and amendments made in the session to the risk register which was agreed to be shared with all attendees following the workshop:

HAZ ID 3: Collision of pipeline/outfall SI vessel with other vessels (seagoing commercial or passenger) when arriving, manoeuvring and departing investigation sites. Ph 1 Score: 8/25

- General comments: As per 'Comments on Disposition'
- Frequency: Agreed at 2
- Consequence/Severity RML – elevated damage to SI vessel from 1-2. No overall change from 4
- Consequence/Severity RWC – elevated damage to other (seagoing/commercial vessel) to Minor/Moderate. No overall change from 4

HAZ ID 5: Breakout of pipeline/outfall SI vessels when anchored/moored on site. Ph 1 Score: 8/25

- General comments: As per 'Comments on Disposition'
- Frequency: Agreed at 2
- Consequence/Severity RML – No change to overall consequence score from 4
- Consequence/Severity RWC – elevated damage to other (seagoing/commercial vessel) to Minor/Moderate. No change to overall consequence score from 4

HAZ ID 8: Collision of Project pipeline/outfall construction vessels with passing tug and service, inland freight/cargo and inland passenger. Ph 2 Score: 8/25

- General comments:
- As per 'Comments on Disposition'
- CS noted assumption that diffuser head is within the Order Limits and sufficient space to incorporate SI and construct within the boundary. If this changes, then this hazard (and the risk assessment) should be reviewed given sensitivity and this vessel type navigating in close proximity so sensitive to change
- Frequency: No change. Agreed at 2
- Consequence/Severity RML: No change to overall consequence score of 4
- Consequence/Severity RWC: No change to overall consequence score of 4

HAZ ID 12: Breakout of Project pipeline/outfall construction vessels during construction when anchored/moored on site. Ph 2 Score: 8/25

- General comments: As per 'Comments on Disposition'
- Frequency: No change – agreed at 2
- Consequence/Severity RML: Contact with groynes considered most likely consequence. No change to overall consequence score of 4
- Consequence/Severity RWC: No change to overall consequence score of 4

HAZ ID 14: Collision of Project pipeline/outfall construction vessels with passing vessels outside the defined construction area. Ph 2 Score: 8/25

- General comments: As per 'Comments on Disposition'
- Frequency: No change to score of 2
- Consequence/Severity RML: Amend environment to 'significant impact on environment'. No change to overall consequence score of 4
- Consequence/Severity RWC: No change to overall consequence score of 4

HAZ ID 18: Grounding/snagging of diffuser by passing vessel (once pipeline/diffuser installed, while tunnel construction continues). Ph 2 Score: 8/25

- General comments:

- As per 'Comments on Disposition'
- CJH noted this is the longest duration hazard due to presence of pipeline throughout tunnel construction period.
- CS noted recreational motorboat contacting a groyne in the area and causing major damage to the recreational vessel. JJH agreed to re-look at incident data (as not seen) and also raise with recreational stakeholders in consultation – agreed that consequence potential of contact with the diffuser is more significant for recreational vessel (primarily through risk to people rather than absolute value) and embedded risk control of AtoN's should help mitigate likelihood
- Frequency: No change to score of 2
- Consequence/Severity RML: No change to overall consequence score of 4
- Consequence/Severity RWC: No change to overall consequence score of 4

The group reviewed (collectively) the remaining hazards in the hazard summary table and NASH agreed to share the workbook with attendees for review and return/comment.

Action A6: NASH to send score sheet for PLA to review and respond within circa 1 week.

7. A.O.B/Actions

Actions as below.

A1: CS to provide POLARIS extract/details of usage inc. key vessel parameters where known

A2: CS to forward any relevant details of Explosives Licence to NASH Maritime

A3: CS to provide introduction to Barbara Juist from PLA Marine Services for information on any mooring rental/intra-port usage

A4: CS to provide information on largest vessel transiting over tunnel route for emergency anchoring potential (length and DWT would be helpful)

A5: NASH Maritime to consider anchoring potential with Project team so that maximum depth penetration potential can be defined from planned and emergency anchoring.

A6: NASH Maritime to send score sheet (by 14-May-2021) for PLA to review and respond by 21-May-2021

Annex C
PLA Consultation Presentation
24-Mar-2021

Lower Thames Crossing
Navigation Risk Assessment

Task-1
Shipping & Navigation Specification

10-Mar-2021

20-NASH-0068

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Objectives | Scope | Agenda

Objective: Set out and agree the scope of the Shipping & Navigation studies required to support the DCO

Scope & Agenda:

1. Develop assessment envelope – define the relevant marine operations
2. Agree with LTC and key relevant stakeholders which other projects/interfacing projects need consideration
3. Define interfaces with EIA and NRA for DCO
4. Determine provisional Preliminary NRA SOW Inc:
    1. Data requirements
    2. Study Area(s)
    3. NRA Methodology
    4. Confirmation of other studies
5. Desktop review of potential navigation risk impacts
6. Scope Consultation with SHA (PLA) and relevant IP (PoTL)
7. Prepare S&N Specification Report

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1. Assessment Envelope - Scheme Definition

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1. Assessment Envelope - Scheme Definition

- 4 key components of the Preliminary NRA (as per14-Jan-21 meeting)

No.	Stage	Activity / Feature
1	Pre-Construction	Site Investigation
2	Construction	Temporary in river works (discharge pipeline, outfalls, jetty)
3	Construction	Import and Export of material (to non PoTL facilities)
4	Permanent Works	Permanent works, exclusions, protections (impact to no-anchoring and explosives anchorage)

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1. Assessment Envelope - Scheme Definition

- Focus on the Construction Stage definitions (temp in river structures and import/exports)
- **Structures** - Defined from DCO
- **DCO Powers** – Interpreting the S&N relevant extent and powers being sought within DCO [ongoing]
- **River Transport** - Developing a River Transport Management Strategy / Plan to define a credible precautionary import/export scenario at non PoTL facilities [ongoing]
  - Marine movements – materials, volumes, dimensions
  - Vessel, barge and marine plant types
  - Marine facilities
  - Programme of works/movements

								Delivery		
Materials required for LTC	**Number**	**width**	**height**	**depth**	**weight (per unit)**	**bulk density**	**volume**	**Start**	**Finish**	**Days**
		m	**m**	**m**	**kg**	**kg/m3**	**m3**	**date**	**date**	
Tunnel										
Pre-Cast Tunnel Segments (Main)	36090	2	5.78	1	14,000		11.56	Apr-25	Mar-27	699
Pre-Cast Tunnel Segments (Key)	4010	2	1.5	1			3	Apr-25	Mar-27	699
Pre-Cast Central Culvert (Deck)	8020	1	5	4	14,000		20	Jul-25	Mar-27	608
Cross passage rings	104			~1				Jul-25	Mar-27	608
SGI Cross Passage Segments (Main)	3744	0.6	1.3 (approx)	0.2	195					
SGI Cross Passage Segments (Key)	1248	0.6	1.3 (approx)	0.2	185					
SGI Cross Passage Segments (Top)	624	0.6	0.4 (approx)	0.2	63					
OR										
Sand						1,500	79,365	Apr-25	Mar-27	699
Aggregates						1,650	152,380	Apr-25	Mar-27	699
Cement/additives						3,150	42,328	Apr-25	Mar-27	699
Reinforcement										
Other concrete requirements										
Sand										
Aggregates										
Cement/additives										
Reinforcement										
Other materials/equipment										
tunnel segment moulds	50	>2	>6		6,000					
Spoil / Muck out	Excluded					2,500	810,295	Jul-25	Mar-27	608
Tunnel Boring Machine	Excluded									

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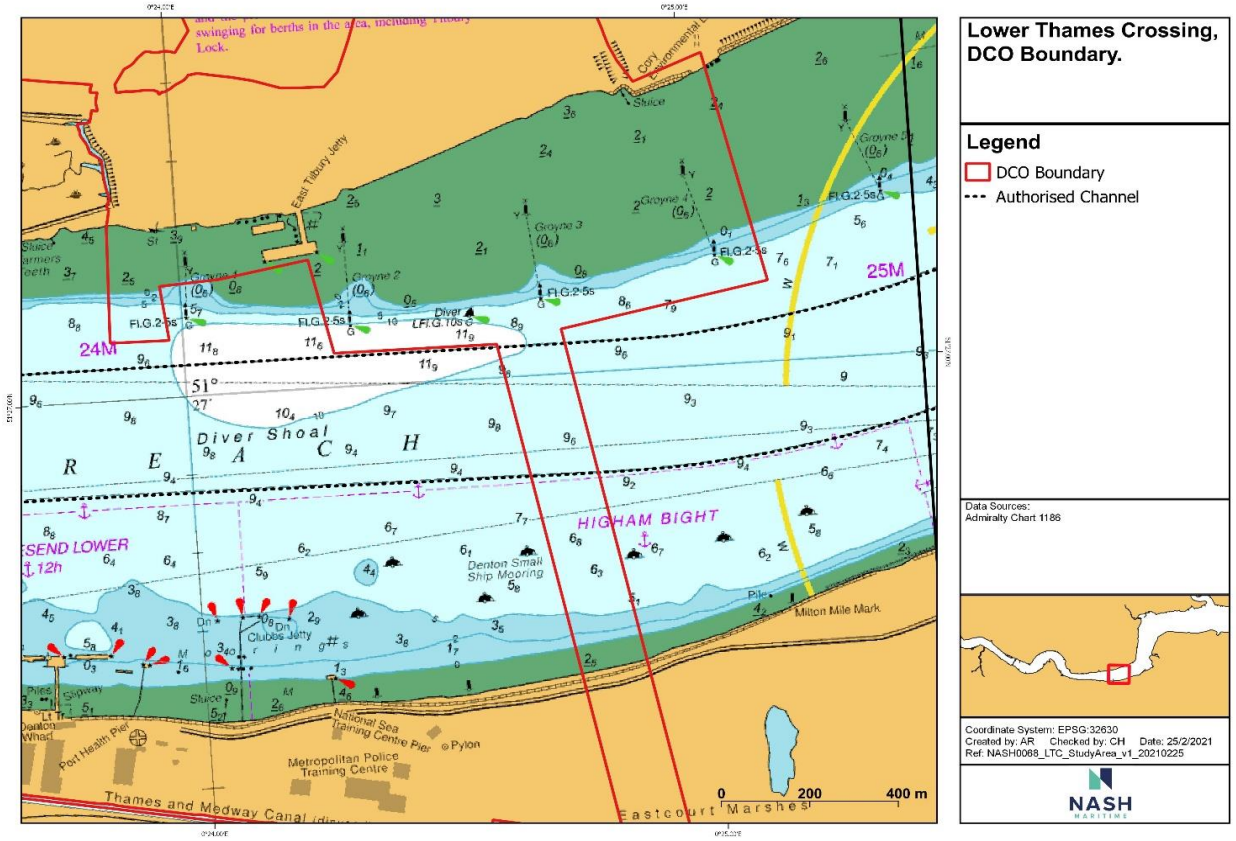
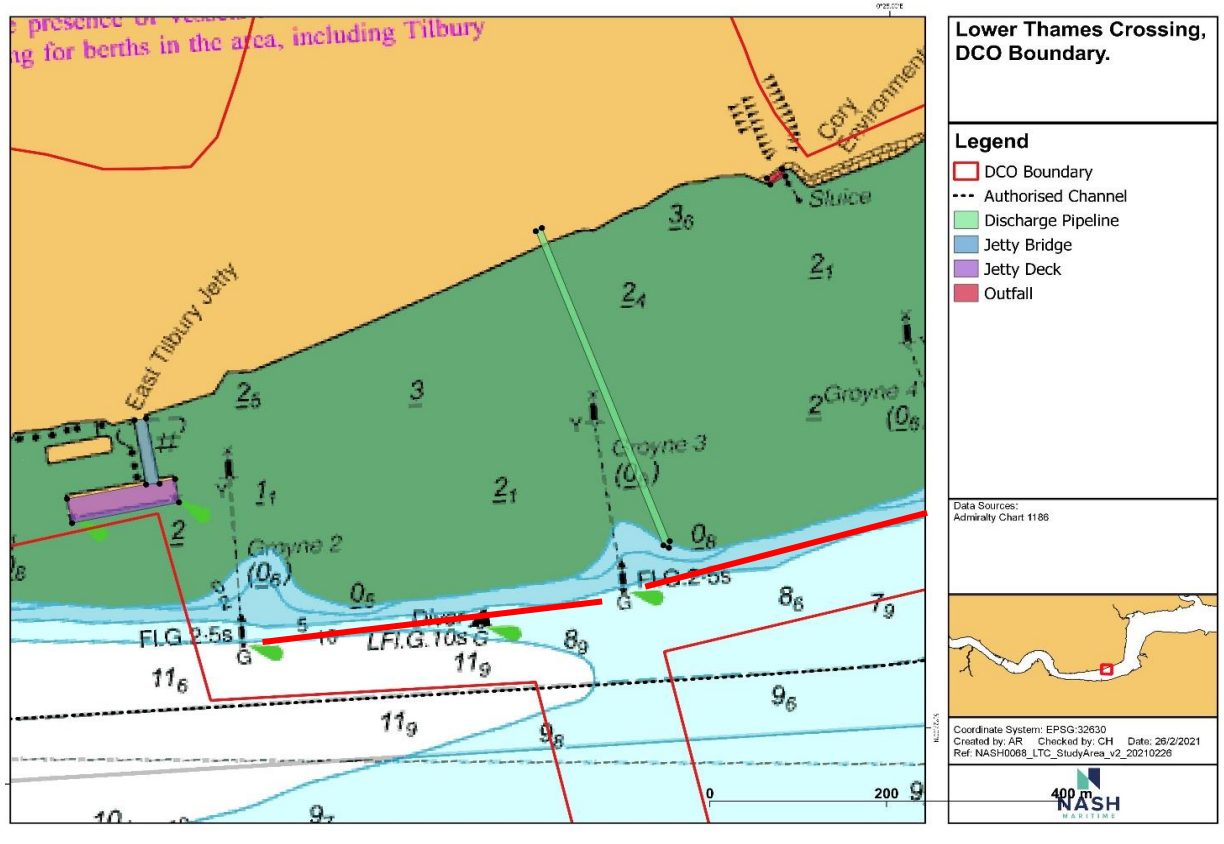
1. Assessment Envelope - Scheme Definition - Structures



(Marine) DCO limits / Study Area



Jetty, Pipeline, Outfall co-ords - as per DCO/Deemed ML co-ordinates ('in-river' extent of discharge pipeline & diffuser head shown in red *[groyne line]* for NRA worst case/precautionary assessment scenario)

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1. Assessment Envelope - Scheme Definition - Structures

Ingerbourne Jetty/ East Tilbury [Present]

DCO Limits being reviewed in relation to extended Ingerbourne Jetty

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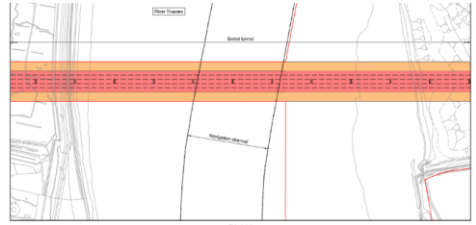
1. Assessment Envelope - Scheme Definition – DCO Powers

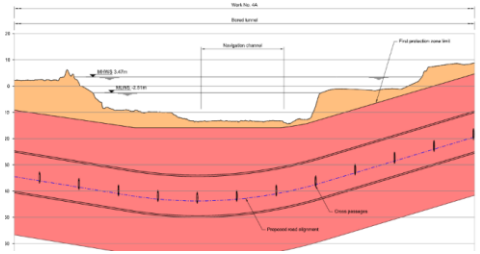
Section / Title	Article / Para	Relevance / Summary
PART 4 SUPPLEMENTAL POWERS		
Powers in relation to relevant navigations or watercourses	Para 18	Gives wide ranging powers to potentially impact navigation anywhere within the DCO boundaries - providing (Schedule 14) it is agreed with PLA [see below)
Discharge of Water	Para 19	Gives wide ranging powers to discharge to watercourses - subject to consent
Authority to survey and investigate the land	Para 21	Gives wide ranging powers to survey (including excavations and boreholes) on land and in the water within the DCO boundaries
PART 7 MISCELLANEOUS AND GENERAL		
Deemed Marine Licence	Para 59	Marine licence is deemed to have been issued per Schedule 15 and the conditions therein
SCHEDULE 11 LAND OF WHICH TEMPORARY POSSESSION MAY BE TAKEN Article 35		
		Locations potentially impacting navigation illustrated on multiple drawings including areas where temporary possession may be taken - including: marine works, river outfall, existing East Tilbury Jetty and transportation and removal area of materials from tunnelling works in the north portal.
SCHEDULE 14 PROTECTIVE PROVISIONS Article 58		
PART 7 FOR THE PROTECTION OF THE PORT OF LONDON AUTHORITY	Para 82	Requires PLA to approval for any part of the development below high water or affecting navigation on the Thames.
	Para 83	to be given in writing by PLA before commencing specified work.
	Para 84	Tunnelling works to ensure navigable channel can be maintained (now and in future) by PLA to a depth of TBC –[PLA/LTC in discussion] Allowing 0.5m overdredge.

	Para 88	Any work which gives rise to sedimentation, scouring, currents or wave action, which would be materially detrimental to traffic in, or the flow or regime of, the river Thames may require LTC to remediate. Assume NRA does not need to consider the potential for these impacts
	Para 89	NRA to consider impact of any work on existing Navigation aids
	Para 94	NRA to consider need for additional nav aids
SCHEDULE 15 DEEMED MA[illegible]E LICEN		**Article 59**
PART 2 LICENCSABLE [illegible]RINE A[illegible]IVITIES		
	[illegible]3	Licence allows construction of certain structures within the Thames at certain locations for certain periods
	Para 5 (1)	May include construction, alteration, improvement, maintenance, operation and decommissioning
	Para 5 (1) (a)	Construction of a buried subtidal outfall on northern shore with diffuser on subtidal river slope. Permitted during construction only: to be decommissioned after construction of LTC
	Para 5 (1) (b)	permanent outfall on northern shore discharge at MHWS. Not relevant to NRA
	Para 5 (1) (c)	alterations to (but not extending) existing jetty [Ingrebourne jetty]
	Para 5 (1) (d)	may include operating existing jetty for offloading concrete tunnel segments allows 24 hour working and task lighting
	Para 5 (1) (e)	decommissioning existing jetty only a requirement if the jetty is used

	Para 5(2) (c)	existing jetty
PART 4 CONDITIONS *General conditions*		
removal of temporary structures etc.	Para 19.	Requires removal of temporary structures with 30 business days of completing relevant activities
PART 6 CHANGES TO THE DEEMED MARINE LICENCE		
	Para 26	any changes require approval from MMO
SCHEDULE 16 DOCUMENTS TO BE CERTIFIED Article 60		
		River Restrictions Plan - Regulation 5(2)(o) identifies tunnel route and profile and exclusion/restriction areas relevant to navigation



PLAN



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1. Assessment Envelope - Scheme Definition – River Transport

- Genesis of River Transport Management Strategy / Plan
- Precautionary
- Realistic worst case
- Example →
- Link?

Materials required for LTC	Number	width	height	depth	weight (per unit)	bulk density	volume	Delivery Start	Finish	Days
		m	m	m	kg	kg/m3	m3	date	date	
Tunnel										
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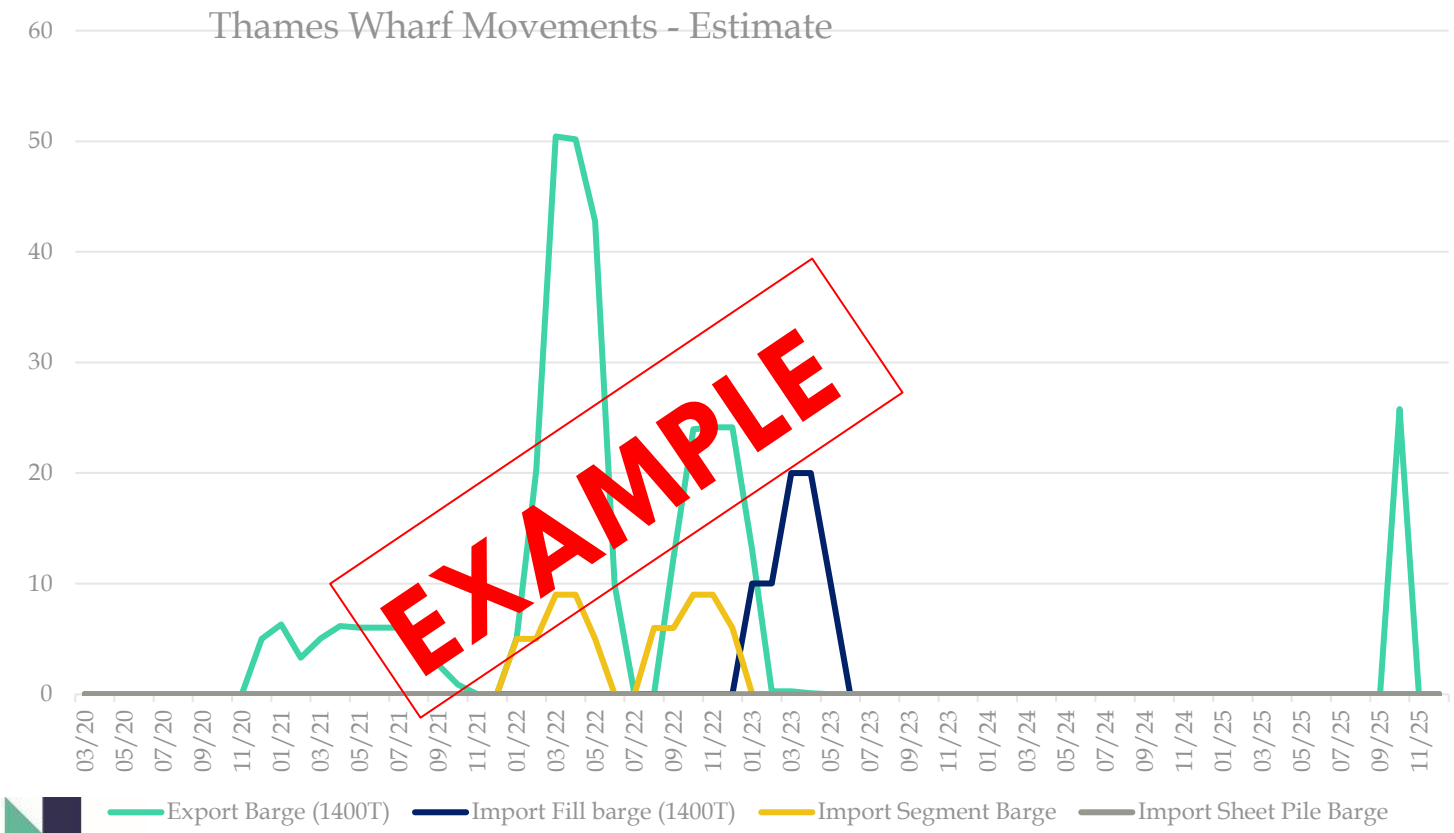
1. Assessment Envelope - Scheme Definition – River Transport



- Activities:
  - Import / Export – Material 1
- Project Moves
  - Excluded – via Tilbury
- Berths Usage
- Movements – precautionary worst case
  - Peak Scenario
  - Off-Peak
  - Tidal windows
- Passage Plan (indicative within RTMP)

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4. Determine provisional Preliminary NRA SOW

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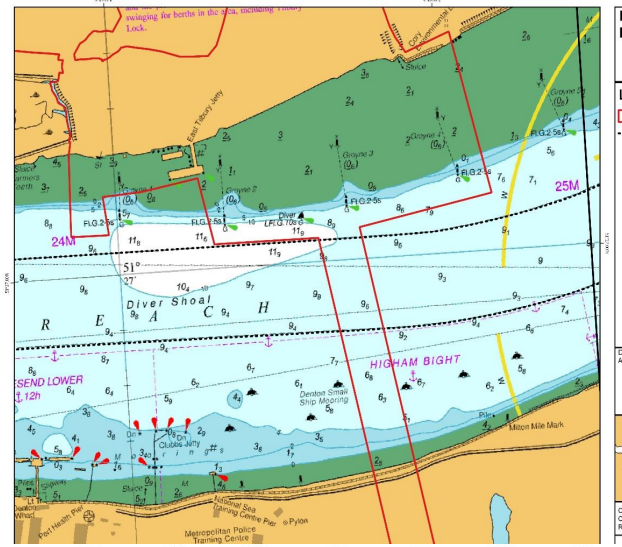
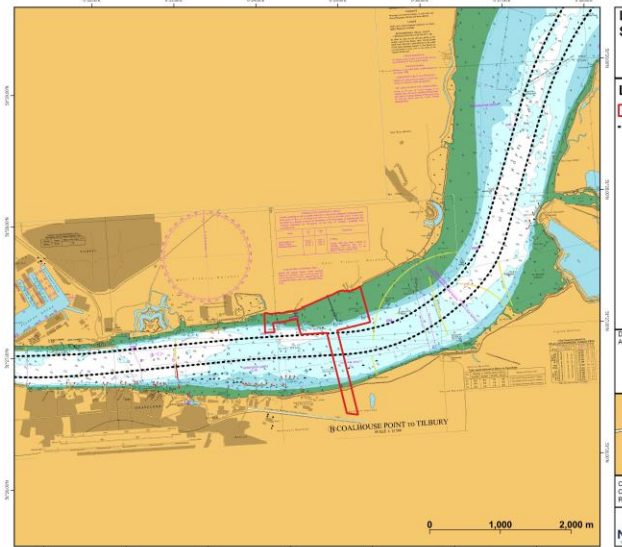
4. Determine provisional Preliminary NRA SOW

- Study Area – Risk Assessment Area
- AIS Data
  - Sep 2018 [Used for Specification]
  - 14 days duration from Aug-2019 (0000 on Mon-29-Jul – 2359 on Sun-11-Aug inclusive)
  - 14 days duration from Oct-2019 (0000 on Mon-14-Oct – 2359 on Sun-27-Oct inclusive)
- Incident Data – PLA, MAIB, RNLI?
- Legislation, Guidance, Procedures and Codes of Practice – as per PLA
- Future baseline traffic profiles assumptions? Tilbury 2?
- Navigational Safety focus





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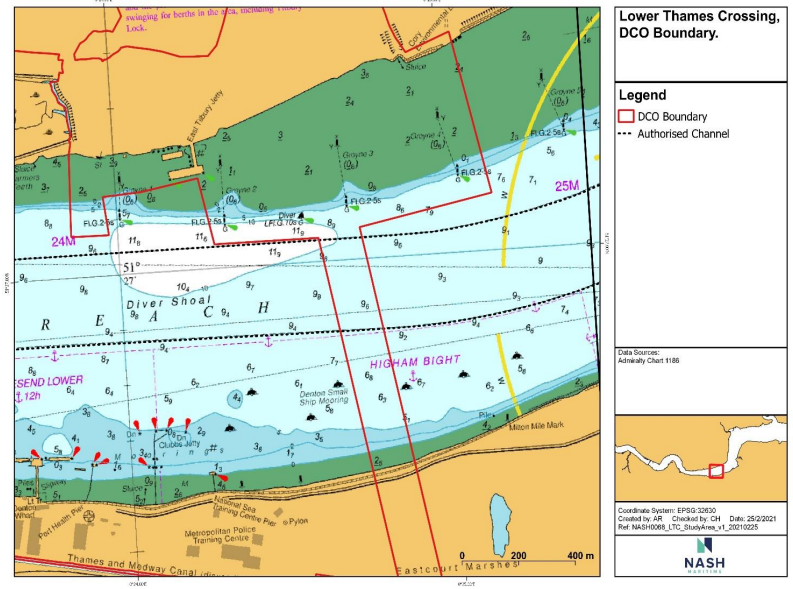
4. Determine provisional Preliminary NRA SOW

- NRA Methodology
- PLA Risk Assessment Methodology
- Baseline (inherent) and Residual (with risk controls)

RISK ASSESSMENT MATRIX: RISK CRITERIA		FREQUENCY				
		Level 1	Level 2	Level 3	Level 4	Level 5
		Rare	Unlikely	Possible	Likely	Almost Certain
		Very unlikely / Has rarely occurred in industry	Unlikely	One or more times in 10 years	Could likely to occur during works	Will occur during works
Consequence	5 – Loss of vessel or severe damage to vessel. Multiple fatalities International news coverage. Serious long-term impact on environment and/or permanent damage.	Moderate (5)	High (10)	Extreme (15)	Extreme (20)	Extreme (25)
	4 – Major damage to vessel. Single Fatality. National news coverage. Significant impact on environment with medium to long term effects	Minor (4)	Moderate (8)	High (12)	Extreme (16)	Extreme (20)
	3 – Moderate damage to vessel. Moderate / major injury Regional news coverage. Limited impact on environment with short-term or long-term effects	Minor (3)	Moderate (6)	Moderate (9)	High (12)	Extreme (15)
	2 - Minor or superficial damage to vessel. Minor injuries and local news coverage. Minor impact on environment with no lasting effects	Slight (2)	Minor (4)	Moderate (6)	Moderate (8)	High (10)
	1 - Insignificant or no damage to vessel / equipment. No injuries. Insignificant impact on environment	Slight (1)	Slight (2)	Minor (3)	Minor (4)	Moderate (5)



5. Desktop review of potential navigation risk impacts

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5. Desktop review of potential navigation risk impacts

- Early Analysis - Sep-2018 AIS data as used for SI NRA in 2019

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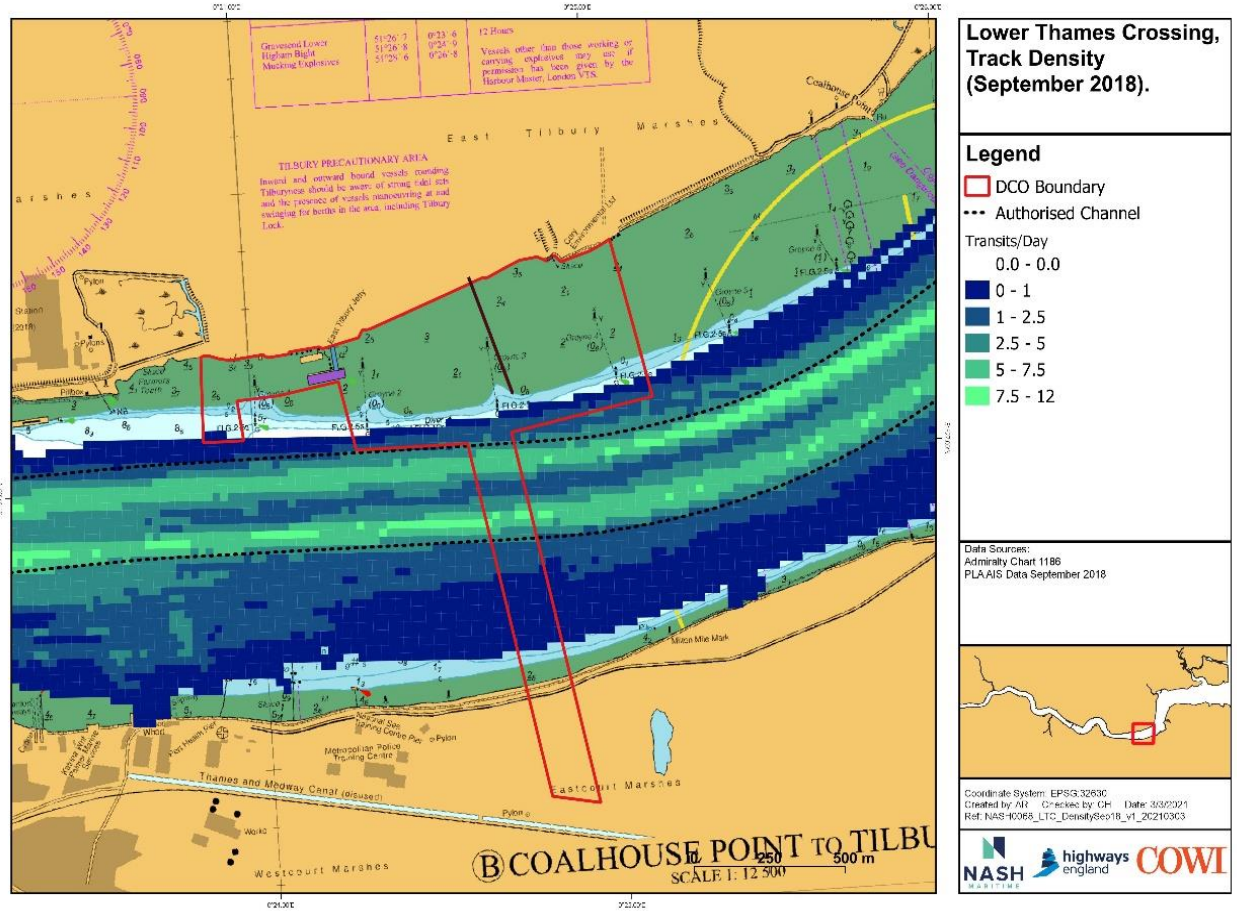
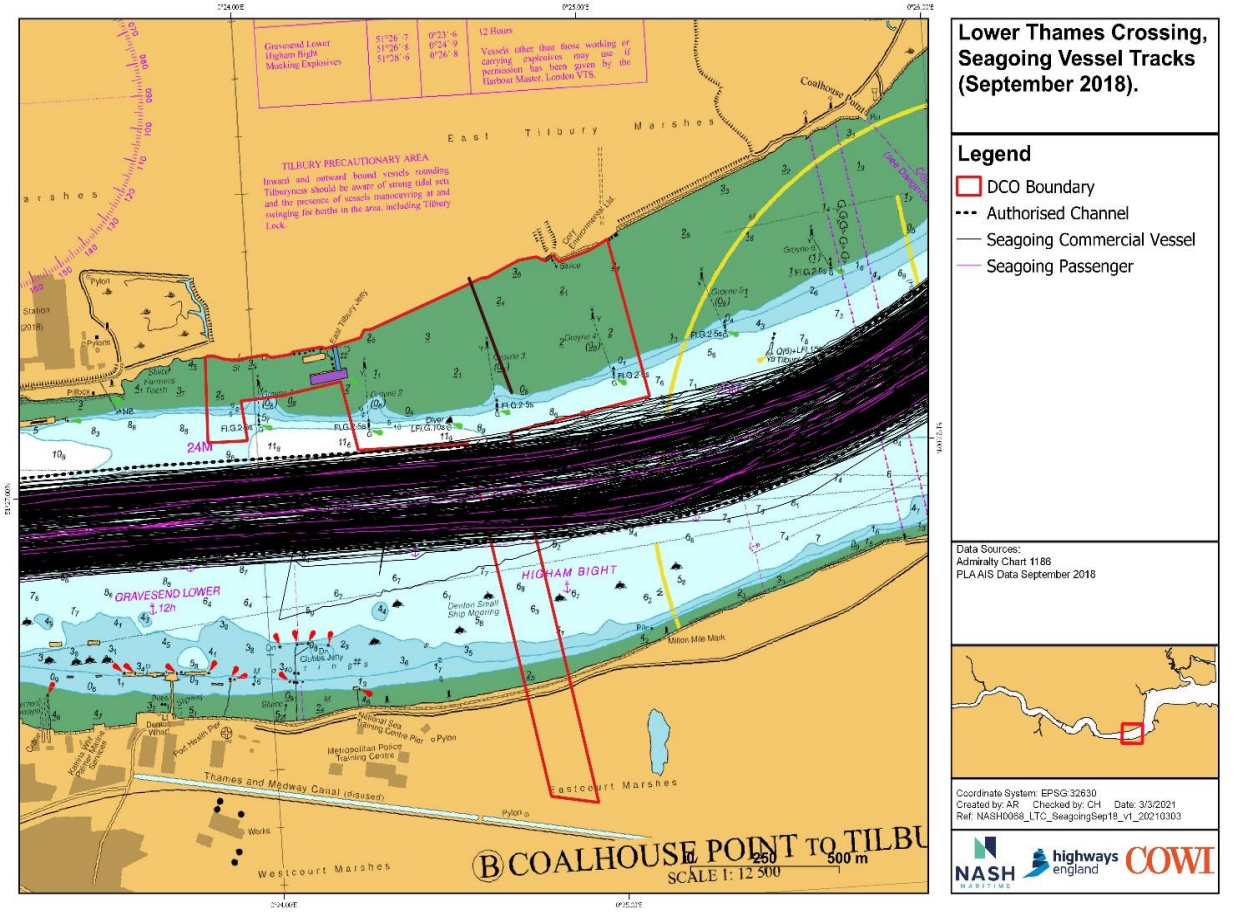
5. Desktop review of potential navigation risk impacts





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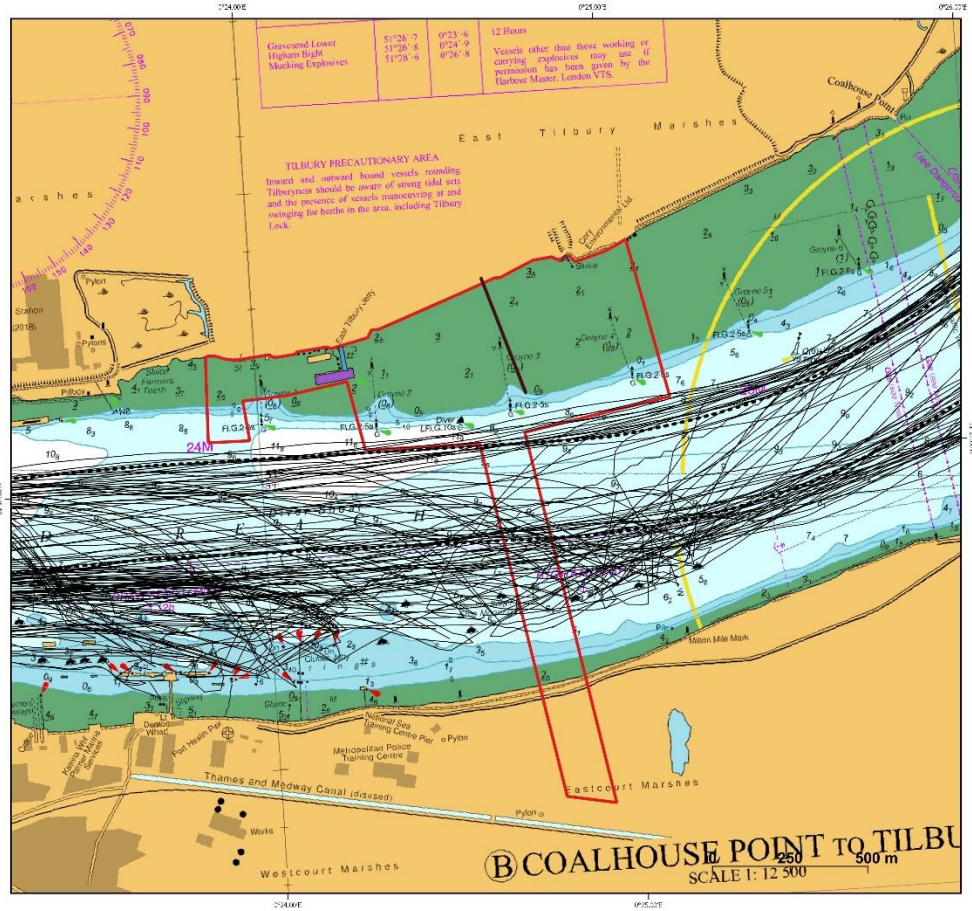
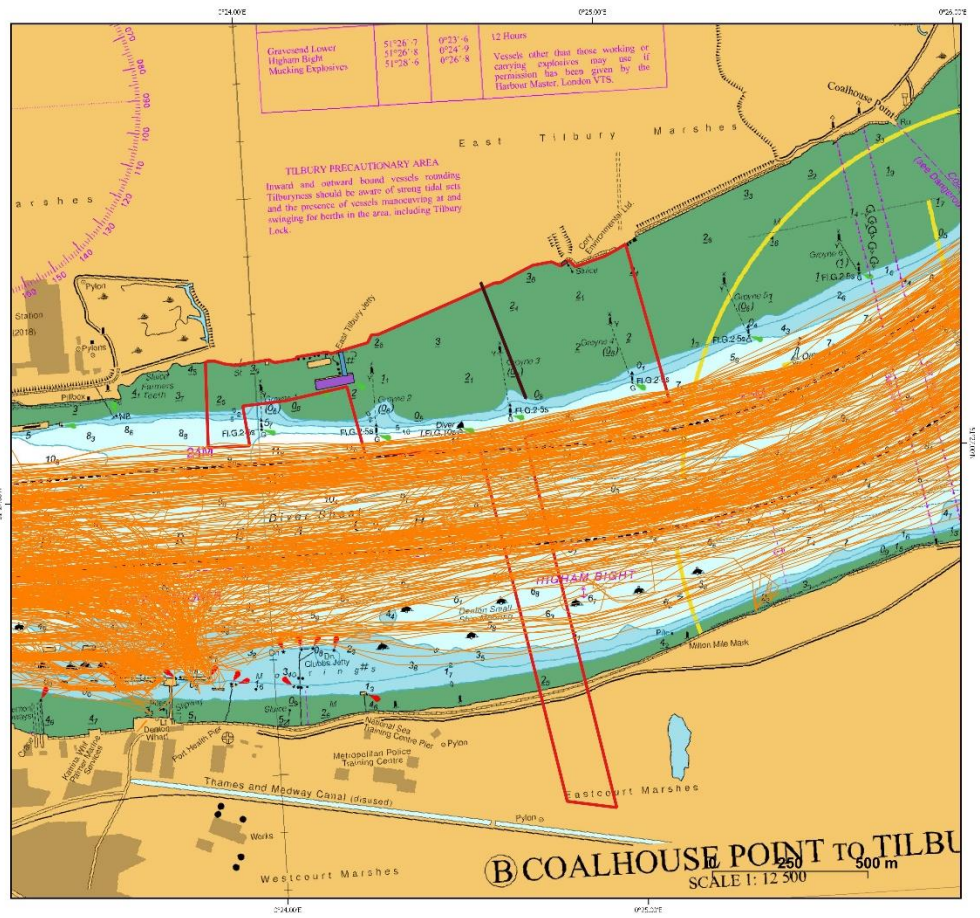
5. Desktop review of potential navigation risk impacts





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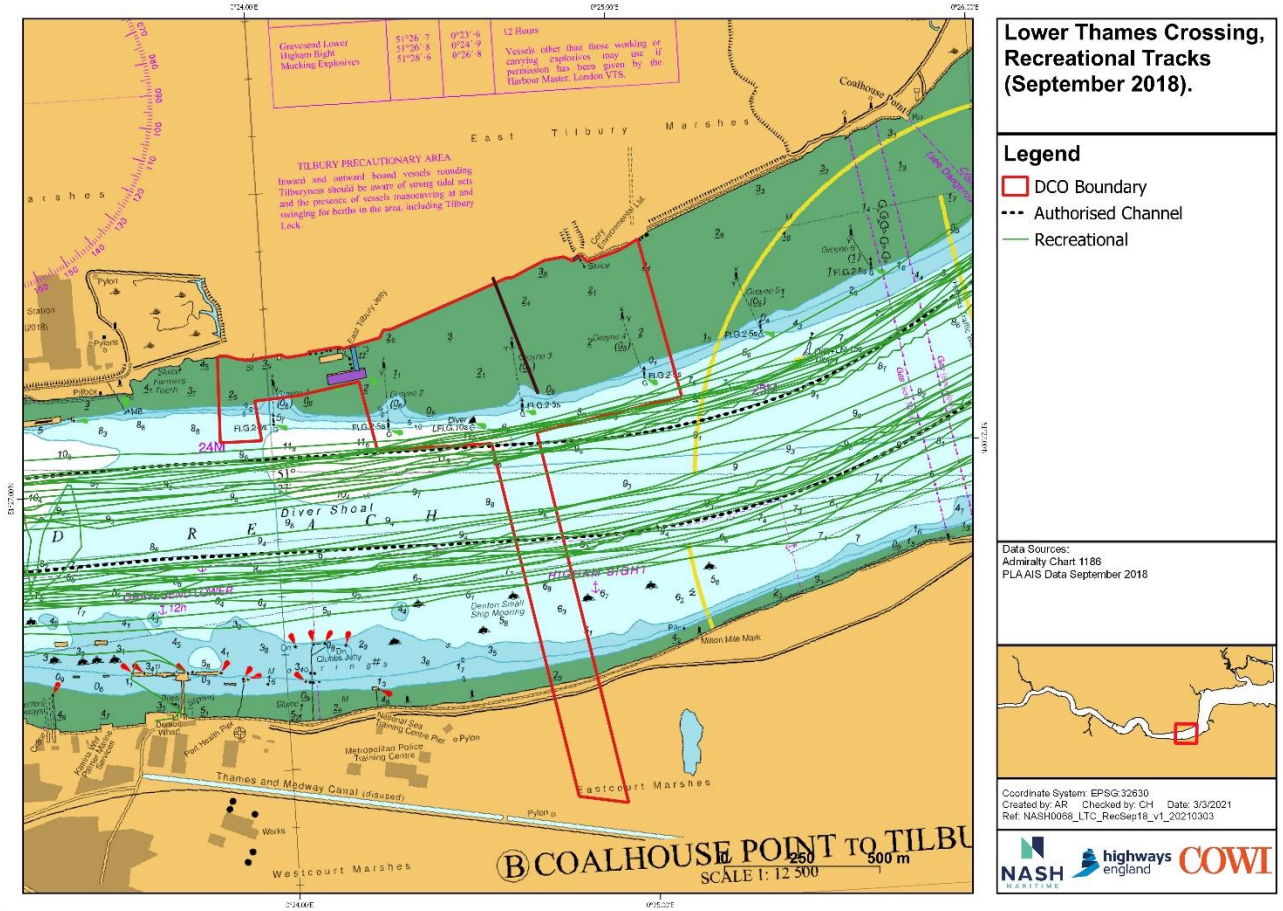
5. Desktop review of potential navigation risk impacts



Lower Thames Crossing, Recreational Tracks (September 2018).

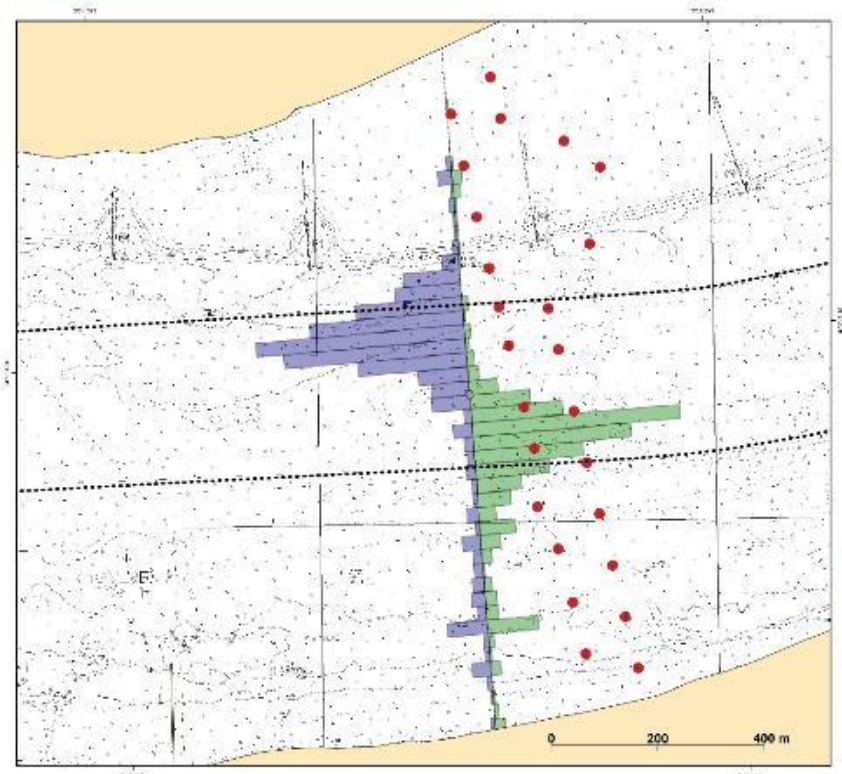
Legend

- DCO Boundary
- Authorised Channel
- Recreational

Data Sources:
Admiralty Chart 1186
PLA AIS Data September 2018

Coordinate System: EPSG:32630
Created by: AR Checked by: CH Date: 3/3/2021
Ref: NASH0068_LTC_RecSep18_v1_20210303

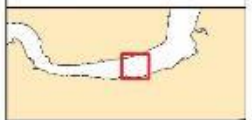
NASH MARITIME highways england COWI



Lower Thames Crossing, Transit Gate.

Legend

- Borehole Locations
- Authorised Channel



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5. Desktop review of potential navigation risk impacts

- Key potential Impacts/Hazards by stage

No.	Stage	Activity / Feature	Impact / Hazard
1	Pre-Construction	Site Investigation	Marine movements (collision, contact, grounding, breakout) Large Vessel Navigation (within authorised channel)
2	Construction	Temporary in river works (discharge pipeline, outfalls)	Marine movements (collision, contact, grounding, breakout)
3	Construction	Import and Export of material to non PoTL facilities	Marine movements (collision, contact, grounding, breakout)
4	Permanent Works	Permanent works	Impact to no-anchoring and explosives anchorages (from exclusions) Permanent in-river structures

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5. Desktop review of potential navigation risk impacts

Vessel Types

- Applicable for all phases of assessment (for continuity)
- Consider grouping (small commercial / large commercial)

No.	Vessel Type	Notes
1	Project Vessels (inc SI and construction vessels)	Site Investigation, Construction vessels
2	Inland Freight / Cargo	
3	Inland Passenger Vessels	
4	Recreational Vessels	
5	Seagoing Commercial Vessels	Vessels subject to compulsory pilotage (>80m, >50m Specified Vessels) - "Piloted vessel"
6	Seagoing Passenger Vessels	Vessels subject to compulsory pilotage (>80m, >50m Specified Vessels) - "Piloted vessel"
7	Tug & Service Vessels	3rd party
8	Project Towage Vessels	Project vessels for Import/Export

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5. Desktop review of potential navigation risk impacts

No.	Stage	Activity / Feature
1	Pre-Construction	Site Investigation

- Key potential Impacts/Hazards by stage

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5. Desktop review of potential navigation risk impacts

No.	Stage	Activity / Feature
2	Construction	Temporary in river works (discharge pipeline, outfalls)

- Key potential Impacts/Hazards by stage

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5. Desktop review of potential navigation risk impacts

No.	Stage	Activity / Feature
3	Construction	Import and Export of material to non PoTL facilities

- Key potential Impacts/Hazards by stage

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5. Desktop review of potential navigation risk impacts

No.	Stage	Activity / Feature
4	Permanent Works	Permanent works, exclusions, protections (impact to no-anchoring and explosives anchorage)

- Key potential Impacts/Hazards by stage

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5. Desktop review of potential navigation risk impacts

Stakeholder Consultees

- Letter/Email and remote meeting option

Consultee	Notes
Port of London Authority	HM |HM Recreation |Pilots| Marine Services-TBC
Port of Tilbury Ltd	HM
Gravesend Sailing Club	Secretary@gravesendsailingclub.org.uk
Gravesend Rowing Club	secretary@gravesendrc.co.uk
National Maritime Training Centre	TBC
Key Operators	Towage Operator -TBC

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5. Desktop review of potential navigation risk impacts

Interfacing Projects

- Tideway
- Silvertown Tunnel
- Thurrock causeway – overlapping DCO boundary
- London Resort

Interfacing Operations/Wharves

- Tideway (Ingrebourne/East Tilbury Jetty)
- Tilbury: Port of Tilbury and Tilbury2
- Motts Wharf (to immediate W of E Tilbury Jetty)

Others:

- http://www.pla.co.uk/About-Us/River-Works-Licence-Applications-Received
- DCO/NSIP Projects?

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6. Scope Consultation with SHA (PLA) and relevant IP (PoTL)

- As per above slide
- Consultation during NRA

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Summary

- Scheme Definition
  - Structures
  - DCO
  - River Transport
- NRA approach
  - NRA methodology
  - Data inputs
  - Stakeholder consultation
  - Key issues/concerns
  - Risk controls
- Timescales

Report	Draft	Final
Shipping and Navigation Specification	15-Mar	19-Mar
River Trasnport Strategy	25-Mar	08-Apr
Navigation Risk Assessment	10-Jun	24-Jun
Workshops	**Date**	
HazID workshop	04-May	
Residual Risk Workshop	14-May	

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Any Other Business

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Appendix B Minutes of risk assessment workshop with PLA and PoTLL

Notes of Meetings

Lower Thames Crossing (21-NASH-0168)

Client:	Lower Thames Crossing
Project:	Lower Thames Crossing
Venue:	Video/telecon (MS Teams)
Date of Meeting:	10-May-21 (10:00-13:00)
Present:	
Port of London Authority (PLA)	Cathryn Spain (CS) | Harbour Master
Port of Tilbury London (PoTLL)	Nick Evans (NE) | Asset Manager Marine
Lower Thames Crossing	Ian Mockett (IM) | Senior Market Director
NASH Maritime	Chris Hutchings (CJH) | Project Manager
NASH Maritime	Jamie Holmes (JJH) I Project Director

0.	Introductions and meeting objectives
	CJH commenced the meeting, introduced attendees. CJH and JJH noted that the Specification report for the Preliminary NRA (PNRA) would now be updated and re-issued following comments from Project legal. The purpose and aim of the meeting as defined in the accompanying slide pack (to be read in conjunction with these minutes) is to confirm the scheme and review the draft PNRA identified hazards and preliminary scoring results together with potential risk controls.
1.	**Scheme summary | Order Limits and key marine/navigation features**
	CJH explained the key project features confirming the updates introduced at previous meeting (24 March 2021), specifically including the revision to the Draft DCO and further definition on marine/navigation aspects of the proposed scheme. Key aspects include: • Order Limits (red line boundary) reduced and the potential for use of the East Tilbury jetty is no longer included and not being progressed in the DCO Temporary in-river works prior to and during construction of tunnel: • Features consists of discharge pipeline and outfall between groynes three and four on northern shore. Intended to be in place for duration of construction and removed on completion (slide 4/34). • Overview provided of construction & decommissioning of discharge pipeline and outfall including key activities, plant (where known) and schedule of works (slide 6/34). Permanent works – on completion of construction of tunnel: • The relevant navigation interface is noting the tunnel protection zones (slide 4/34)

	Use of river during construction of tunnel: • CJH provided overview of materials during construction works including indicative import/export volumes and material types (slide 5/34) • Project premise (following the revision to the draft DCO) is that marine imports/exports will be to established facilities, and CS and NE confirmed PLA and PoTL understanding that these movements would therefore be included under existing navigational risk assessments for PLA and any other SHA (e.g. PoTL if movements enter their limits) • CS explained that establishment/usage of additional marine facilities for project (if proposed) will necessitate NRA update Overview of schedule provided inc. mobilisation in Jul-2023 with tunnelling between Jul-2025 to Mar-2027 and completion by Jul-2028. Project phases for purposes of pNRA are considered as below (slide 7–8/34). Ph0 is scoped out of the pNRA (as previous NRA provides basis for review/update once SI borehole locations are known and SI Contractor develops RAMS) and Ph3 being considered in terms of navigation implications associated with penetration into the protection zones rather than in a risk assessment approach. • Ph0 – Pre-Construction SI for tunnel (additional boreholes along tunnel route) • Ph1 – Pre-Construction SI for pipeline and diffuser • Ph2 – Construction and duration of installation for pipeline and diffuser • Ph3 – Operations/Permanent Works: Protection zones around tunnel and relevant navigation implications
2	**Scope of the Preliminary Navigational Risk Assessment**
	CJH summarised the key points as per the Specification for Phase 0 and Phase 3. Phase 0: Pre-Construction SI for tunnel (slide 10/34) • CS agreed that NRA undertaken for SI in 2019 remains valid basis and the risk controls agreed from this work will be anticipated to be taken forward. JJH noted this, and once boreholes are known and contractor develops methodology, the risk assessment should be reviewed/validated. Phase 3 – Operations/Permanent Works: Protection zones around tunnel and relevant al implications (slide 11-15/34) • CJH drew attention to the potential impact of protection zones on usage of the designated anchorage Higham Bight and moorings with respect to the draft DCO definition and some recent project correspondence in relation to permitted activities/exclusions being sought. • Designated Anchorage: – CS noted, following review of circa 2 years POLARIS data prior to meeting, that the anchorage is not heavily used with circa 20 movements recorded in the period. Action A1: CS to provide POLARIS extract/details of usage inc. key vessel parameters where known – Anchorage is Unrestricted (in terms of mooring duration) and maximum vessel 100m vessel length limit as per: https://www.pla.co.uk/assets/platidetables2021webversion.pdf (accessed 10 May 2021) – JJH queried status of Explosives Licence and CS confirmed that anchorage is licensed by HSE on this basis, but she had no knowledge of it being used as such over last 2 years. Action A2: CS to forward any relevant details to NASH Maritime

	• Denton Small Ship Moorings: – CS noted that POLARIS records this area as 'Denton Swing' and doesn't itemise down further (e.g. by individual buoy). – CS noted that any intraport usage and moorings rented by others will not be recorded in POLARIS and so will show underuse relative to reality. JJH noted opportunity extrapolate from project AIS Data although any use/definition by PLA would be helpful to validate this extrapolation. – Action A3: CS to provide introduction to Barbara Juist from PLA Marine Services for information on any mooring rental/intra-port usage Discussion held on key risk being seen as potential bed penetration in relation to 1st and 2nd protection zone by planned vessel anchoring (less for those using moorings). NASH to review for routine anchoring vessels (based on PLA data/assumptions for maximum 100m vessel length). NASH to also consider emergency anchoring over the tunnel route (e.g. in authorised channel) as, whilst likelihood may be lower, the vessels will be larger than 100m and therefore have a deeper penetration depth potential. Action A4: CS to provide information on largest vessel transiting over tunnel route (length and DWT would be helpful). Action A5: NASH to consider with Project team so that maximum depth penetration potential can be defined from planned and emergency anchoring. All agreed above approach considered appropriate rather than conventional risk assessment given specific nature of question in relation to Phase 3 of the project. Phase 1 and 2 being considered under conventional risk assessment.
3.	**Vessel traffic data, analysis and review**
	CJH confirmed vessel type groupings and presented AIS data as used (from the pre-agreed windows of 14 days Aug-2019 and 14 days Oct-2019) with breakdown by vessel type together with density and gate analysis (slide 16-23/34) to characterise the baseline. Discussion held on data and generally considered as an accurate representation. • Noted use of East Tilbury jetty is specific to Tideway and activity will complete in due course. • CJH noted that Tilbury2 wasn't operational in the data window so additional AIS data was collected for use of the Tilbury 2 Ro-Ro (from Q4 2020) to understand spatial usage of the area and whether any risk of potential interface issue with Project. • Following points discussed on Tilbury2: – NE noted that upstream Ro-Ro berth currently being used more than downstream Ro-Ro (in shown data) – NE expects increased usage of both Ro-Ro berths and commencing usage of CMAT berth which will be used by larger vessels than Ro-Ro – NE considered that approaches/departures in the shown data (inc. swinging) are spatially representative of how movements will occur in the future across Tilbury2 – Vessels will be well clear of any Project interface issue, and no material impact foreseen in relation to the Ph 1 and Ph2 works • Following points discussed on potential future Tilbury expansion including consideration of recent Free Port status: – Whilst future developments may spread to the east they will go no further than Groyne No. 1.

	– Marine usage of future facilities (design and vessel type/size etc…) is yet to be fully defined but NE provided projections including predicted vessel type covering 2022-2029 (email 12 April 2021) and considers that they will approach/depart berths in similar way to as shown in the Q4 2020 data – NE confirmed envisages above future project plans will be well clear of any Project interface issue and foresees no material impact in relation to the Ph 1 and Ph2 works The group reviewed PLA incident data (2010-2020) as shown in slide 24/34 in relation to the area. The incident database was reviewed on screen by the group and specific incidents relevant to the incident area and risk assessment were noted – specifically five including: • 1x near miss (grounding/contact with groyne) of large vessel following engine failure – noting anchor was deployed) • 2x near miss collision/close quarters situation. One with 2 large vessels resulting in 1 leaving authorised channel • 1x grounding and contact with groyne of a jack up barge under tow (due to being towed with legs deployed) • 1x near miss (grounding/contact with groyne) of commercially operated RIB
4.	**Risk assessment methodology**
	CJH confirmed PLA methodology being adopted for the assessment (slide 25-28/34). Discussion points raised included: • Potentially relevant interfacing projects identified as per list (NE confirmed that future PoTL baseline traffic movements had been shared as part of this). • Whilst movement numbers may decrease/increase over the future baseline, the vessel types/mix is likely to be comparable, and no significant change in 'how' vessel traffic uses the Project area spatially is expected. • JJH explained that the Project team therefore considers the Project to not be sensitive to change in the future baseline of movement numbers, and no material impact is envisaged from variance in movement numbers as the future traffic is not likely to change the spatial use of the study area.
5.	**Hazard identification**
	The group reviewed hazard identification and grouping by hazard type, vessel type, project phase and area leading to the matrix of 18 identified hazards across Phase 1 and 2 (slide 29 & 32/34). CJH explained logic of identifying hazards by order hierarchy: • Project phase • Area • Hazard type • Vessel type No additional hazards were identified in the workshop. Embedded risk controls (included within inherent risk assessment) were reviewed (slide 30/34) and discussed. Following points agreed: • Risk Control E1: Charting – agreed. • Risk Control E2: Aids to navigation (AtoNs) – Noted it is intended to place a special mark on the diffuser outfall head – agreed. • Risk Control E3: Navigate with due care and attention: JJH queried sensitivity of site to wash (during SI and construction of the pipeline and diffuser). Agreed this would

	be managed by VTS under a 'pass with precaution' through a PLA Temporary NTM rather any speed easement requirement/mandate. • Risk Control E4: 'Passage Plan and RAMS': It is assumed that passage plans and RAMS will be developed for the SI works and construction which will include definition of metocean limits (noting limits on visibility, wind speed and wave height were determined for the SI works in 2019). Agreed. Additional risk controls were reviewed: • Additional Risk Control A1: NTM: CS noted this is not a mandated requirement and so correctly assumed as an additional, and group agreed is likely to be taken forward given good practice and benefits (and a means to implement RC ID E3). Agreed. • Additional Risk Control A2: Marine Operations Plan, Stakeholder Engagement and Co-ordination: Agreed. • Additional Risk Control A3: Safety Boat. Noted likely to be included in contractor RAMS for duration of SI and construction of pipeline/diffuser and emphasised here as option. • Additional Risk Control: Speed reduction: discussed but considered to be covered by RC ID E3. Removed. • Waiting/Layby moorings: discussed but not thought to be required within project Phases 1&2. Removed. Group agreed that, subject to the inherent risk assessment, the above risk controls were appropriate, and no further risk controls were identified at this stage.
6.	**Risk scoring workshop**
	CJH and JJH introduced the workshop section by explaining that preliminary scoring of the inherent scenario (risk of the project with embedded risk controls in place) had been undertaken by the project team in advance of the session, based on data, analysis, expertise and project knowledge. To be validated with stakeholder consultation. The pre-scored inherent risk table was shared to provide advance context of scoring – noting no hazard being scored greater than 8 (out of 25) and so resulting in the 'Moderate' category and considered acceptable risk. Discussion on realistic most likely (RML) and realistic worst credible (RWC), with JJH and CJH confirming that RML and RWC were considered qualitatively (with accompanying narrative around the consequence severity across people, property, environment, reputation and port-impact used as a basis in scoring total with a precautionary basis behind taking the RWC). The group reviewed the six hazards with the top-ranking scores (of 8/25) with following comments and amendments made in the session to the risk register which was agreed to be shared with all attendees following the workshop: HAZ ID 3: Collision of pipeline/outfall SI vessel with other vessels (seagoing commercial or passenger) when arriving, manoeuvring and departing investigation sites. Ph 1 Score: 8/25 • General comments: As per 'Comments on Disposition' • Frequency: Agreed at 2 • Consequence/Severity RML – elevated damage to SI vessel from 1-2. No overall change from 4 • Consequence/Severity RWC – elevated damage to other (seagoing/commercial vessel) to Minor/Moderate. No overall change from 4 HAZ ID 5: Breakout of pipeline/outfall SI vessels when anchored/moored on site. Ph 1 Score: 8/25 • General comments: As per 'Comments on Disposition'

	• Frequency: Agreed at 2 • Consequence/Severity RML – No change to overall consequence score from 4 • Consequence/Severity RWC – elevated damage to other (seagoing/commercial vessel) to Minor/Moderate. No change to overall consequence score from 4 HAZ ID 8: Collision of Project pipeline/outfall construction vessels with passing tug and service, inland freight/cargo and inland passenger. Ph 2 Score: 8/25 • General comments: – As per 'Comments on Disposition'. – CS noted assumption that diffuser head is within the Order Limits and sufficient space to incorporate SI and construct within the boundary. If this changes, then this hazard (and the risk assessment) should be reviewed given sensitivity and this vessel type navigating in close proximity so sensitive to change. • Frequency: No change. Agreed at 2 • Consequence/Severity RML: No change to overall consequence score of 4 • Consequence/Severity RWC: No change to overall consequence score of 4 HAZ ID 12: Breakout of Project pipeline/outfall construction vessels during construction when anchored/moored on site. Ph 2 Score: 8/25 • General comments: As per 'Comments on Disposition' • Frequency: No change – agreed at 2 • Consequence/Severity RML: Contact with groynes considered most likely consequence. No change to overall consequence score of 4 • Consequence/Severity RWC: No change to overall consequence score of 4 HAZ ID 14: Collision of Project pipeline/outfall construction vessels with passing vessels outside the defined construction area. Ph 2 Score: 8/25 • General comments: As per 'Comments on Disposition' • Frequency: No change to score of 2 • Consequence/Severity RML: Amend environment to 'significant impact on environment'. No change to overall consequence score of 4 • Consequence/Severity RWC: No change to overall consequence score of 4 HAZ ID 18: Grounding/snagging of diffuser by passing vessel (once pipeline/diffuser installed, while tunnel construction continues). Ph 2 Score: 8/25 • General comments: – As per 'Comments on Disposition'. – CJH noted this is the longest duration hazard due to presence of pipeline throughout tunnel construction period. – CS noted recreational motorboat contacting a groyne in the area and causing major damage to the recreational vessel. JJH agreed to re-look at incident data (as not seen) and also raise with recreational stakeholders in consultation – agreed that consequence potential of contact with the diffuser is more significant for recreational vessel (primarily through risk to people rather than absolute value) and embedded risk control of AtoNs should help mitigate likelihood. • Frequency: No change to score of 2 • Consequence/Severity RML: No change to overall consequence score of 4 • Consequence/Severity RWC: No change to overall consequence score of 4 The group reviewed (collectively) the remaining hazards in the hazard summary table and NASH agreed to share the workbook with attendees for review and return/comment.

	Action A6: NASH to send score sheet for PLA to review and respond within circa 1 week.
7.	**A.O.B/actions**
	Actions as below. A1: CS to provide POLARIS extract/details of usage inc. key vessel parameters where known A2: CS to forward any relevant details of Explosives Licence to NASH Maritime A3: CS to provide introduction to Barbara Juist from PLA Marine Services for information on any mooring rental/intra-port usage A4: CS to provide information on largest vessel transiting over tunnel route for emergency anchoring potential (length and DWT would be helpful) A5: NASH Maritime to consider anchoring potential with Project team so that maximum depth penetration potential can be defined from planned and emergency anchoring. A6: NASH Maritime to send score sheet (by 14 May 2021) for PLA to review and respond by 21 May 2021

Appendix C Minutes of meeting with Gravesend and Thurrock yacht clubs

Notes of Meetings

Lower Thames Crossing (21-NASH-0168)

Client:	Lower Thames Crossing
Project:	Lower Thames Crossing
Venue:	Video/telecon (MS Teams)
Date of Meeting:	13-May-21 (12:00-13:00)
Present:	
Gravesend Sailing Club	Jeff Keys (JK) |Vice Commodore
Thurrock Yacht Club	Roy Fitch (RF) | President
NASH Maritime	Chris Hutchings (CJH) | Project Manager
NASH Maritime	Jamie Holmes (JJH) I Project Director

0.	Introductions and meeting objectives
	CJH commenced the meeting, introduced attendees The purpose and aim of the meeting is to outline project and key navigation issues relevant to recreational stakeholders.
1.	**Scheme summary | Order Limits and key marine/navigation features**
	CJH explained the key features of the proposed project (from draft DCO and further definition on marine/navigation aspects). Key aspects include: Order Limits (red line boundary) noting this has recently been reduced in marine extents (and other changes). Temporary in-river works prior to and during construction of tunnel: • Discharge pipeline and outfall between groynes three and four on northern shore. Intended to be in place for duration of construction and removed on completion. • Construction & decommissioning of discharge pipeline and outfall including key activities, plant (where known) and schedule of works. • Site investigation of discharge pipeline and outfall. • Site investigation over main tunnel route (JJH noted these are additional boreholes to supplement the SI undertaken in 2019 during which Gravesend Sailing Club (GSC) were consulted). Permanent works – on completion of construction of tunnel there are some navigation considerations for tunnel protection zones (between riverbed and tunnel and threat from penetration, e.g. anchors) which are being reviewed by project team albeit not relevant from a recreational perspective. Overview of preliminary schedule is based on mobilization in Jul-2023 with tunnelling between Jul-2025 to Mar-2027 and completion by Jul-2028.

	RF queried whether diffuser will be marked and JJH confirmed a proposed risk control is to include a marker (and to be discussed later in session). RF and JK noted existing sensitivity of users to mud/silt build-up and whether the scheme may impact this. JK noted in particular that GSC have issues with accretion around their launch point and approaches and in the lock (to Embankment Marina) and that the groynes (when installed some time ago) had altered depths/deposition in Gravesend Reach. JJH noted that impact on sediment/morphology is anticipated to be examined as part of the overall project design development and any changes (and sensitivity) expected to be assessed. JJH and CJH noted the relatively modest size of diffuser, and the pipeline would be trenched and buried so structures which would likely impact sedimentation may reasonably be considered low. CJH noted another consideration for sedimentation would be the discharge itself, although this is primarily runoff and any potential impacts will be controlled through Environment Agency consent conditions. Action: NASH Maritime to report stakeholder concerns on sedimentation issue to Project team for follow up. CJH provided overview of materials required during construction (e.g. concrete tunnel linings or aggregates for their production on site). Some materials may be imported to site through existing marine facilities/terminals.
2	**Scope of the Preliminary Navigational Risk Assessment (pNRA)**
	CJH explained that the scope of the pNRA has been agreed with PLA (as Statutory Harbour Authority) and also discussed with Port of Tilbury. Project phases for purposes of pNRA are considered as below. • Ph0 – Pre-Construction SI for tunnel (additional boreholes along tunnel route) • Ph1 – Pre-Construction SI for pipeline and diffuser • Ph2 – Construction and duration of installation for pipeline and diffuser • Ph3 – Operations/Permanent Works: Protection zones around tunnel and relevant navigation implications Ph0 is scoped out of the pNRA (JJH noted previous NRA provides basis for review/update once SI borehole locations are known and SI Contractor develops RAMS – this was discussed and reviewed, noting Gravesend Sailing Club participation in the 2019 NRA that was undertaken). Ph1 and Ph2 being considered under conventional risk assessment. Ph3 being addressed separately.
3.	**Vessel traffic data, analysis and review**
	CJH explained vessels are grouped into categories for analysis and assessment, and then presented AIS data used for analysis. AIS data was sourced for 14 days Aug-2019 and 14 days Oct-2019 (ensuring any COVID-19 impact on data was not present) with additional data sourced in locality of Tilbury2 Sep/Oct-2020 following the commencement of operations at this berth to ensure understanding of how area is used. Discussion held on data and generally considered as an accurate representation of baseline usage of the area. • Density plots show general distribution and numbers of traffic in the area. • Plots reviewed by vessel type/category. • JK noted that Tilbury2 opening in 2020 (as shown on plots) has resulted in many of the sailing activities being kept to the south, and this is expected to increase. JJH noted that recreational traffic is often underrepresented in the data and the importance of stakeholder consultation in order to qualitatively understand baseline

	usage of the area. JJH and CJH invited GSC to outline their usage of the area and also usage of others. Gravesend Sailing Club • Dinghy racing held on Saturdays/Sunday racing between Apr and Oct – typically up to 12 dinghies use the area during racing. • Mixture of series racing and some events/regattas – some in evening. • Racing held in relation to tide. Racing on incoming tide (typically launch HW-3 and recover at HW / HW+1). • Dinghy racing generally located between Denton and Gravesend Promenade (south side of river), although do periodically cross river. Dinghy cruises may cover longer ground (up to DP World London Gateway for example). • Generally use channel markers and groyne marks for racecourses. Two safety boats available to the club which are used for club-organised activities. Both boats are used when racing crosses the river. If localised racing on one side, then one safety boat used (monitoring VHF CH 68 and a club channel). • Non-organised sailing dinghies do use the area. • Small cruisers (up to 30ft) kept on circa 24 mooring trots (rented from PLA) with series, regattas and non-organised events as above. • Noted restricted tidal access at the club (and previously discussed points re yachts stored ashore and launched via Embankment Marina. • Club seeks to retain up-to-date information on website (www.gravesendsc.org.uk) of planned activities. Thurrock Yacht Club • Located further away from site so less potential for conflict or interface with the Project • Seasonal use with racing series and events/regattas • Thursday evening racing (summer), generally local but occasionally longer distances, for example to Higham Bight area • Cruisers up to circa 38ft, no dinghies presently (and would be local to confines of club if this is taken forwards by the club) • RF noted, in relation to the outfall/pipeline, that the data shown is through transits (on the flood using northern side inbound and outbound on south side as per requirements) • Some motorboats in the club – considered higher risk due to draft and seeking tidal relief • Club seeks to retain up-to-date information on website (www.thurrockyachtclub.org.uk/) of planned activities RF and JK offered comment on other recreational users occasionally using the area: • Erith Sailing Club and Greenwich Yacht Club – website provides information on events, and these clubs periodically use the area. • Some multi-club events between Gravesend Yacht Club, Erith Sailing Club, Greenwich Sailing Club, Thurrock Yacht Club (with a nominated host club), e.g. Gravesham trophy when boats will travel from respective club to host club. • Blend of sailing boats (yachts and dinghies) and motorboats in the general area. • Gravesend Rowing Club – operates between Denton and rowing club and does not cross river (previously did a longer trip downriver), so seen as low interface potential.

	• Embankment Marina – mainly live-aboard house boats (and GYC use for access to ashore storage and some vessels kept in marina), so not high usage of the river (noted previously discussed sedimentation and lock access issues). • Stamford Creek – small fishing boat club, quite localised. • JJH queried use by general public (not part of organised clubs). Public access to river is limited on northern side so non-organised activity potential is limited and not seen in experience of RF and JK. More public access potential on the south, although fairly limited (some from Sunshine Greek and Gravesend creek historically, although less in recent years). CJH explained that the project is reviewing PLA incident database (2010–2020) in relation to the area: • JJH noted that there have been some reportable incidents of vessels making contact with groynes with considerable damage to vessel, and this is considered a relevant incident type given diffuser. RF and JK considered the groynes to be well marked and so incidents generally due to master error – more likely when vessels duck in and out of the groynes to gain relief against an adverse tide direction. • Noted that, during large vessel transits, recreational vessels will often go closer to the groynes to remain clear of the large vessel, bringing them closer to contact risk in reduced sea room. PLA VTS periodically requests recreational vessels to remain well clear of large vessels and this can reduce usable area for short periods. • No interface issues with Tideway and their use of East Tilbury jetty with tug and tows. • No interface issues with high-speed craft/RIBS. • No general other interface issues with other users.
4.	**Risk assessment methodology**
	CJH outlined that the PLA risk assessment methodology is being adopted for the assessment and that including basis behind scoring likelihood and consequence of hazard and levels of tolerability. JJH noted then in preparing a score for likelihood/consequence a blend of the RML and RWC scenarios is considered qualitatively (e.g. with respect to severity across people, property, environment, reputation and port-impact) and taking a generally precautionary basis forward into the overall score.
5.	**Hazard Identification**
	CJH explained hazard identification and grouping by hazard type, vessel type, project phase and area leading to the matrix of 18 identified hazards across Phases 1 and 2. JJH asked if any other hazards were relevant, and RF noted importance of considering non-local recreational vessels (i.e. those visiting) as they will have less familiarity with the area and potentially less likely to be aware of works so could be considered higher risk. JJH noted this. Embedded risk controls (included within inherent risk assessment) were reviewed and discussed, including: Following points agreed: • Risk Control E1: Charting • Risk Control E2: AtoNs – Noted it is intended to place a special mark on the diffuser outfall head • Risk Control E3: Navigate with due care and attention which may include a ‘pass with precaution’ through a PLA Temporary NTM rather any speed easement requirement/mandate

	• Risk Control E4: 'Passage Plan and RAMS' – It is assumed that passage plans and RAMS will be developed for the SI works and construction • Risk Control E5: Pilotage for vessels subject to compulsory pilotage Additional risk controls were reviewed: • Additional Risk Control A1: NTM which is likely to be taken forwards. • Additional Risk Control A2: Marine Operations Plan, Stakeholder Engagement and Coordination – discussion on ensuring flow down of communication to club memberships, and clubs are keen to ensure they are kept up to date through project communication. • Additional Risk Control A3: Safety Boat. Noted likely to be included in contractor RAMS for duration of SI and construction of pipeline/diffuser. JJH clarified that a guard boat was not being proposed. Group agreed that, subject to the inherent risk assessment, the above risk controls were appropriate, and no further risk controls were identified at this stage.
6.	**Risk scoring workshop**
	CJH and JJH explained a that preliminary scoring of the inherent scenario (risk of the project with embedded risk controls in place) had been undertaken by the project team and reviewed with PLA and PoTL. Shared preliminary scoring and noted no hazard had a score of greater than 8 (out of 25) and so resulting in the 'Moderate' category and considered acceptable risk (with adopted risk controls).
7.	**A.O.B/actions**
	CJH and JJH thank for attendance and participation, and clubs emphasised interest in ensuring they are updated on process. Action: NASH Maritime to report stakeholder concerns on sedimentation issue to Project team for follow up. Action : Gravesend Sailing Club and Thurrock Yacht Club to monitor Lower Thames Crossing website for further updates: https://highwaysengland.co.uk/our-work/lower-thames-crossing/. Consider completing the 'Keep in Touch' page: https://highwaysengland.co.uk/our-work/lower-thames-crossing/contact-us-and-archive/contact-us/

Appendix D Higham Bight explosives licence

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HM4 Licence No. 9/92. File Ref: ((431 143/2

THE DANGEROUS SUBSTANCES IN HARBOUR AREAS REGULATIONS 1987

EXPLOSIVES LICENCE

1. The Health and Safety Executive hereby grants to

PORT OF LONDON AUTHORITY

a Licence for the purposes of Part IX of the Dangerous Substances in Harbour Areas Regulations 1987, permitting explosives to be brought into and carried and handled within the harbour area known as

RIVER THAMES ANCHORAGES

as defined in the Port of London Act 1968 as amended.

2. The Licence is subject to the conditions in the Terms hereto.

3. In this Licence, including the Terms, the "Regulations" means the Dangerous Substances in Harbour Areas Regulations 1987, and words and expressions used in this Licence shall, unless the context otherwise requires, have the same meanings as in the Regulations.

4. This Licence revokes all previous Licences issued under the Regulations in respect of this place and shall remain in force until revoked by the Health and Safety Executive in writing.

Dated this 25 day of May 1992

[redacted]

The holder of the post designated H.M. Chief Inspector of Explosives, a person authorised by the Health and Safety Executive to act in that behalf.

CERTIFIED TO BE A TRUE COPY
H.M. INSPECTOR OF EXPLOSIVES

HA4 Licence No. 3/92.

TERMS OF LICENCE

1. Nothing in this Licence shall prohibit

(a) the entry of explosives into; or

(b) the handling of explosives at;

any other place within this harbour area at which explosives may be handled under the Regulations.

2. Nothing in this Licence shall prohibit the passage of a vessel carrying explosives through this harbour area where such passage is solely for the purpose of access to or egress from another place at which explosives may be handled under the Regulations.

3. Except as permitted by the above terms, the licensee shall not permit any person to bring into the harbour area any explosives of such a type or quantity that may not be handled under the provisions of this Licence.

4. A vessel containing explosives shall only be anchored or berthed at such places as are specified in the Schedule to this Licence.

5. Explosives shall only be handled at such places as are specified in the Schedule to this Licence.

6. In respect of a place so specified;

(a) the quantity of explosives present shall not exceed that specified (for the Division of explosives concerned) in column 1 of the Schedule, except that where the explosives include those in Compatibility Groups A, B or F the aggregate quantity present shall not exceed one third of the quantity so specified, unless the explosives in Compatibility Groups A, B or F

(i) are separated from any other explosives so as to prevent communication of explosion to those other explosives; and

(ii) do not exceed one third of the quantity so specified

(b) no handling of explosives shall take place while

(i) any person not involved in the explosives handling operation is present in any building within the distance specified (for the Division and quantity of explosives concerned) in column 2 of the schedule; or

(ii) any passenger vessel is berthed or anchored within the distance specified (for the Division and quantity of explosives concerned) in column 3 of the Schedule; or

(iii) any other vessel or vehicle containing an unrelated consignment of explosives, or any person not required to be involved with the handling operation, is within the distance specified (for the Division and quantity of explosives concerned) in column 4 of the Schedule;

(c) any Special Conditions in the Schedule shall be complied with.

7. Where the quantity of explosives present is not specified in column 1 of the relevant part of the Schedule, then for the purposes of ascertaining the distances referred to in the previous term, that quantity shall be rounded up, that is to say, the explosives shall be treated as being of a quantity equal to the next higher quantity specified in that column.

8. Where explosives in different Divisions are carried together then;

(a) for the purpose of applying the schedule, they shall all be deemed to be in the Division amongst them which comes highest in the following list, that is Division 1.1 (highest), 1.2, 1.3, and 1.5 (lowest);

(b) except that where explosives in Division 1.5 are carried or handled with explosives in Division 1.2 then, for the purpose of applying the schedule, they shall all be deemed to be in Division 1.1.

9. Distances referred to in the Schedule shall be measured between that part of the explosives and that part of the passenger vessel, other vessel or vehicle, or other place, as the case may be, which gives the smallest distance.

10. (a) As soon as practicable after the Licence has been granted, the licensee shall prepare and send to the Health and Safety Executive and to the local planning authority, a plan showing each place where explosives are allowed to be handled under this Licence.

(b) There shall be delineated on the plan the area of land which is within the safeguarding distances from that place as specified in the relevant part of the Schedule.

(c) The plan shall be prepared in accordance with the guidance issued by the Health and Safety Executive entitled "The Preparation of Safeguarding Plans".

(d) Where the safeguarding distances are altered pursuant to a variation of the Licence, the licensee shall prepare and send a revised plan to the above mentioned bodies as soon as is practicable after that alteration.

11. (a) Where after this Licence has been granted there is any development, subsequent to the date of the survey on which the Licence was based, within the relevant safeguarding distances referred to above which is likely to materially affect either the probability of an accident with the explosives or the magnitude of the consequences of such an accident, the licensee shall, before the development is commenced or as soon as is practicable thereafter, give written notice of it to the Health and Safety Executive.

(b) Without prejudice to the generality of part (a) of this term, any development within the safeguarding distances involving a material increase of the population or in the numbers of buildings shall be so notified.

12. Notwithstanding Regulation 9, Regulations 6 and 8 of the 1987 Regulations shall apply to ferry boats operating entirely within smooth or partially smooth waters within the meaning of the Merchant Shipping (Smooth and Partially Smooth Waters) Rules 1977.

13. In these Terms and in the Schedule -

(a) reference to explosives is a reference to explosives that are not exempted from the licensing provisions of Part IX of the Regulations.

(b) references to quantities of explosives are references to net explosives quantities, that is to say, excluding any packaging or inert parts of explosives.

(c) "local planning authority" means

(i) in England and Wales, the local planning authority within the meaning of the Town and Country Planning Act 1971,

(ii) in Scotland the authority responsible for planning functions within the meaning of section 172 of the Local Government (Scotland) Act 1973;

for the area within the safeguarding distances referred to above. Where the area is within the jurisdiction of more than one planning authority then the phrase shall mean them all.

(d) "passenger vessel" means a vessel carrying more than twelve passengers;

(e) a "passenger" is any person defined as such in the Merchant Shipping Act.

SCHEDULE

Name of place (as shown on plan) : Chapman's Anchorage Number 1.

Safeguarding distances :

SD1 : 600 metres SD2 : 1200 metres SD3 : 2400 metres

COLUMN 1				COLUMN 2	COLUMN 3	COLUMN 4
Maximum aggregate quantity (in tonnes) of explosives of each Division of Class 1 allowed to be present if distance limitations are met.				Distance from berth within which buildings may only be occupied by persons essential to the handling operation.	Limiting distance to a passenger vessel at a berth or anchorage.	Limiting distance to persons in the open or other explosives.
1.1 or	1.2 or	1.3 or	1.5	metres	metres	metres
360	U/L	U/L	360	1200	1200	400
200	U/L	U/L	200	1200	982	327
100	U/L	U/L	100	1200	780	260

NOTE: Where the entry in column 1 is U/L, this means that unlimited quantities of that Division of explosive may be loaded, unloaded or handled at that place.

SPECIAL CONDITIONS : The combined total quantity of Hazard Division 1.1 or 1.5 explosives on Nos 1,2 and 3 Anchorages at any one time shall not exceed 1050 tonnes.

Licence No. 9/92. File Ref: H 831/143.2

SCHEDULE

Name of place (as shown on plan) : Chapman's Anchorage Number 2.

Safeguarding distances :

SD1 : 933 metres SD2 : 1400 metres SD3 : 2800 metres

COLUMN 1				COLUMN 2	COLUMN 3	COLUMN 4
Maximum aggregate quantity (in tonnes) of explosives of each Division of Class 1 allowed to be present if distance limitations are met.				Distance from berth within which buildings may only be occupied by persons essential to the handling operation.	Limiting distance to a passenger vessel at a berth or anchorage.	Limiting distance to persons in the open or other explosives.
1.1 or	1.2 or	1.3 or	1.5	metres	metres	metres
600	U/L	U/L	600	1400	1400	470
400	U/L	U/L	400	1400	1238	413
200	U/L	U/L	200	1400	982	327

NOTE: Where the entry in column 1 is U/L, this means that unlimited quantities of that Division of explosive may be loaded, unloaded or handled at that place.

SPECIAL CONDITIONS : The combined total quantity of Hazard Division 1.1 or 1.5 explosives on Nos 1,2 and 3 Anchorages at any one time shall not exceed 1050 tonnes.

Licence No. 9/92.

File Ref: [illegible]

SCHEDULE

Name of place (as shown on plan) : Chapman's Anchorage Number 3.

Safeguarding distances :

SD1 : 1140 metres SD2 : 1700 metres SD3 : 3400 metres

COLUMN 1				COLUMN 2	COLUMN 3	COLUMN 4
Maximum aggregate quantity (in tonnes) of explosives of each Division of Class 1 allowed to be present if distance limitations are met.				Distance from berth within which buildings may only be occupied by persons essential to the handling operation.	Limiting distance to a passenger vessel at a berth or anchorage.	Limiting distance to persons in the open or other explosives.
1.1 or	1.2 or	1.3 or	1.5	metres	metres	metres
1050	U/L	U/L	1050	1700	1700	567
500	U/L	U/L	500	1700	1333	444
200	U/L	U/L	200	1700	982	327

NOTE: Where the entry in column 1 is U/L, this means that unlimited quantities of that Division of explosive may be loaded, unloaded or handled at that place.

SPECIAL CONDITIONS : The combined total quantity of Hazard Division 1.1 or 1.5 explosives on Nos 1,2 and 3 Anchorages at any one time shall not exceed 1050 tonnes.

Licence No. 9/92. File Ref: 41 -811/143/2

SCHEDULE

Name of place (as shown on plan) : Higham Bight.

Safeguarding distances :

SD1 : 461 metres SD2 : 692 metres SD3 : 1384 metres

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Maximum aggregate quantity (in tonnes) of explosives of each Division of Class 1 allowed to be present if distance limitations are met.	Distance from berth within which buildings may only be occupied by persons essential to the handling operation.	Limiting distance to a passenger vessel at a berth or anchorage.	Limiting distance to persons in the open or other explosives.
1.1 or 1.2 or 1.3 or 1.5	metres	metres	metres
70 U/L U/L 70	1350	692	231
35 U/L U/L 35	1350	549	183

NOTE: Where the entry in column 1 is U/L, this means that unlimited quantities of that Division of explosive may be loaded, unloaded or handled at that place.

SPECIAL CONDITIONS : None

Licence No. 9/92. File Ref: (I .811/143/2

SCHEDULE

Name of place (as shown on plan) : Mucking Bight.

Safeguarding distances :

SD1 : 582 metres SD2 : 872 metres SD3 : 1745 metres

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Maximum aggregate quantity (in tonnes) of explosives of each Division of Class 1 allowed to be present if distance limitations are met.	Distance from berth within which buildings may only be occupied by persons essential to the handling operation.	Limiting distance to a passenger vessel at a berth or anchorage.	Limiting distance to persons in the open or other explosives.
1.1 or 1.2 or 1.3 or 1.5	metres	metres	metres
140 U/L U/L 140	1725	872	291
70 U/L U/L 70	1725	692	231

NOTE: Where the entry in column 1 is U/L, this means that unlimited quantities of that Division of explosive may be loaded, unloaded or handled at that place.

SPECIAL CONDITIONS : None

Chapman's Anthorage 1,2 & 3

Plan to Licence No 9/92

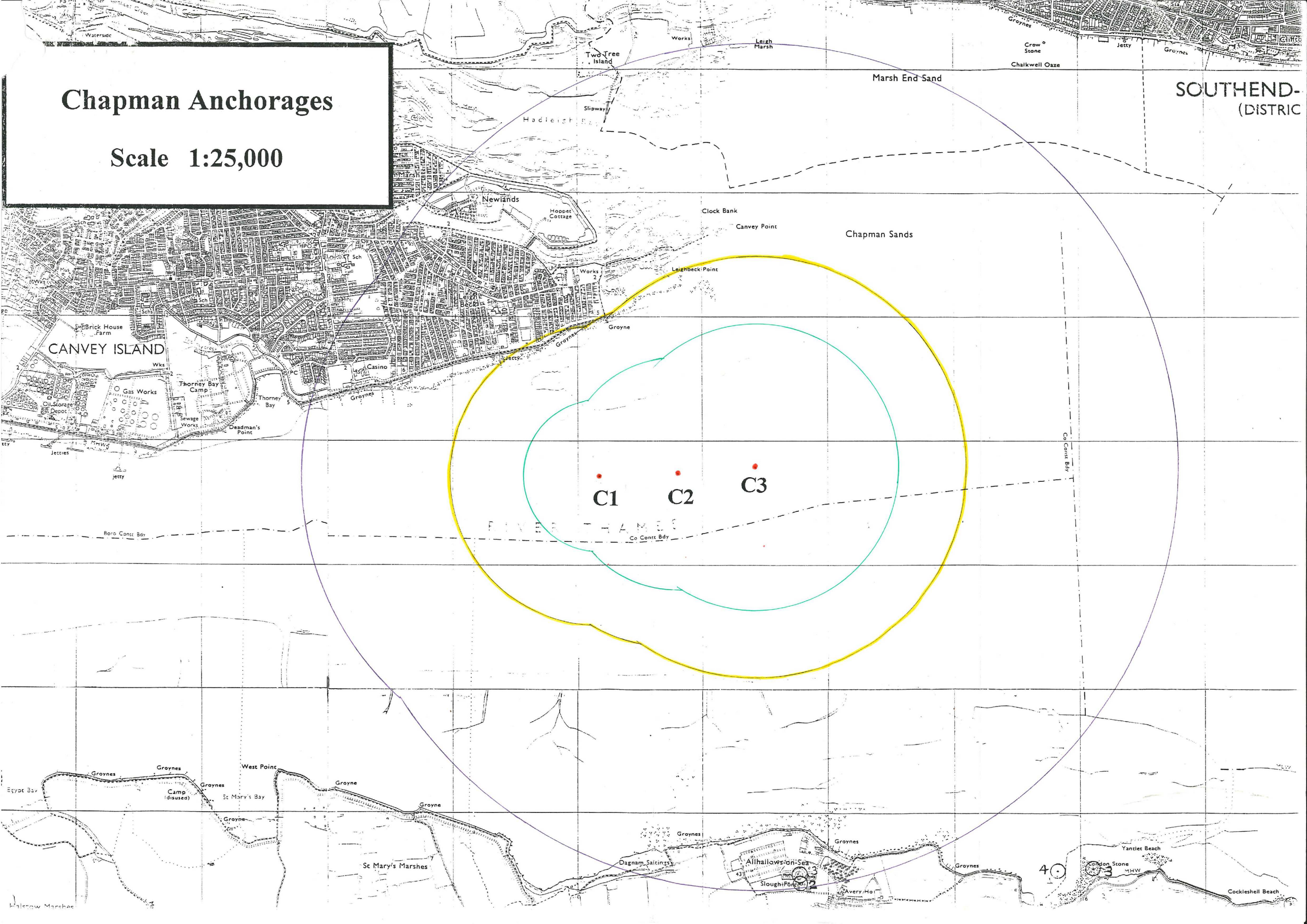
[illegible]
H.M. PRINCIPAL SPECIALIST
INSPECTOR (EXPLOSIVES).

CERTIFIED TO BE A TRUE COPY
H.M. INSPECTOR OF EXPLOSIVES

VI/4811/145/2

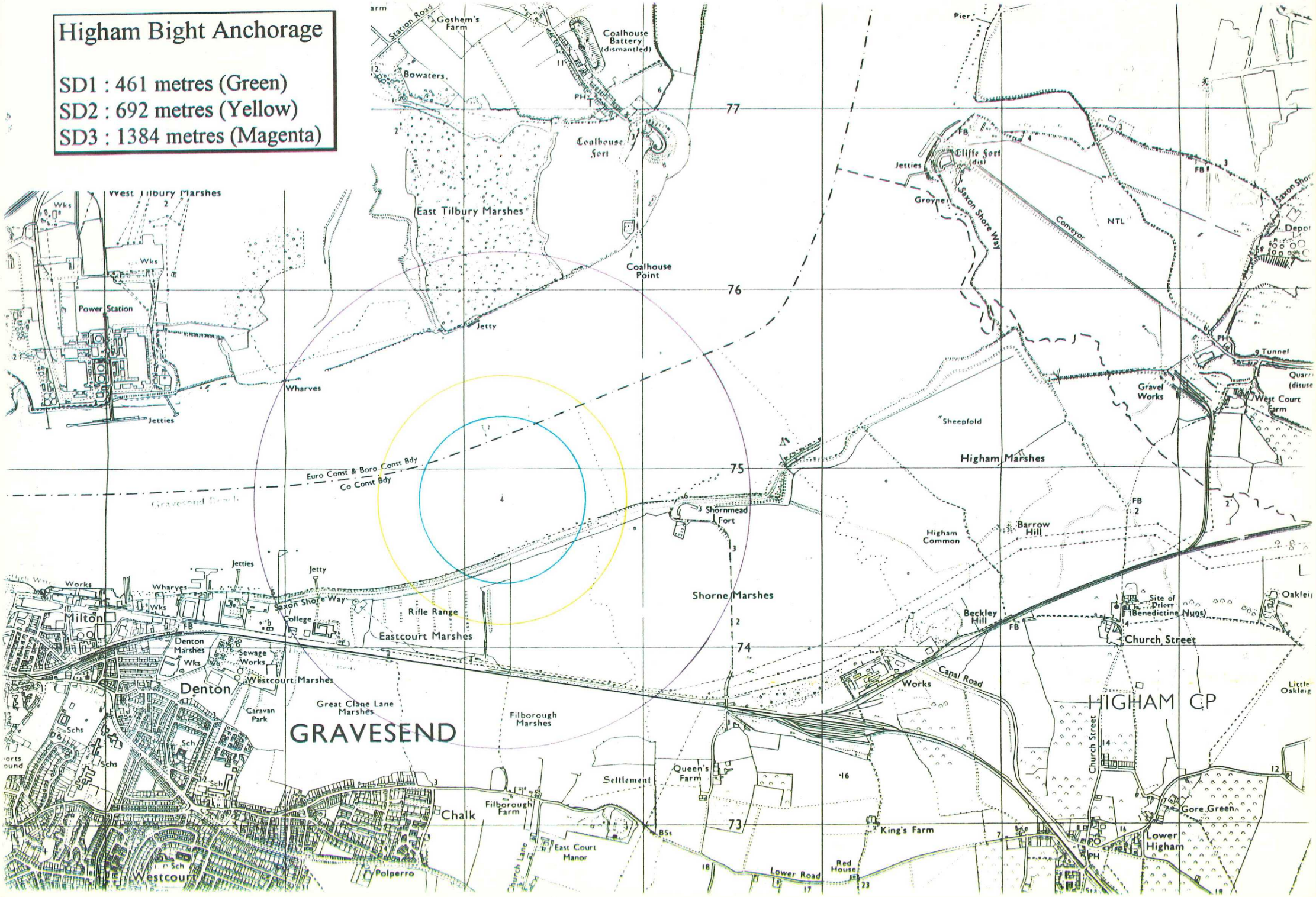
Chapman Anchorages

Scale 1:25,000



Higham Bight Anchorage

SD1 : 461 metres (Green)
SD2 : 692 metres (Yellow)
SD3 : 1384 metres (Magenta)



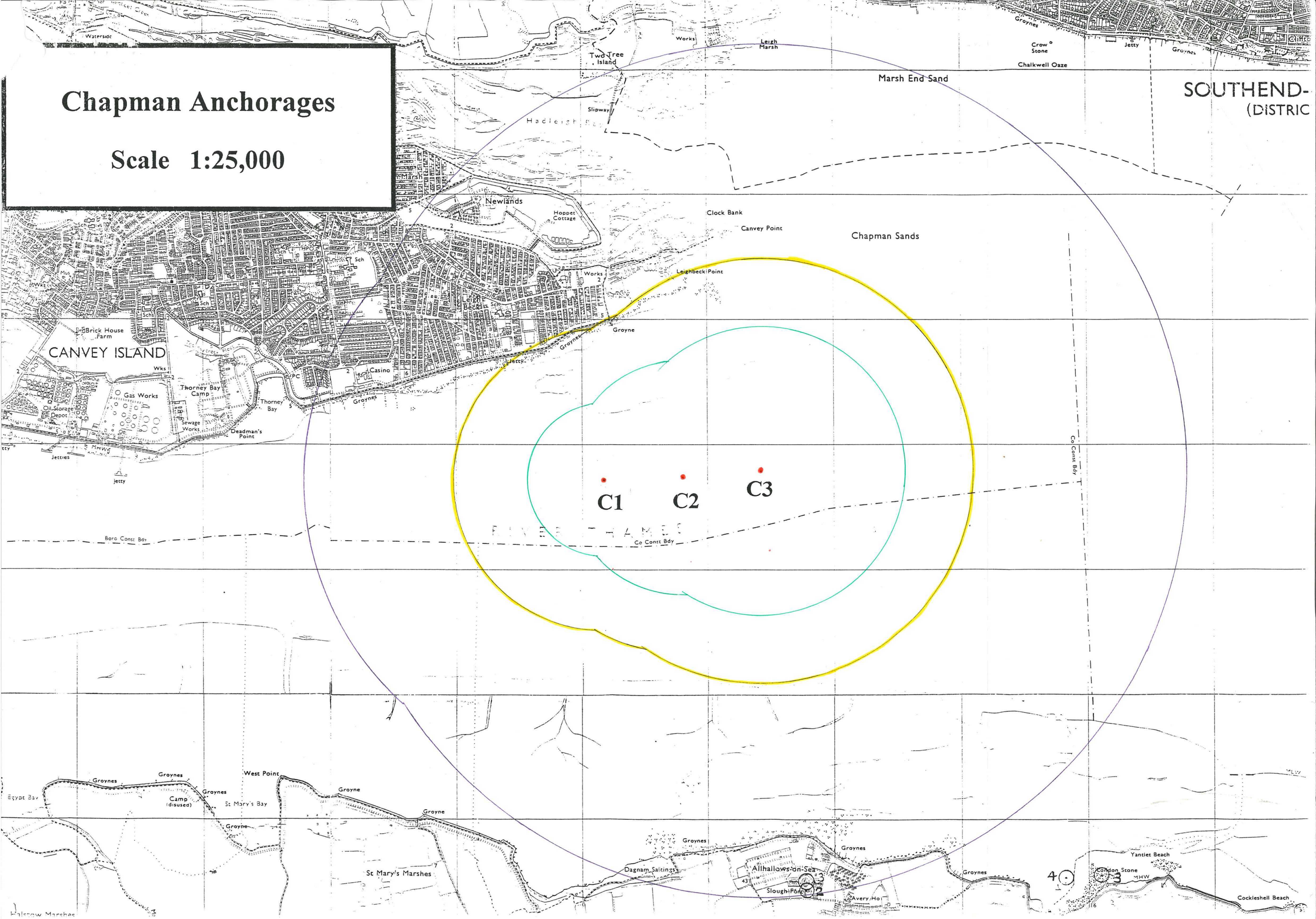
Chapman's Anchorage 1243

Plan to Licence No 9/92

H.M. PRINCIPAL SPECIALIST INSPECTOR (EXPLOSIVES).

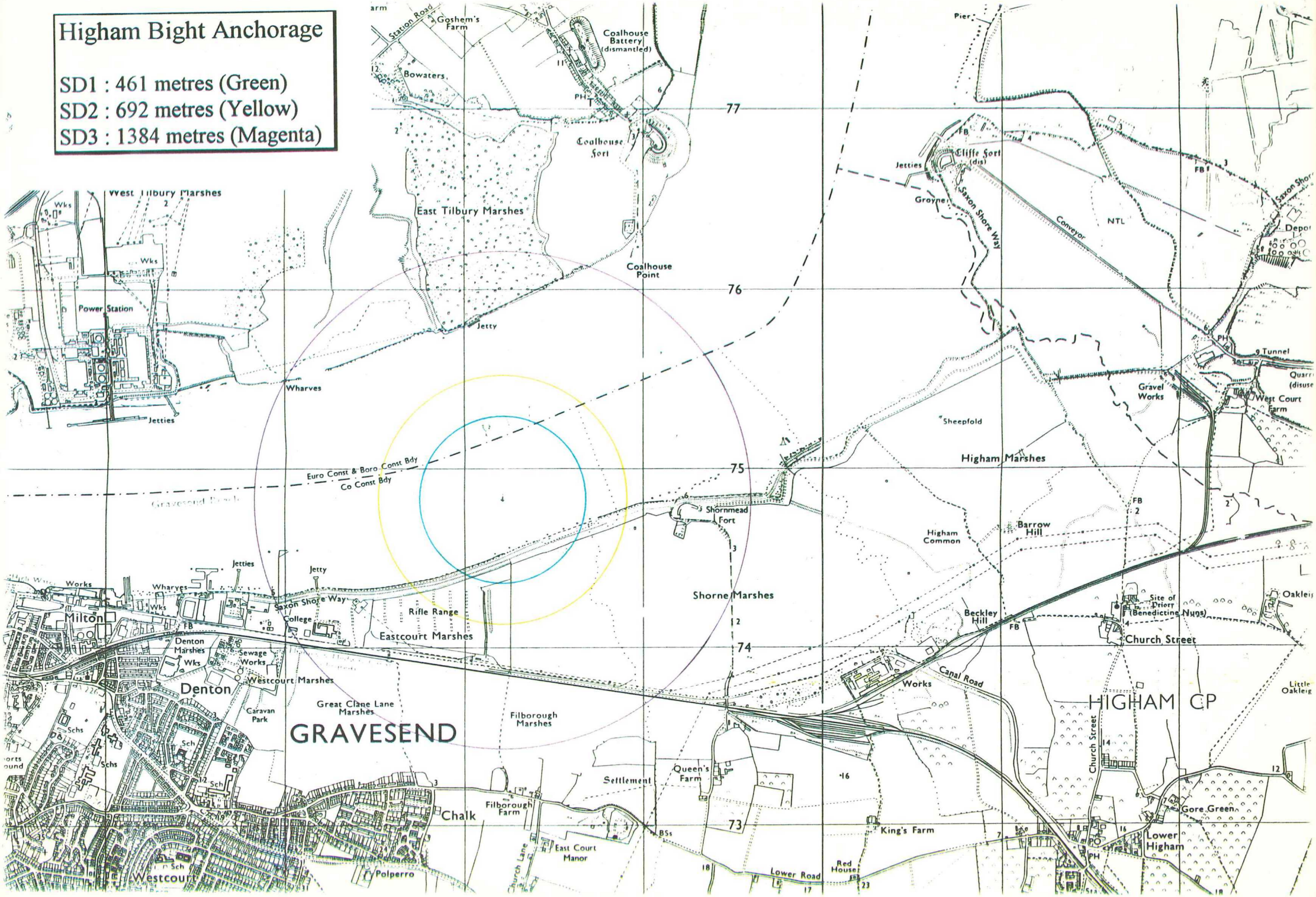
Chapman Anchorages

Scale 1:25,000



Higham Bight Anchorage

SD1 : 461 metres (Green)
SD2 : 692 metres (Yellow)
SD3 : 1384 metres (Magenta)



EXPLOSIVES QUANTITIES
~~AUGUST 1995~~
Dec 2008.

	C1	C2	C3
Chapman Anchorages	360 tonnes	600 tonnes	1050 tonnes
Mucking Anchorage	140 tonnes		
Higham Anchorage	70 tonnes		

All quantities shown are "Net Explosive Quantity".

Appendix E Hazard dispositions and outcome descriptions

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:1	Contact/grounding of pipeline/outfall/ temporary works area SI vessel with existing structures	• GI vessel will likely need to survey intertidal and sub-tidal areas between groynes 3 and 4 and between groynes 5 and 6. • High tidal flows at the edges of the channel and in intertidal areas • Vessel hits East Tilbury Jetty enroute to site • Vessel hits groynes enroute to/at site.	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other structures • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to crew and workers • Serious damage to vessel – moderate damage to other structures • Minor impact on the environment with no lasting effects • Local/national adverse publicity • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:2	Contact with pipeline/outfall l / temporary works area SI vessel (when moored) by passing vessels (All types).	• Busy section of the river • However, navigation channel is some distance from site • Site mostly protected by groynes • Likely would need to be a shallow draught vessel to avoid grounding • AIS track data show that recreational vessels (then tug and service vessels) get closest to A3 and A5 construction area"	Most likely outcome • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost Reasonable worst credible outcome • Possibility of major injuries to recreational vessel users • Serious damage to vessel • Moderate damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:3	Collision of pipeline/outfall / temporary works area SI vessel with other vessels (seagoing commercial or passenger) when arriving, manoeuvring and departing investigation sites.	• SI vessel moves from between the groynes into busier waterway possibly crossing paths of other vessels • Other vessels unfamiliar with seeing vessels between groynes • Strong tidal currents • SI vessel may be tidally (depth) constrained as it starts to leave the area • Seagoing vessels have to stay in navigation channel	**Most likely outcome** • Minor or no injuries • Minor damage to SI vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to SI vessel crew • Serious damage to vessel • Minor/moderate damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Moderate port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:4	Collision of pipeline/outfall /temporary works area SI vessel with other vessels (all other types)) when arriving, manoeuvring and departing investigation sites.	• SI vessel moves from between the groynes into busier waterway possibly crossing paths of other vessels • Other vessels unfamiliar with seeing vessels between groynes • Strong tidal currents • SI vessel may be tidally (depth) constrained as it starts to leave the area • Other vessels do not have to stay in navigation channel so may be closer to the edge of construction area with less time to react	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to SI vessel crew • Serious damage to vessel • Minor damage to other vessel • Minor impact on the environment with no lasting effects • Local news coverage • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:5	Breakout of pipeline/outfall/ temporary works area SI vessels when anchored/moored on site.	• High tidal flows in intertidal areas. Vessel inadequately anchored • Extreme weather (wind/waves) leads to breakout. • Mooring in vicinity of works so spatially deconflicted from other users. • Intertidal nature of location means reduced exposure duration. • Most likely = no contact after breakout, vessel recovered • Worst case = contact with seagoing vessel after breakout	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to SI vessel crew • Serious damage to vessel • Minor/moderate damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Moderate port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:6	Collision of Project pipeline/outfall / temporary works area construction vessels with passing seagoing commercial and passenger vessels	• Assumption - pipeline/outfall/ temporary works area installation vessel always within DCO Order Limits • Seagoing vessels would leave the authorised channel and move into much shallower water. • Very unlikely to have sufficient water depth within DCO boundary and thus Area 3. • Area A3 also "protected" to some extent by presence of groynes 3 & 4 • Area A5 also "protected “to some extent by presence of groynes 5 and 6 .	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to SI vessel crew • Serious damage to vessel • Minor damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:7	Collision of Project pipeline/outfall / temporary works area construction vessels with passing recreational vessels.	• Assumption - pipeline/outfall / temporary works area installation vessel always within DCO Order Limits • Deeper draught recreational vessels navigating in shallow water unlikely to have sufficient water depth to enter within DCO boundary and thus Area 3 and Area 5. • Area A3 also ""protected"" to some extent by presence of groynes 3 & 4. • Area A5 also ""protected" "to some extent by presence of groynes 5 and 6. • Shallower draught vessels, more likely to be in this area. These likely to be smaller vessels"	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to recreational vessel users • Serious damage to vessel • Moderate damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:8	Collision of Project pipeline/outfall / temporary works area construction vessels with passing tug and service, inland freight/cargo and inland passenger	• Assumption - pipeline/outfall/ temporary works area installation vessel always within DCO Order Limits • Deeper draught vessels navigating in shallow water unlikely to have sufficient water depth to enter within DCO boundary and thus Area 3 and Area 5 • Area A3 also ""protected"" to some extent by presence of groynes 3 & 4. • Area A5 also ""protected" "to some extent by presence of groynes 5 and 6. • Shallower draught vessels, more likely to be in this area. These likely to be smaller vessels"	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to vessels crew • Serious damage to vessel • Minor damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Moderate port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:9	Collision between any 3rd party vessels caused as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on site.	• Assumption - pipeline/outfall installation / temporary works area vessel always within DCO Order Limits • Area A3 is in shallow water and "protected" to some extent by presence of groynes 3 & 4. • Area A5 also "protected “to some extent by presence of groynes 5 and 6. • Only smaller/shallower draught vessels would be able to enter the construction area between groynes Hazard requires two vessels in this area • Also refer to Haz Id #11 - consider comparable consequence	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to recreational vessel users • Moderate damage to vessel • Moderate damage to other vessel • Insignificant impact on the environment • Local news coverage • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:10	Grounding of Project pipeline/outfall / temporary works area construction vessels during construction.	• Assumption - pipeline/outfall installation / temporary works area vessel always within DCO Order Limits • Project pipeline/outfall / temporary works area construction vessel will need to operate in the intertidal and sub-tidal areas between groynes 3 and 4 and between groynes 5 and 6. • High tidal flows at the edges of the channel and in intertidal areas • Vessel manoeuvring at limits of tidal state • Vessels are capable of taking the ground or will incur minimal damage • Reasonable likelihood given intertidal nature of area	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:11	Grounding of non-project vessels as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on site during construction (All types).	• Assumption - pipeline/outfall installation / temporary works area vessel always within DCO Order Limits • Likely only smaller recreational vessels in between groynes to avoid tide. • Other vessels would avoid the shallow water and groynes 3 & 4, so would not ground within area A3. • Other vessels would avoid the shallow water and groynes 5 & 6, so would not ground within area A3.	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to recreational vessel users • Moderate damage to vessel • Moderate damage to other vessel • Insignificant impact on the environment • Local news coverage • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:12	Breakout of Project pipeline/outfall / temporary works area construction vessels during construction when anchored/moored on site.	• High tidal flows in intertidal areas. Vessel inadequately anchored. • Extreme weather (wind/waves) leads to breakout. • Mooring in vicinity of works, so spatially deconflicted from other users. • Intertidal nature of location means reduced exposure duration. • Most likely = no contact after breakout, vessel recovered • Worst case = contact with seagoing vessel after breakout	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to vessel crew • Serious damage to vessel • Minor damage to other vessel – minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Moderate port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:13	Contact/grounding of Project pipeline/outfall / temporary works area construction vessels with existing structures	• Project pipeline/outfall/ temporary works area construction vessel will need to operate in intertidal and sub-tidal areas between groynes 3 and 4 and between groynes 5 and 6. • High tidal flows at the edges of the channel and in intertidal areas • Vessel hits East Tilbury Jetty enroute to site • Vessel hits groynes enroute to/at site • comparable with Haz ID #1 but elevated consequence due to larger vessels	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other structures • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to crew and workers • Serious damage to vessel • Moderate damage to other structures • Minor impact on the environment with no lasting effects • Local/national adverse publicity • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:14	Collision of Project pipeline/outfall/ temporary works area construction vessels with passing vessels outside the defined construction area	• Project outfall/pipeline vessel/ temporary works area moves from between the groynes into busier waterway possibly crossing paths of other vessels • Other vessels unfamiliar with seeing vessels emerging from between groynes • Strong tidal currents • Project outfall/pipeline vessels may be tidally (depth) constrained as they start to leave the area • Other vessels may be navigating close to the edge of construction area with limited time to react"	**Most likely outcome** • No injuries to crew • Minor damage to vessel • No impact on the environment • Local adverse publicity **Reasonable worst credible outcome** • Major injuries and multiple fatalities • Major damage to vessel rendering it unoperational • Significant impact on the environment with lasting effects • National adverse publicity

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:15	Collision between any 3rd party vessel caused as a result of avoiding Project pipeline/outfall construction / temporary works area vessels transiting to/from site.	• Construction vessels are barges with limited manoeuvrability navigating in potentially strong tidal flows • infrequent for main construction barge. • Supply barges more frequent but also manoeuvrable • Likelihood of collision involving large vessels is low as project vessels with wait to avoid them • similar severity to Haz ID#8 but less likely	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to vessels crew • Serious damage to vessel • Minor damage to other vessel • Minor impact on the environment with no lasting effects • Regional news coverage with potential for reputational damage • Moderate port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:16	Grounding of Project pipeline/outfall construction / temporary works area vessels whilst on passage to site outside the defined construction area.	• Vessel manoeuvring at limits of tidal state. Project pipeline/outfall construction vessels capable of taking the ground or would incur minimal damage. • Unlikely given deep water in areas A2 and A4 and likely passage from deeper water.	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:17	Grounding of non project vessels as a result of avoiding Project pipeline/outfall / temporary works area construction vessels on passage (All types).	• Unlikely event. • Adequate sea room for vessels to safely take avoiding action in sufficient depth of water.	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries to recreational vessel users • Moderate damage to vessel • Moderate damage to other vessel • Insignificant impact on the environment • Local news coverage • Insignificant port cost

Hazard ID	Hazard	Comments on disposition	Consequence
Haz ID #:18	Grounding/snagging of diffuser by passing vessel (once pipeline/diffuser installed, while tunnel construction continues)	• Assumption – diffuser head has at least 1m water depth at all states of tide and within Order Limits. • Most likely grounding/snagging is with yacht/deeper draught recreational vessel.	**Most likely outcome** • Minor or no injuries • Insignificant or no damage to vessel • Insignificant or no damage other vessel • Insignificant impact on the environment with no lasting effects • Unlikely to generate any adverse publicity • Insignificant port cost **Reasonable worst credible outcome** • Possibility of major injuries • Moderate damage to vessel • Major damage to structure • Insignificant impact on the environment • Local news coverage • Insignificant port cost

Appendix F Lower Thames Crossing ground investigations navigation risk assessment

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Lower Thames Crossing Ground Investigations

Navigational Risk Assessment

River Based Works – Phase 2A Overwater GI

HE540039-PCI-GEN-GEN-REP-GEO-00027

Highways England

Project number: 60602233

10 October 2019

Revision History

Revision	Revision date	Details	Authorized	Name	Position
R01-00	13-Aug-2019	Draft for internal review			
R02-00	16-Aug-2019	Draft for review			
R03-00	10-Oct-2019	Issue for use. No change	[redacted]	Patrick Cox	Director

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Table of Contents

1. Scope of Document

This document provides a record of the marine Navigation Risk Assessment (NRA) undertaken for the over water Ground Investigation (GI) works for the Lower Thames Crossing Project. The over water investigation is planned to commence in September 2019 using 2 jack up barges (JUBs) and supporting attendant vessels operating within Gravesend Reach.

The NRA forms a requirement of the Temporary River Works Licence Application being made to the Port of London Authority (PLA) to understand the effects of the GI on marine safety to navigation.

1.1 Report Structure

The following provides an overview of the report structure:

- Overview of the proposed works, method statements and schedule (Section 2)
- Confirmation of the scope of the Navigation Risk Assessment (Section 3)
- Characterisation of the Study Area with regards to physical site characterisation and the environmental conditions (Section 4)
- Detailed review of navigation in the study area, including review of navigation management, analysis of vessel traffic and incident data (Section 5)
- Stakeholder consultation and a summary of a detailed bridge navigation simulation undertaken with PLA Pilot practitioners is provided in Sections 6 and 7
- Outline of the Navigation Risk Assessment methodology, identification of key hazards and impacts associated with the development (Section 8)
- Discussion and definition of possible additional risk controls (Section 9)
- Full Navigation Risk Assessment of hazards using the adapted PLA's methodology under a baseline scenario and a residual scenario including application of possible risk controls (Section 10)
- Study findings including conclusions and recommendations (Section 11)

1.2 Supporting Documents

This document should be read in conjunction with the following documents

Doc Ref	Doc Title	Notes
HE540039-PCI-GEN-GEN-REP-GEO-00024	Navigation Risk Assessment – Navigation Simulation	
HE540039-PCI-GEN-GEN-REP-SAF-00007	Construction Phase Plan (CPP)	
G3365_MS002	Method Statement Towing, Positioning and Jacking – Aran 120 & Skate 3E	
G3365_MS002	Method Statement Towing, Positioning and Jacking – Aran 120 & 250	
HE540039-CJV-VGT-S3P_BH000000_-SK-VG-00365_WIP10042019	Sketch Location of River Boreholes	Figure 1 of this document
HE540039-PCI-GEN-GEN-PRG-GEO-00007	Programme of Works (inc. Schedule)	

2. Introduction

2.1 Project Description

The Lower Thames Crossing will create a fixed link across the River Thames to the east of London connecting the A2 and the M25. The design of the crossing is based on a bored tunnel under the Thames.

The preferred route announced by the Secretary of State for Transport, and following extensive consultation, involves:

- a new road south of the river which will join the A2 east of Gravesend (the Western Southern Link);
- a bored tunnel crossing under the River Thames east of Gravesend and Tilbury;
- a new road north of the river which will join the M25 London orbital motorway between junctions 29 and 30.

2.2 Ground Investigation Works - Methodology

The Method Statements developed in conjunction with the Construction Phase Plan for the GI is summarised below to provide an overview and context.

The tunnel will be bored by a large diameter Tunnel Boring Machine with mined cross passages for which knowledge of the ground conditions is critical to safety and hence Ground Investigation (GI) works are being undertaken. AECOM, a part of the Perfect Circle JV, is delivering the GI as management contractor (Contractor) with Fugro appointed as the specialist GI subcontractor and provider of the vessels, equipment and operators. Cascade, a joint venture of Arcadis, COWI and Jacobs has been appointed as Technical Partner to Highways England for the project responsible for scheme development and design.

Overwater boreholes advanced by cable percussion and rotary follow-on techniques are to be performed at 25 locations across the river as shown in Figure 1. Final locations will be adjusted require to overcome constraints including potential unexploded ordnance and

archaeology but maintaining the navigational requirements as priority. The boreholes will be drilled to a maximum depth of around 85m below ground level although they may be extended if ground conditions require.

The GI will be undertaken using jack up barges (JUBs) located in the river and manoeuvred by attendant vessels into position where they will be located to each borehole location and remain on station for approximately 4 to 5 days duration.

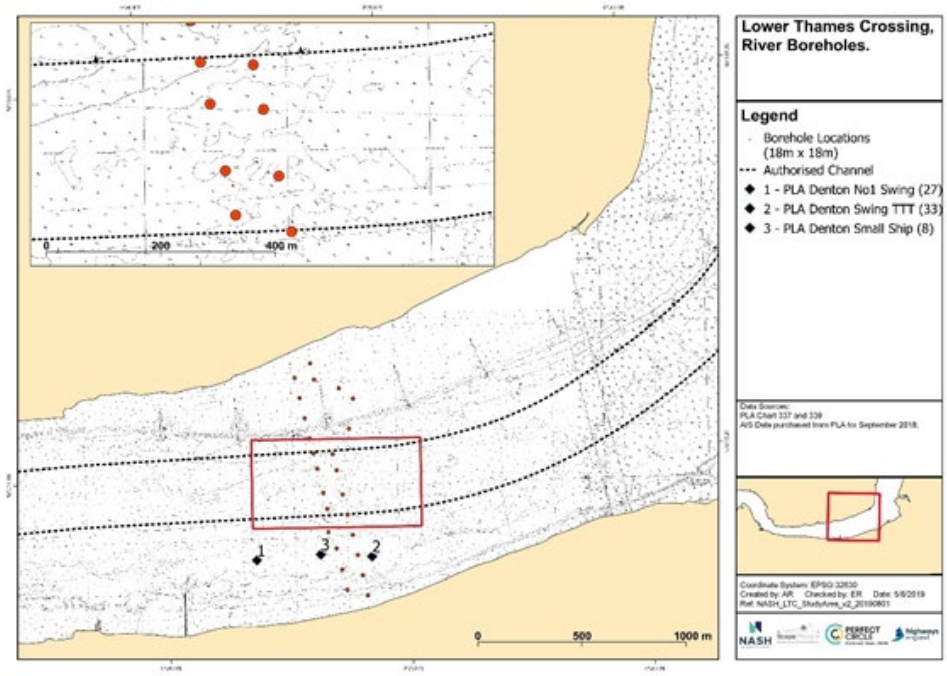

Figure 1: Project Study Area (borehole locations to scale with 18m jack up). Authorised Channel and key mooring locations marked.

For 8 borehole locations, the barges will be operating within the boundaries of the authorised navigation channel as shown in Figure 1:

- Boreholes 15 and 16 on, or near, the northern channel boundary
- Boreholes 13 and 14 located to the north of the channel centreline
- Boreholes 11 and 12 located to the south of channel centre line
- Boreholes 09 and 10 on, or near, the southern channel boundary

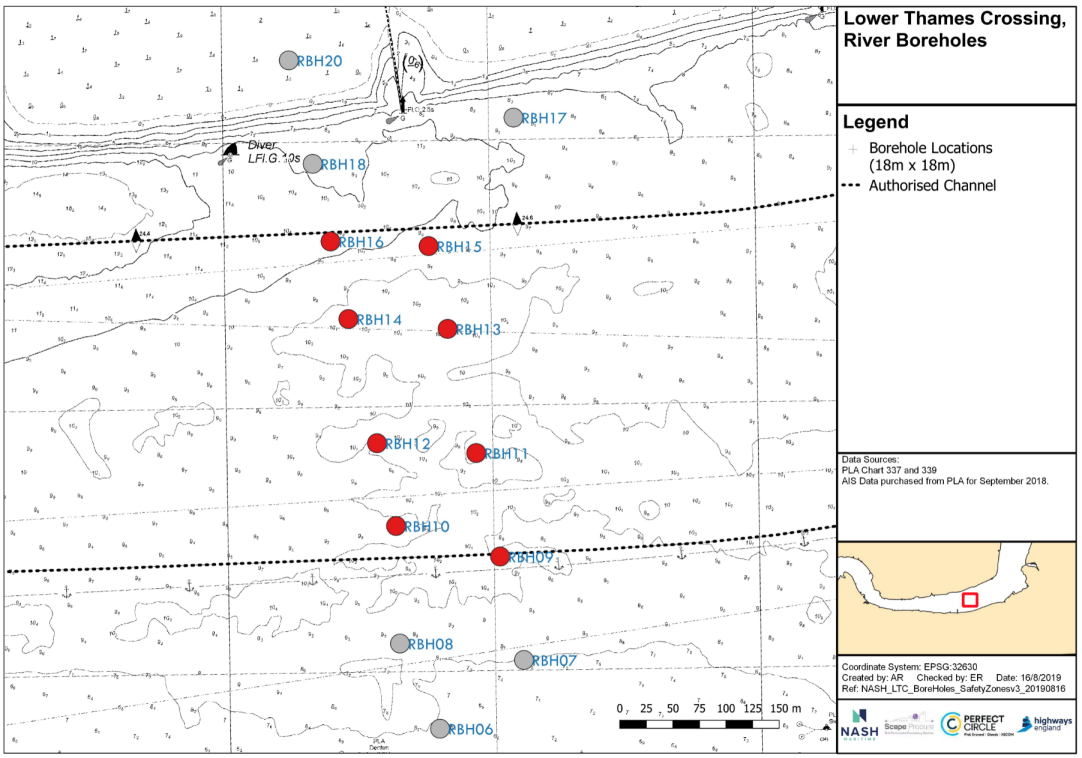

Figure 2: Indicative location of boreholes within navigation channel

2.3 Ground Investigation Works - Schedule

It is anticipated that, subject to licences and procurement, that jack up barges will be mobilised from the Port of Tilbury during w/c 09-Sep and towed to site in order to commence works on 16-Sep. The jack up barges will be working 24 hours a day 7 days a week for approximately 8 weeks, completing in mid Nov. The jack up barges will be on station throughout the works, serviced in situ by attendant vessels and remain at each borehole location for approximately 4 to 5 days.

A schedule for the GI is provided at Ref: HE540039-PCI-GEN-GEN-PRG-GEO-00007 detailing the sequence of works and boreholes which has been optimised to align with the sequencing concepts outlined in Section 9 of this report.

3. Navigation Assessment – Scope and Objectives

The scope of this assessment is to provide an NRA for the GI Works and any impact they may have on safety of navigation, ensuring that the baseline disposition of navigation and marine users is defined, hazards that may arise are identified, risks are assessed (in terms of likelihood and consequence) and risk control measures are proposed considered to ensure that the residual levels of risks are acceptable.

The NRA is intended to meet the requirements of the River Works License (RWL) application requirements of the Port of London Authority (PLA) and Marine Licence. The assessment has therefore been undertaken in line with the simplified PLA Risk Assessment Methodology in order to reflect the temporary nature of the works. More methodological detail is provided at Section 8 and is available on the PLA website (www.pla.co.uk).

4. Study Area

4.1 Site Characterisation and Environmental Conditions

The study area, as shown in Figure 1, is primarily located within 'Gravesend Reach (Lower)' and also extends into the area 'Shornmead to Lower Hope Point' both of which lie within the Lower Tideway district and form the focus of this assessment and are shown on PLA chart No's 337 and 339 respectively.

The study area has intertidal areas to the north and south which dry out at low tidal conditions. There are multiple marine terminals, jetties, slipways and in river moorings from which a variety of craft operate ranging from large commercial through to small recreational craft (as detailed in Section 5). Additionally, other structures are present extending into the river such as groynes on the north shore (to control coastal sediment transport processes) which are marked with navigational lights and shapes. The central portion of the river is dominated by an authorised channel for navigation (indicated by pecked lines on the chart).

4.1.1 Tide and Currents

The tidal ranges are summarised within Table 1. The spring tidal range is 5.86m and the neap tidal range is 3.82m. Tidal flow velocities can exceed 3.5 knots with the ebb (outgoing tide) although typical ebb speeds are in the region of 2 knots. Velocities are often affected by fluvial flows from non-tidal inputs (e.g. heavy rainfall) which can significantly alter river flow velocities and water levels. The bends of the river cause tidal set, generally resulting in flows 'setting' to the outside of a bend.

It is noted that, for the navigation simulation study, default hydrodynamic flows were used in the PLA ship simulator databases which are based on spring tides and therefore form a precautionary approach.

Table 1: Tide Details referred to levels at Denton Wharf (Source: PLA)

Level	Level (m CD)
Highest Astronomic Tide (HAT)	6.97
Mean High Water Springs (MHWS)	6.49
Mean High Water Neaps (MHWN)	5.35
Ordnance Datum (Newlyn)	3.12
Mean Low Water Neaps (MLWN)	1.53
Mean Low Water Springs (MLWS)	0.63
Chart Datum	0

4.1.2 Wind

Gravesend Reach is relatively exposed, with low topography along banks of the river and therefore wind, particularly cross winds, are an important consideration for navigation in this area.

4.1.3 Waves

Locally wind generated and fetch limited waves occur within the reach. These do not affect large vessel operations although smaller craft operations can be impacted.

5. Navigation in the Study Area

The following sections provide an overview of navigation management and vessel traffic in the study area.

5.1 Navigation Overview

Gravesend Reach is used by a wide variety of vessel types including general cargo vessels, tankers, ro-ro vessels, and less regular users such as cruise ships and naval vessels. A defined authorised navigation channel is marked on Admiralty and PLA charts as shown in Figure 1.

There is also a pilot boarding area located in the western extent of the study area, with vessels approaching, slowing and manoeuvring to board and land pilots from a dedicated pilot launch service.

Recreational vessels such as yachts, and motor boats also operate in Gravesend Reach which has a number of small local yacht and sailing clubs located along its banks. The recommended track is to the northern side.

5.2 Navigation Management – Port of London Authority

The PLA is the Statutory Harbour Authority (SHA) and Competent Harbour Authority (CHA) for the River Thames, responsible for "*defining and enforcing the regulations needed to support and manage the safety of navigation on the 95 miles of the tidal River Thames*". Gravesend Reach is located within the Lower District of the PLA with the Harbour Master Lower holding responsibility for navigational safety between Crossness in the west and the seaward limit of the PLA SHA area to the East in the outer Thames Estuary.

It is noted that additionally the Port of Tilbury have a localised SHA responsibility for the Port of Tilbury (within the enclosed Tilbury Lock) and Tilbury2 (3 river berths currently under construction at the former Tilbury Power Station). Both these locations are located to the west of the GI area. The Ports of Tilbury and Tilbury2 have no CHA responsibility encompassed within the PLA responsibility.

The PLA Harbour Master Lower is responsible for the management of navigation safety in on the River Thames and implementing regulation, guidance and administering risk control measures aimed at managing navigation risk and safety within the study area.

The PLA publish their regulations, codes of practice and other general guidance on their website (www.pla.co.uk) and include the following:

- Port of London Act 1968
- Port of London Thames Byelaws 2012
- General Directions for Navigation in the Port of London 2016
- Pilotage Directions 2017
- Code of Practice for Craft Towage Operations on the Thames
- Code of Practice for Rowing & Paddling on the Tidal Thames
- Recreational Users Guide
- Other codes of practice for mooring, berth operators etc.

The PLA also provide other measures to maintain safety of navigation which include:

- Vessel Traffic Services including vessel traffic management and navigational assistance
- Promulgation of information such as Notice to Mariners and Navigation Warnings
- Provision and maintenance of Aids to Navigation

- Hydrographic Services
- Harbour Service Launches and patrols
- Emergency preparedness and response.

5.3 Data Sources

AIS data was acquired from the PLA as a primary source of understanding vessel traffic. AIS data broadcasts information over VHF radio frequency such as vessel name, type, size, and dynamic information on position, course and speed. Thames AIS is mandated on all vessels in excess of 50 tonne gross tonnage, tugs engaged in towing and commercial passenger vessels but may be carried voluntarily by smaller recreational craft - the data is collected and stored by the PLA.

To ensure the AIS data sourced was seasonally representative and accounted for tidal variation, the AIS data period utilised for the assessment was from 10th to 23rd September 2018. To supplement those vessels who are not mandated/do not carry AIS (and therefore absent or underrepresented in the AIS vessel traffic analysis) reference is made to relevant codes of practice from the PLA, expert understanding and stakeholder consultation.

Analysis of vessel traffic density for all vessels is presented in **Figure 3**, which shows that the majority of vessels are transiting within the authorised channel in the centre of the river. During the data period the vessel “Thame” can be seen conducting surveys to the north and south of the authorised channel and in the vicinity of the site. These have been removed in subsequent plots and analysis to avoid any distortion of data and subsequent interpretation.

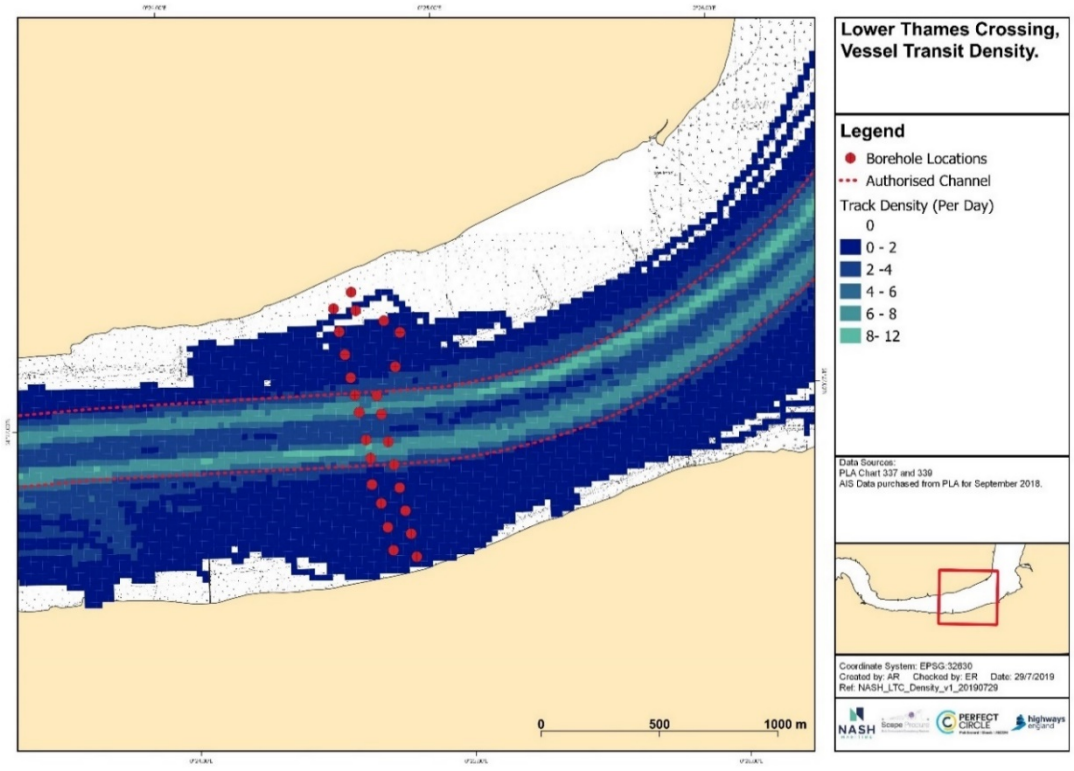

Figure 3: Vessel track density in vicinity of Lower Thames Crossing (including survey vessel tracks to the north and south of the authorised channel).

5.4 Vessel Traffic Types

Analysis has been undertaken of vessels, by vessel type, for consideration in the assessment.

Figure 4 shows the tracks of inland freight and cargo vessels (Cory, GPS, Tideway tug and tows as well as Polla Rose [Thames Shipping], James Prior etc...). The majority of tracks in this reach are

keeping to the edges of the authorised channel or are using the moorings on the south side of the channel.

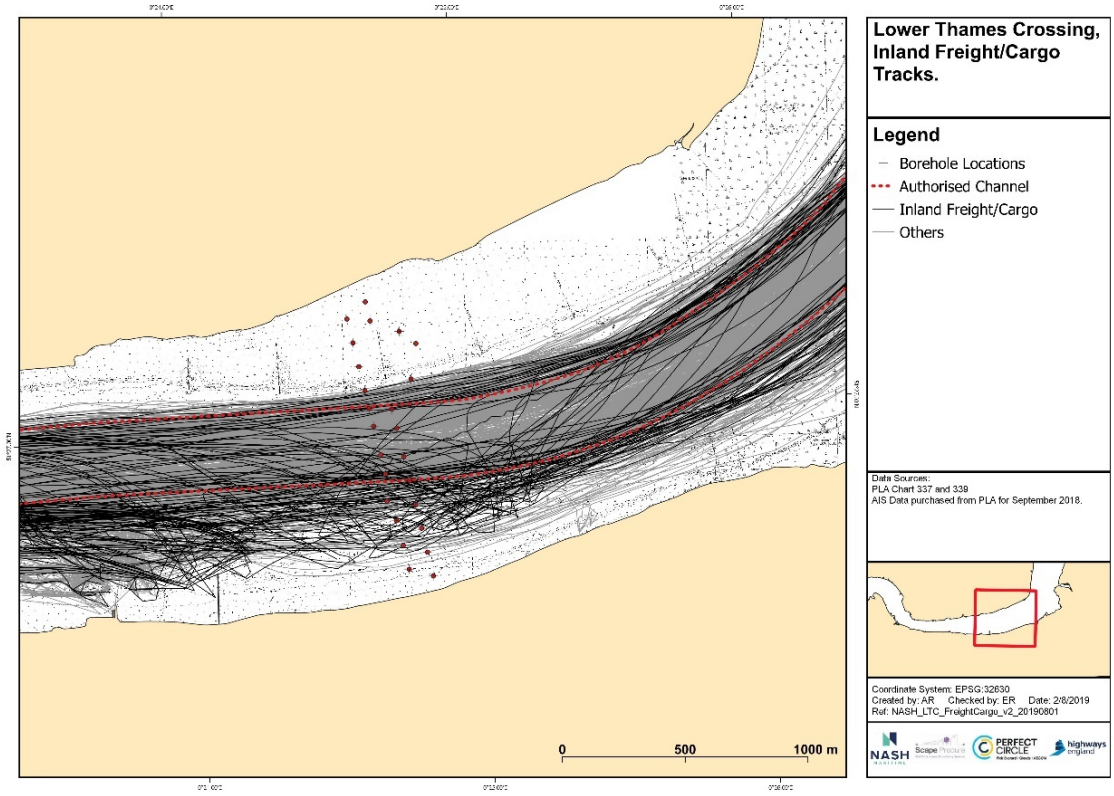

Figure 4: Inland Freight/Cargo Tracks.

Figure 5 shows the tracks of inland passenger vessels (Thames Clippers, sight-seeing vessels etc.). Whilst they are a dominant vessel type in much of the upper reaches, only three transits were recorded passed the project site, namely the Jacob Marley (15m) and the Princess Pocahontas (33m). The Storm Clipper was recorded berthing at Denton Wharf several times, though this is not a scheduled service stop.

Figure 6 gives the tracks of those recreational craft in the study area which carry AIS (estimated to be between 10% and 30%). Smaller craft such as dinghies and rowing boats would not carry AIS and therefore are not represented. Recreational craft passing through this reach of the river would be in transit further upstream, with a minority stopping at locations in this reach. It is noted that many of the recreation craft operate at the boundaries, or outside, the authorised channel – utilising sea room away from larger vessels. Recreation sailing and rowing craft operate out of Gravesend Sailing club and Gravesend Rowing Club, to the west of the GI works. Both Clubs operate safety guidance and rules.

Sailing activities are centred on the weekend, ending in October with scheduled dinghy racing generally on alternate Sundays (01-Sep, 15, Sep, 29-Sep, 13-Oct) and scheduled cruiser (keelboat) events generally on alternate Saturdays 07-Sep, 21-Sep, 28-Sep and 06-Oct) as shown at http://www.gravesendsc.org.uk/. Some members sail outside of these times.

Rowing activities operate from Gravesend Rowing Club. Mid-week rowing is held all year round at 1830 on Wednesdays and Thursdays for juniors and adults respectively **[HOLD – check hours of darkness restriction]** and weekend rowing is scheduled all year round at 1000 on Saturdays and Sundays for juniors and adults respectively. As per the website (http://www.gravesendrc.co.uk) the rowing area does not usually extend beyond Customs Pier or Lower Hope Point without agreement from the club captain or safety adviser and it is advised not to cross the river into the deep (authorised) channel during standard training outings. Generally, rowers stay 50m or 20m from the shore depending on the tidal direction and typically keep inside the jetties

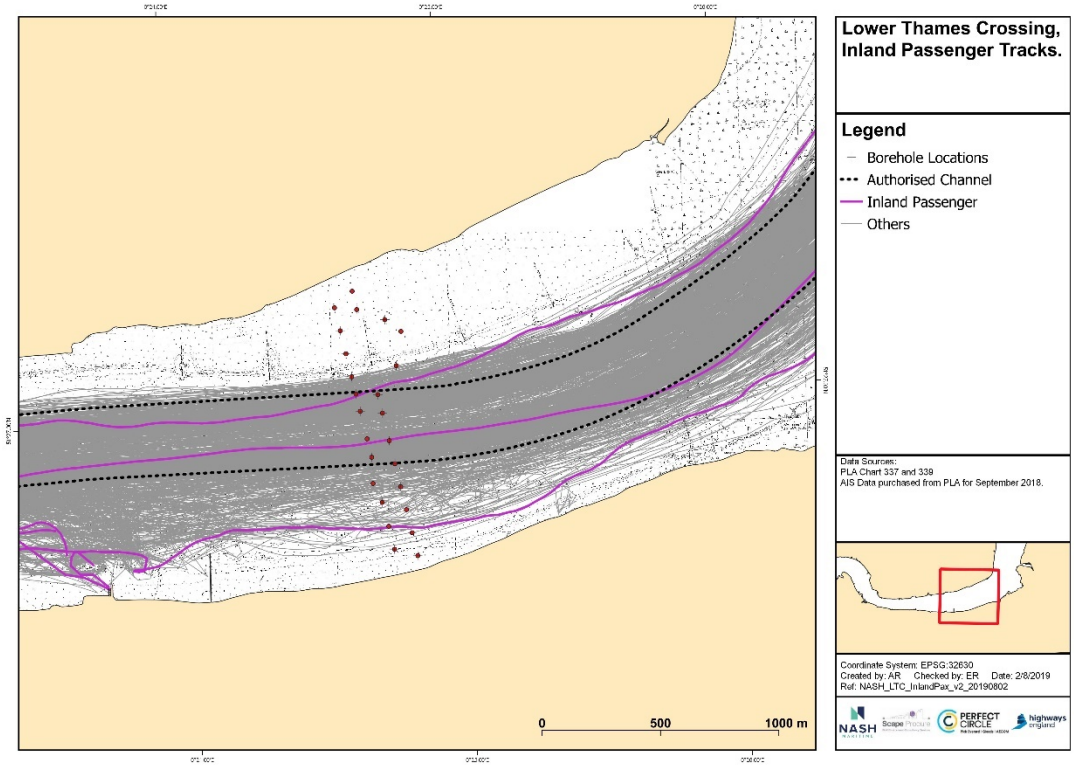

Figure 5: Inland Passenger Vessel Tracks.

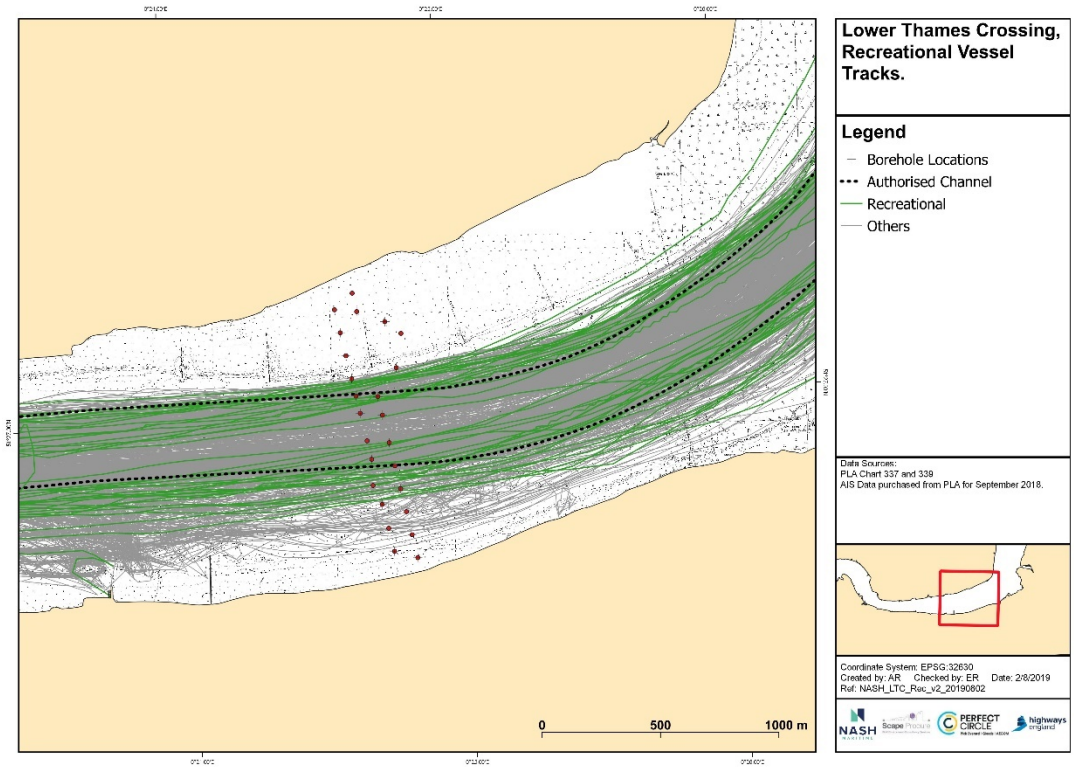

Figure 6: Recreational Vessel Tracks.

Figure 7 and **Figure 8** show the transits of seagoing commercial shipping and seagoing passenger vessels respectively. There is a significant volume of large vessels transiting this reach of the river, to berths further upstream of the study area. Six cruise ships were recorded during the 14 days of data, with lengths between 133m and 245m. Isolated tracks shown outside of the authorised navigational channel are, on investigation, seen to be dredger vessels.

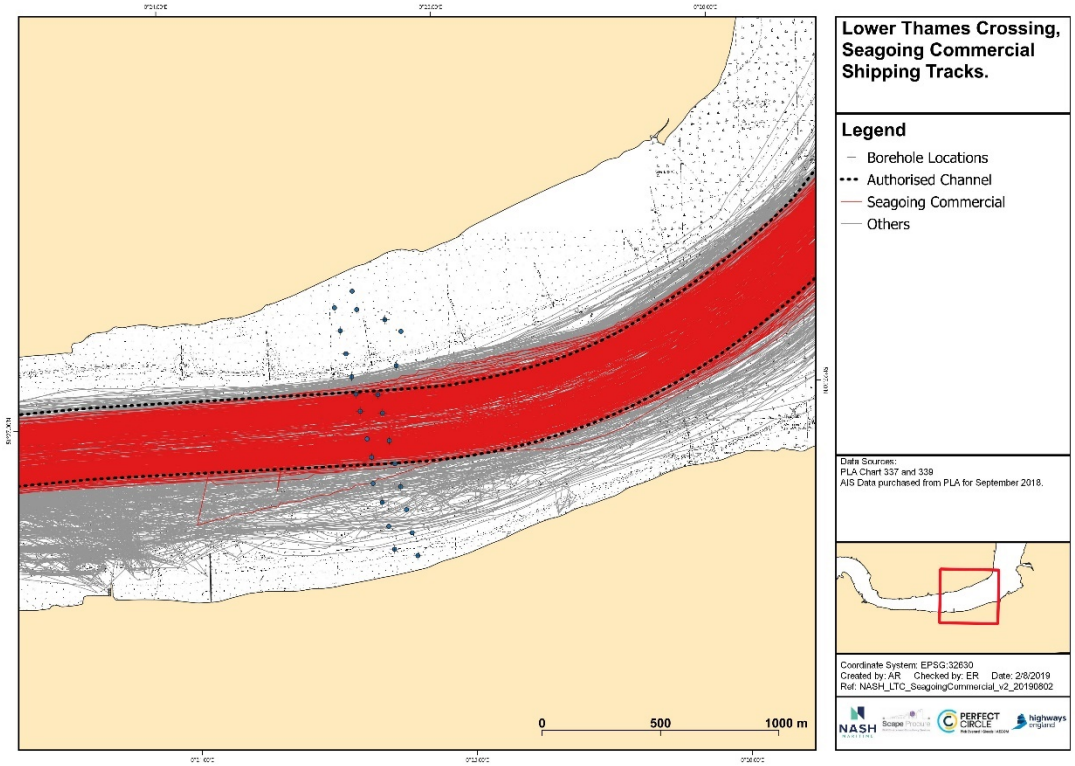

Figure 7: Seagoing Commercial Vessel Tracks.

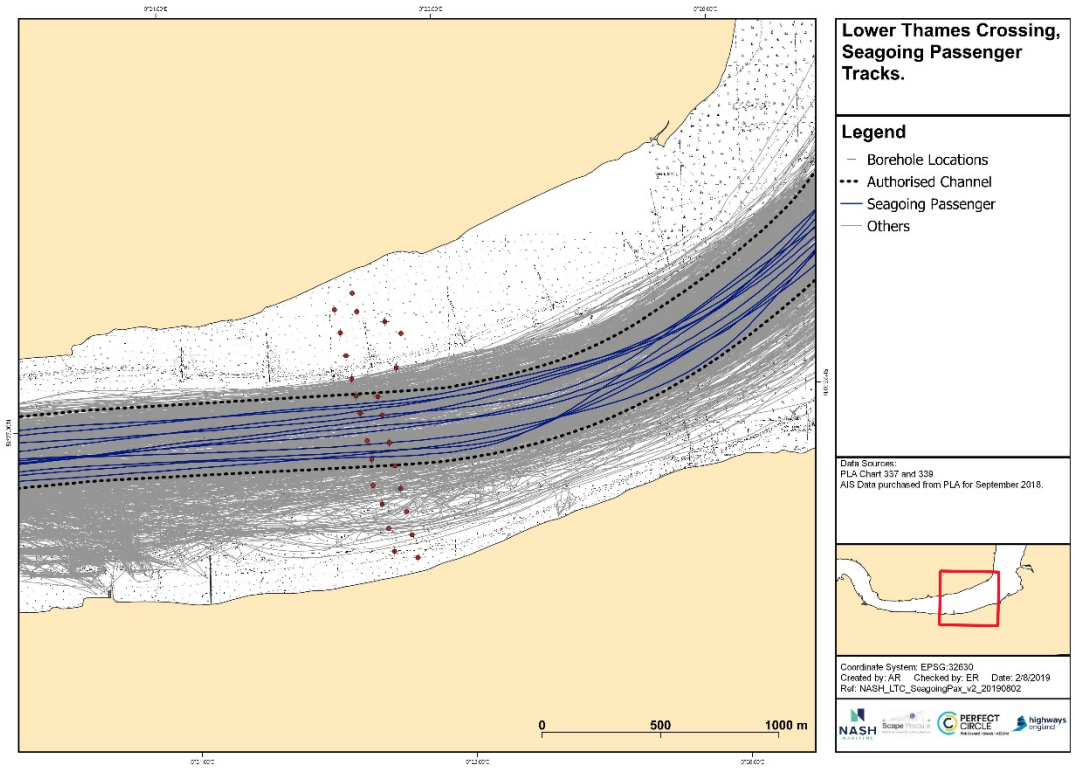

Figure 8: Seagoing Passenger Vessel Tracks.

Figure 9 shows the tracks of tugs and service vessels, commercial vessels not discussed above. There is significant activity of this vessel type in this reach, with tugs, RNLI lifeboats and PLA launches contributing to the key vessel types and a prevalent usage in and out of Denton Wharf which provides boat maintenance and operations support to PLA and other marine users.

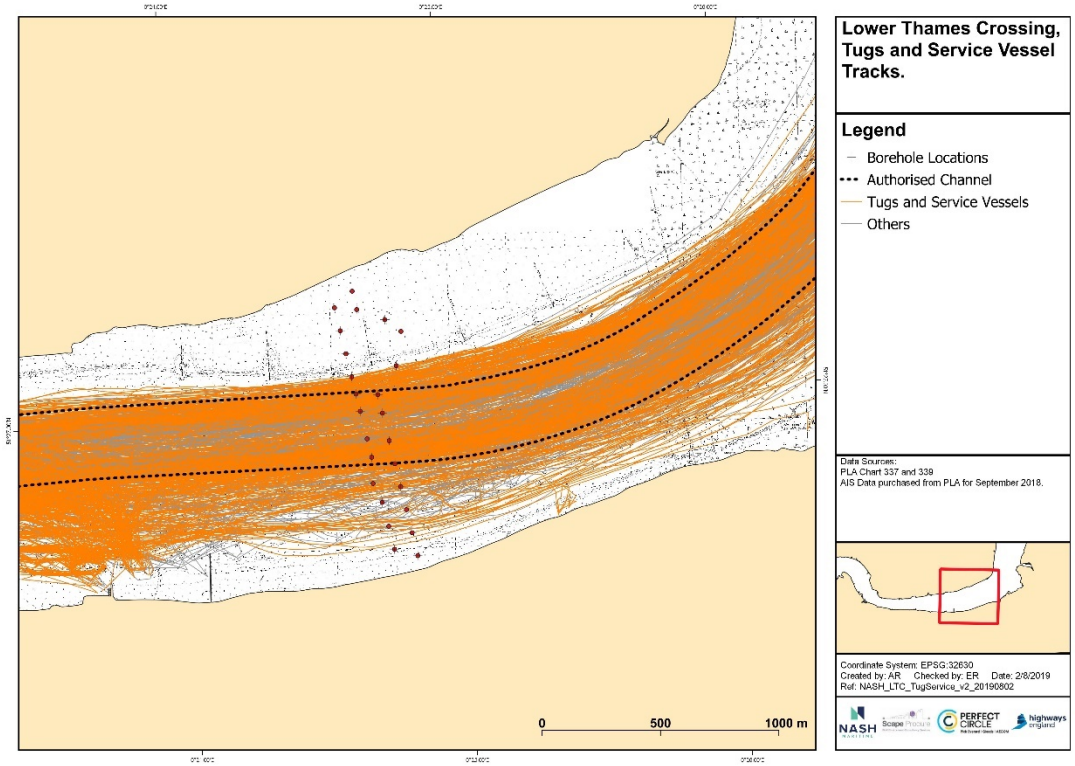

Figure 9: Tugs, Service vessels craft tracks.

Figure 10 describes the tracks by vessel length with the larger vessels keeping to the authorised channel. It should also be noted that smaller vessels are transiting further outside of the authorised channel to the south than the north, due to the shallow waters and groynes to the north.

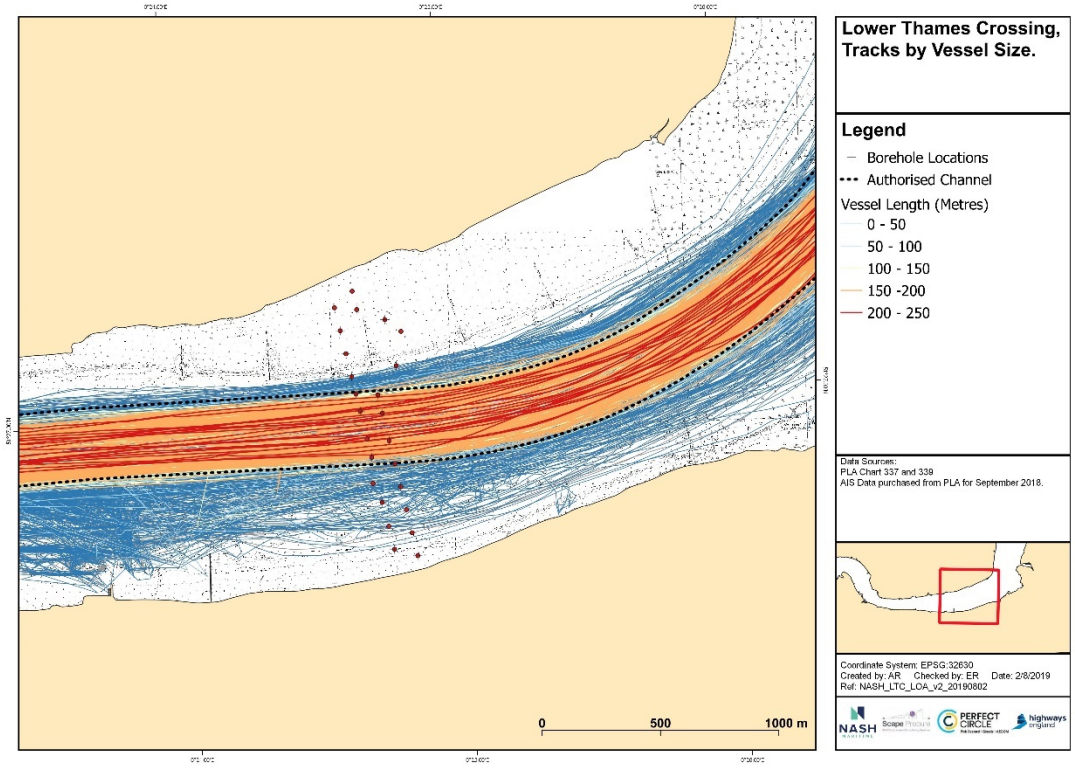

Figure 10: Vessel tracks by length overall.

5.5 Transit Counts and Distribution

To provide more detailed statistics on vessel types and frequency passing the project site, a transit gate was conducted and is presented in **Figure 11**. The plot shows the key distribution with vessels keeping to the starboard side of the authorised channel and fewer transits outside the channel limits.

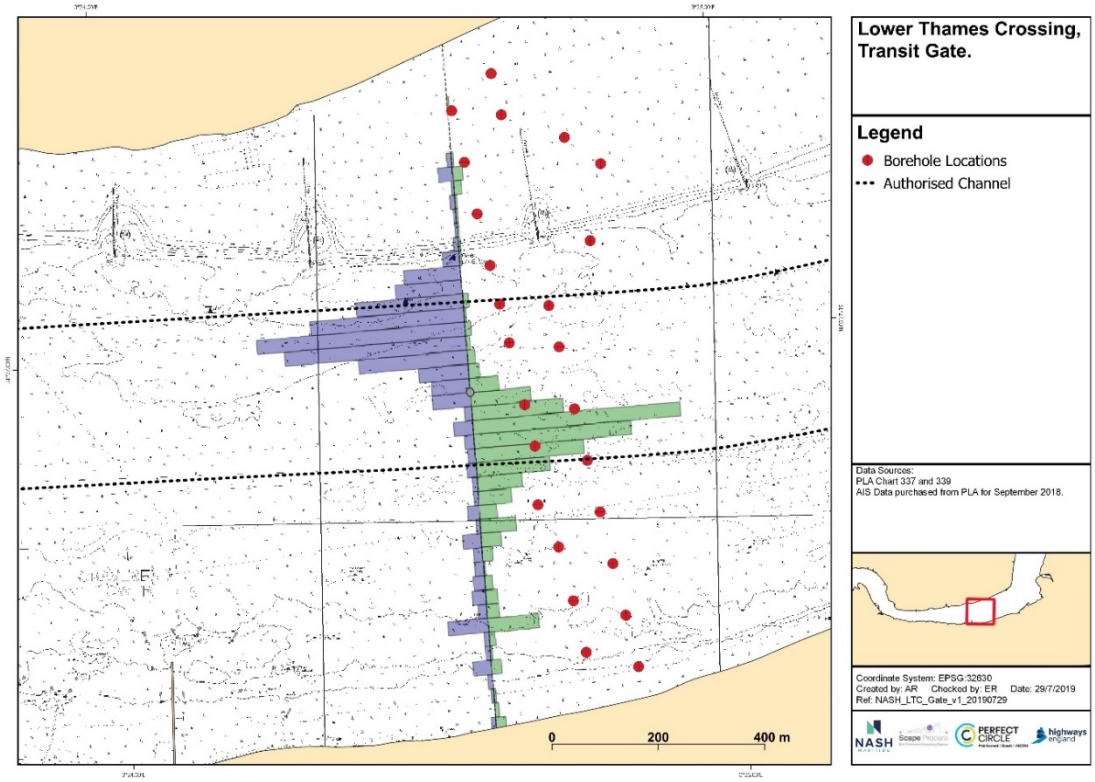

Figure 11: Transit gate at Lower Thames Crossing.

The transits through this gate are broken down by date (**Figure 12**), hour (**Figure 13**), vessel type (**Figure 14**) and vessel length (**Figure 15**). Transits per day have high variability between 42 and 111 with some degree of reduced transits on weekends. The number of transits per hour is also highly variable between 1.5 and 3.9 per hour, with little discernible pattern.

Figure 14 and **Figure 15** demonstrate that large commercial vessels are the most frequent vessel type transiting this reach. A large proportion of these transits are dredgers at approximately 100m LOA. The largest vessels to transit this reach are the 245m Columbus cruise ship and the 242m container vessel Hanjin Kaohsiung.

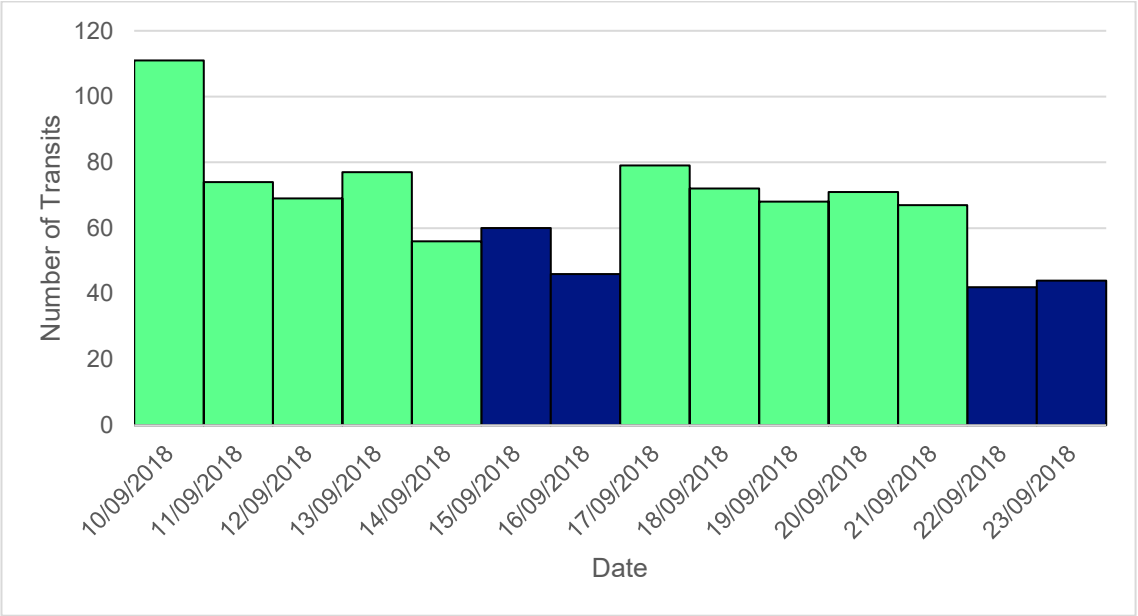

Figure 12: Transit by day.

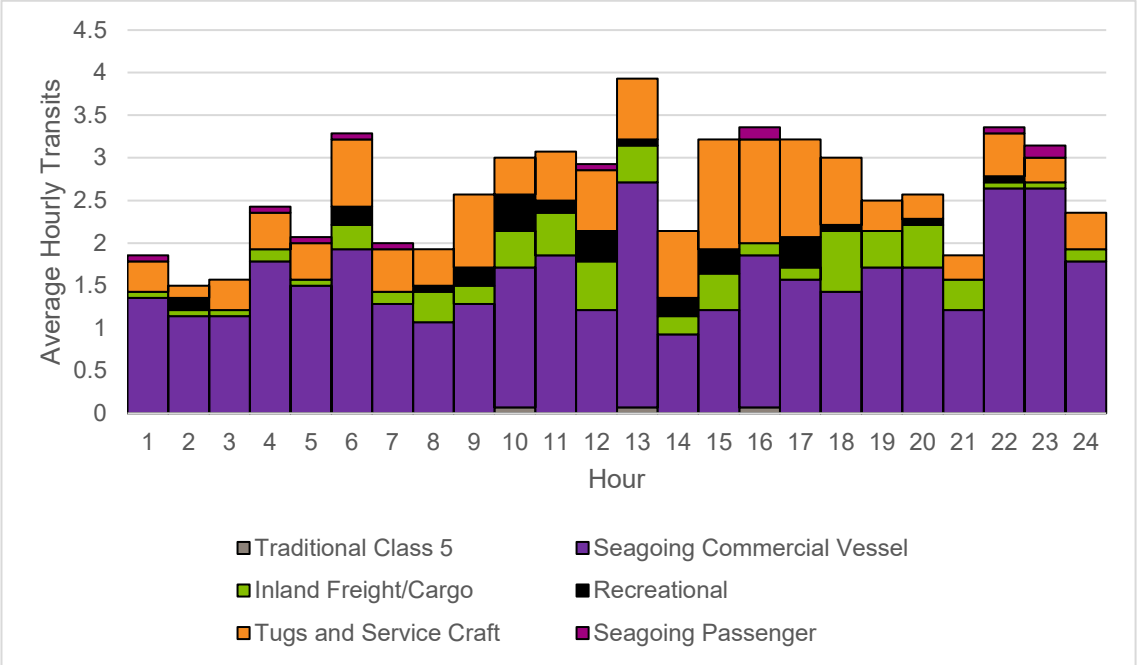

Figure 13: Transit by hour.

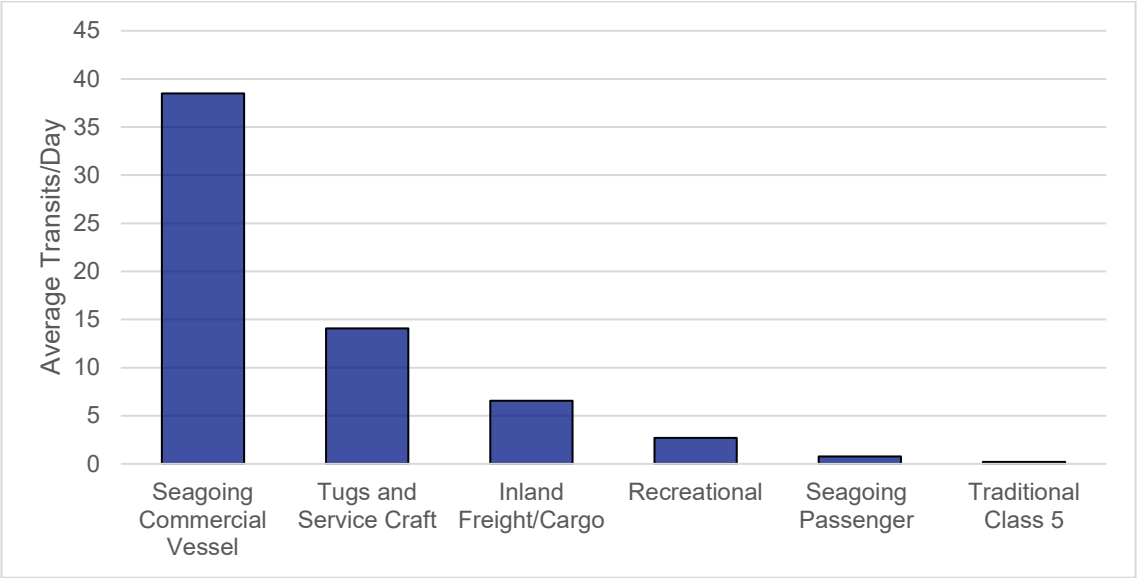

Figure 14: Transits by vessel type.

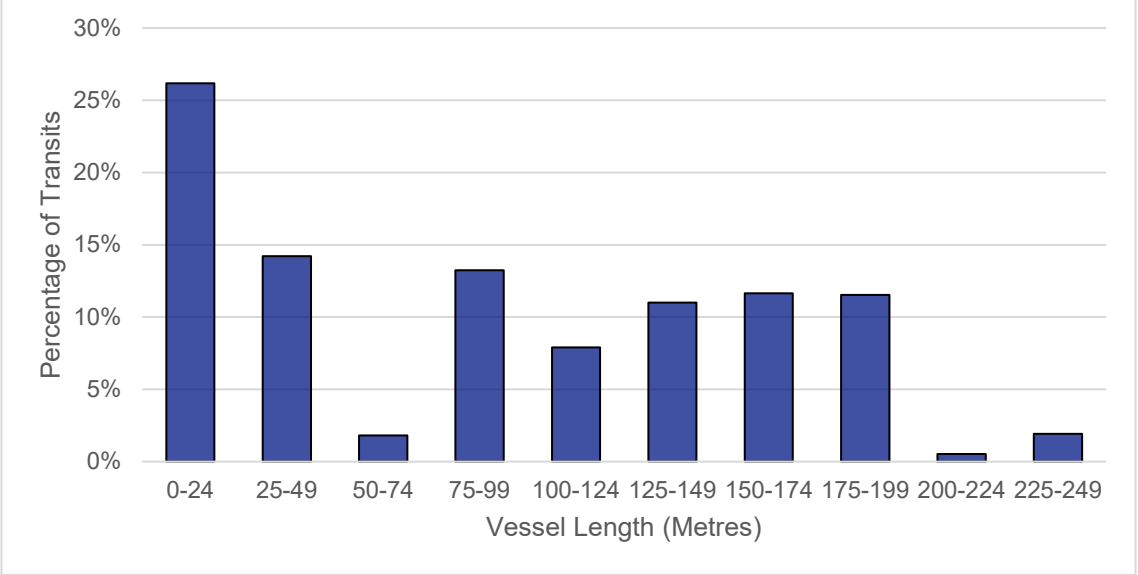

Figure 15: Vessel tracks by length.

5.6 Tidal Height Analysis

Figure 16 investigates the tidal state of transit of seagoing commercial and passenger vessels. The PLA tidal data for Tilbury was joined to the transit time to analyse whether there was a correlation for transiting large commercial vessels at certain states of the tide. The analysis shows that in general inbound transits are more common on the flood or at high water, and outbound transits are more common on the ebb and at low water.

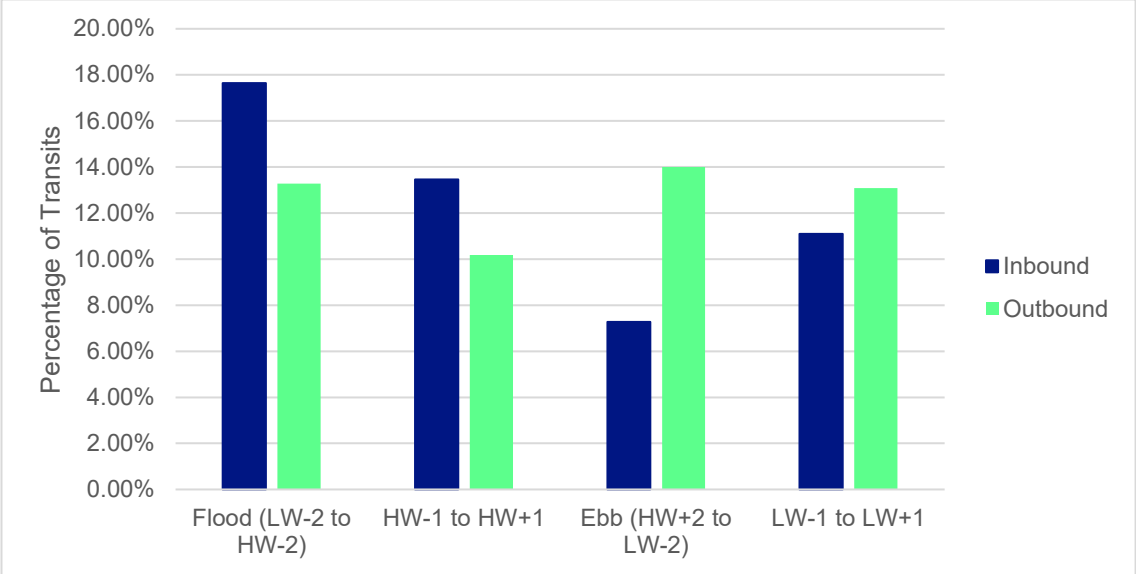

Figure 16: Vessel tracks by tidal state in circa 3 hr periods (Seagoing Commercial and Passenger Only).

5.7 Incidents within Study Area

The PLA Incident database was analysed to identify trends of incidents within the vicinity of Lower Thames Crossing. The PLA database was filtered to “Lower Hope Reach” and “Gravesend Reach”. Whilst this extends some distance from the immediate study area, it provides a greater number of representative incidents.

Figure 17 shows the number of incidents per year and demonstrates a change in reporting method in 2013. For the last five years of data, the number of incidents per year has averaged at 41. When analysed monthly, there is some evidence of a summer peak in incidents, likely associated with increased leisure users on the river (**Figure 18**).

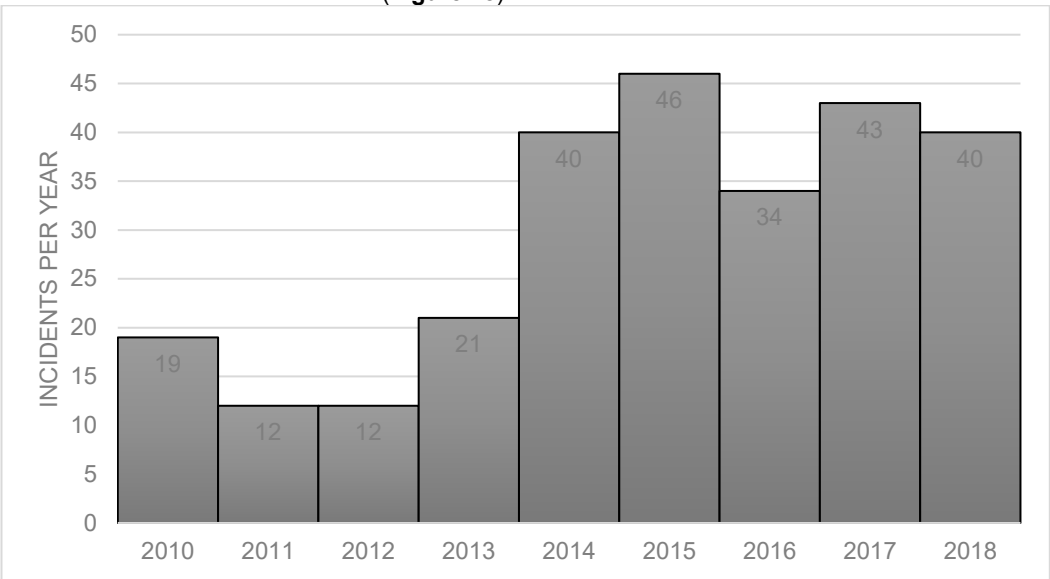

Figure 17: Incidents per year within study area.

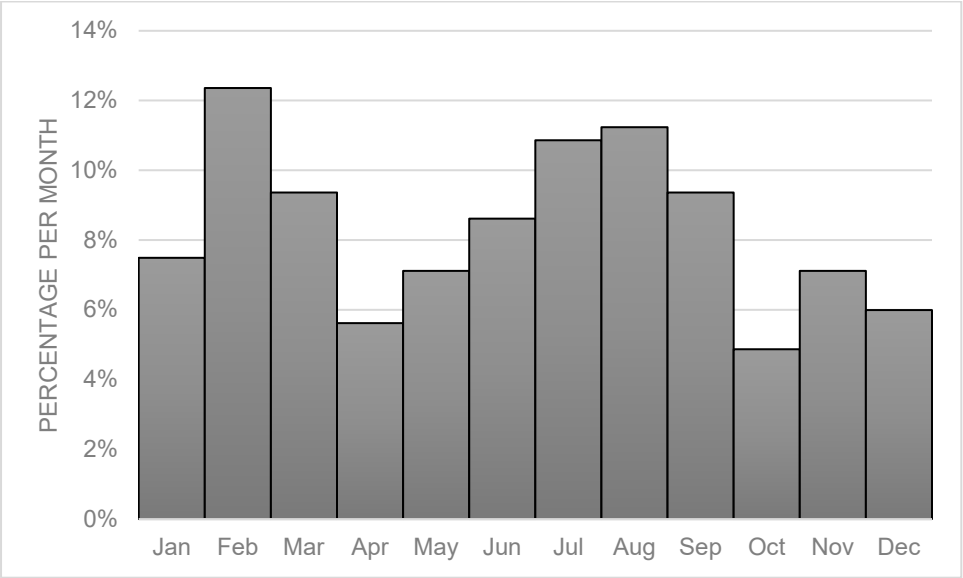

Figure 18: Proportion of incidents by month.

Figure 19 breaks down the incidents since 2014 by vessel type and incident type. The majority of incidents (24%) are classed as other and include pollution, man overboard and floating hazards. For navigational hazards, grounding is the most common incident type (21%) with few collisions (7%) and contacts (4%). Commercial shipping account for the majority of incidents (64%), though Section 5 has demonstrated that this vessel type accounts for 61% of the transits.

These incidents are plotted in Figure 20. The greatest concentration of incidents is to the west of the study area, in the vicinity of Tilbury Landing Stage and Terrace Pier.

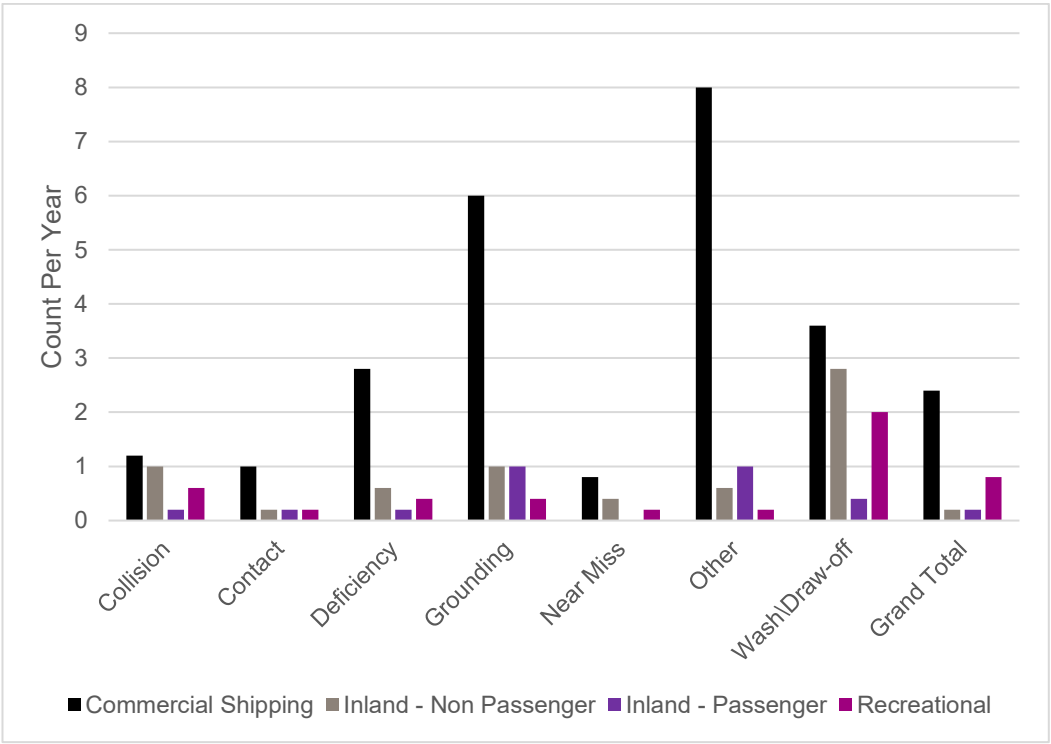

Figure 19: Incidents per year by vessel type and incident category.

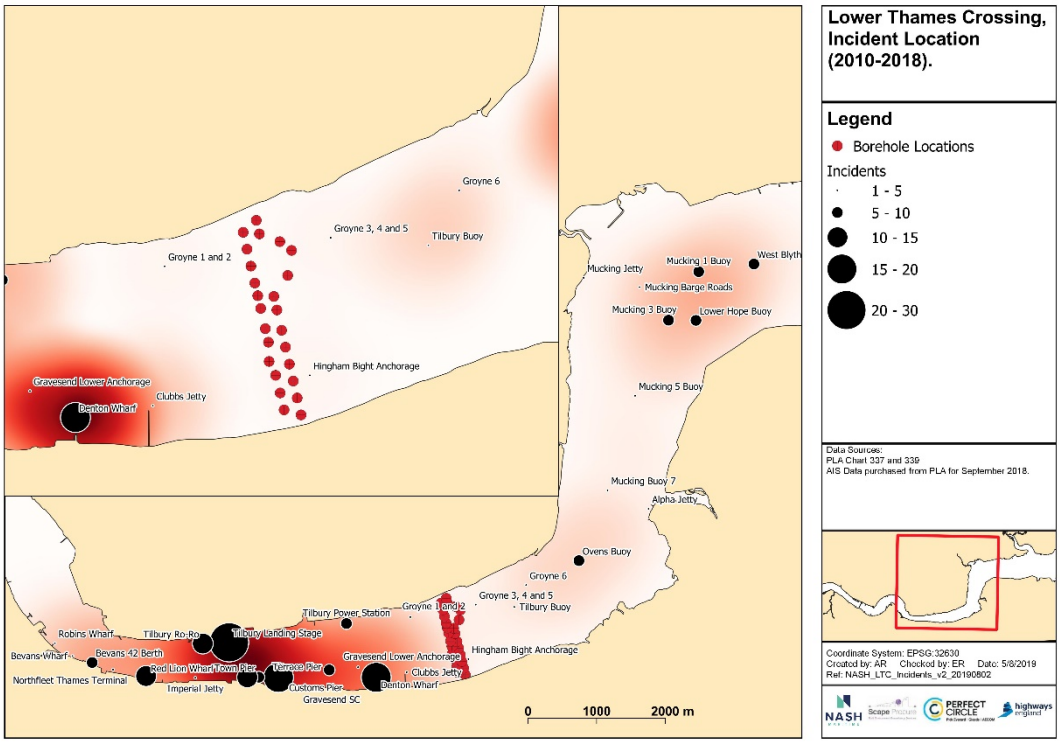

Figure 20: Locations of incidents in PLA database.

5.8 Incident Rates

In order to benchmark the risk profile of vessels in the study area, the incident analysis has been combined with the transit gate to calculate incident rates per movement (Figure 21). These rates use the 2014-2018 incident data between the former Tilbury Power Station and Mucking Buoy 7 and annualised passage figures for the 10th – 23rd September dataset.

Recreational vessels have the highest incident rates, likely the result of being under-represented in the AIS data. Most other vessel types have low incident rates less than 5 x 10^{-5} or one incident in every 20,000 transits.

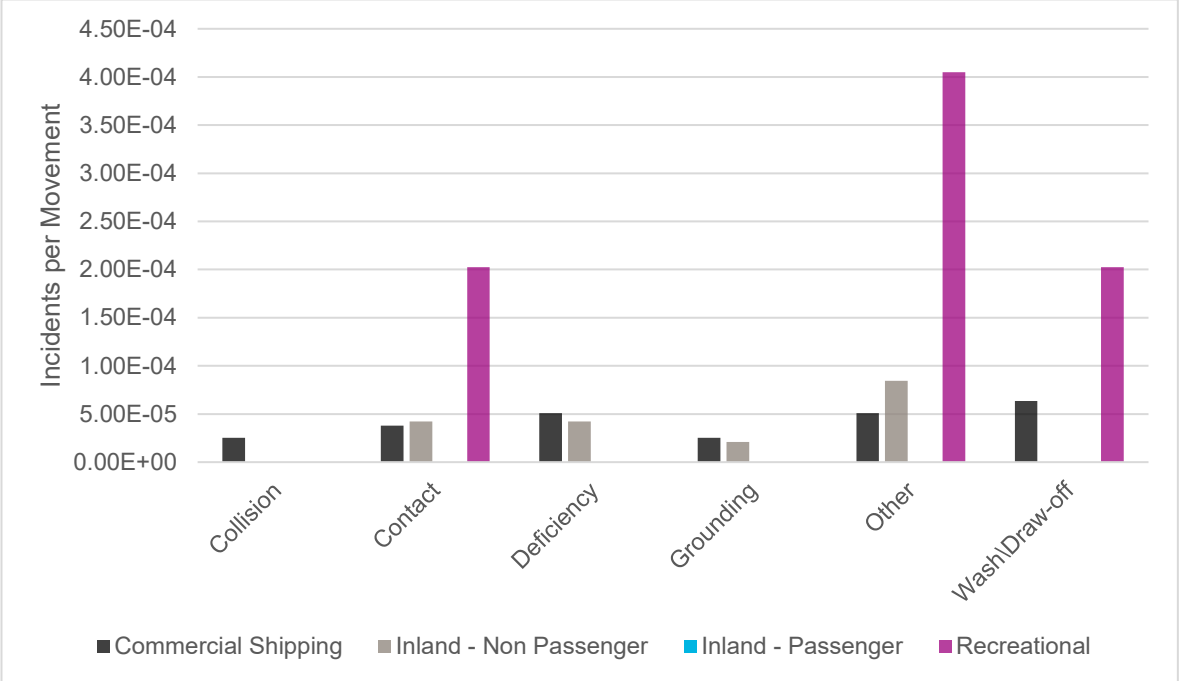

Figure 21: Incidents per Movement between (former) Tilbury Power Station and Mucking Buoy 7) from 2014 onwards.

5.9 Future Vessel Traffic

In 2016, the PLA launched the Thames Vision which sets a number of goals for future vessel traffic on the river for 2035. Within this vision the following relevant goals for vessel traffic were identified. The vision identifies a specific target to increase participation in sport and recreation on and alongside the water.

No increase in traffic forecast is considered necessary for this assessment given the short duration of these temporary works.

6. Stakeholder Consultation

In order to ascertain valuable local knowledge of navigation in Gravesend Reach and the potential impacts of the project, it is important to seek and consider input from organisations and stakeholders who regularly operate in the area. Consultees were identified as per Table 2 with the PLA and a letter was provided by the Client by email informing stakeholders of the project and inviting consultation. An example letter is provided at Appendix A.

Of the 7 consultees, only one formal written response was received (RYA) and therefore, in order to elicit feedback, follow up attempts were made to contact all consultees by telephone. Key and common themes emerging from written and telephone consultation with all non PLA organisations is summarised below:

- All consultees expressed a strong preference for communication and sharing of information on the planned activities by the Contractor so that, where possible, the consultees could plan own activities accordingly.
- Two consultees requested to have a clear point of contact within the Contractor organisation to ensure liaison could be maintained.
- Port of Tilbury noted that, where traffic management/control was required, it was important to seek to minimise any commercial delay to vessels proceeding to and from their port. They also sought to ensure that passing vessel speeds had been considered and in context of wind and visibility constraints (this was facilitated through the navigation simulation as reported in Section 7.
- Tilbury2 Construction team noted no specific concern other than a number of project cargo moves and deliveries being undertaken to their site during the period of works.

The RYA response, received by email on 15-Jul-2019 included the following statements:

- *The boreholes will be made using a jack- up barge and only when its in the navigation channel will it be an issue for shipping.*
- *The PLA propose to use a one way traffic system as necessary.*
- *The recommended route for leisure vessels is to cross the fairway in Lower Hope Reach well below the tunnel works.*
- *Information should be available via NTMs, and also on VHF Ch 68.*
- *We would consider it appropriate that our regional network continue to represent our interests at relevant meetings, etc.*

In light of the extent of consultation response received, the project team incorporated the input and also reviewed the consultee activities closely with the PLA at the preliminary meeting held on 09-August-2019 to ensure the activities of stakeholders had been appropriately considered within the overall assessment.

Table 2: Stakeholder Consultation

Stakeholder	Consultation undertaken
Port of London Authority	Navigation Simulation and 2 x Meeting
Port of Tilbury	Telephone
Tilbury2	Telephone
Gravesend Sailing Club	Telephone
Gravesend Rowing Club	No response
National Sea Training Centre	No response
Royal Yachting Association	Written Response

7. Bridge Navigation Simulation

A full bridge navigation simulation was undertaken at an early stage of this assessment and in order to interrogate the perceived key hazard to large commercial vessels and particularly during the period of works when JUB's are located within the authorised channel. This is reported at Document Ref: HE540039-PCI-GEN-GEN-REP-GEO-00024 although a summary is provided below.

A total of 27 simulations were completed. The simulations took a structured and precautionary approach, considering wind directions of up to 35kts from north/south (cross channel), flood/ebb tide, arrival/departure and with a range of ship types, sizes and manoeuvrability.

The simulations demonstrated that larger ships could pass jack up barges located at all borehole positions in adverse tidal flow conditions and 35 knots steady wind speeds. A minimum clearance distance of 100m to the relevant jack up barge was identified at all borehole locations.

The simulations clearly demonstrated that two-way ship operations should not be permitted in the channel when jack up barges are positioned at the 4 central bore locations. There was considered to be potential for two-way ship operations to be carried out safely at reduced wind speeds when jack up barges are positioned on the channel boundaries (although this was agreed to require further review and assessment). A number of other risk controls were considered and discussed or tested within the simulations and carried forward to the NRA.

7.1 Simulation Analysis

Figures 22 to Figure 24 showing selected cumulative swept paths from the simulations (full swept paths for each simulation run are provided at Appendix C of HE540039-PCI-GEN-GEN-REP-GEO-00024) with each of the borehole locations showing the swept path footprint of simulated vessels together with the 100m exclusion zone/passing distance from each JUB. The use of the boundary of the southern authorised channel is noted with respect to Figure 23.

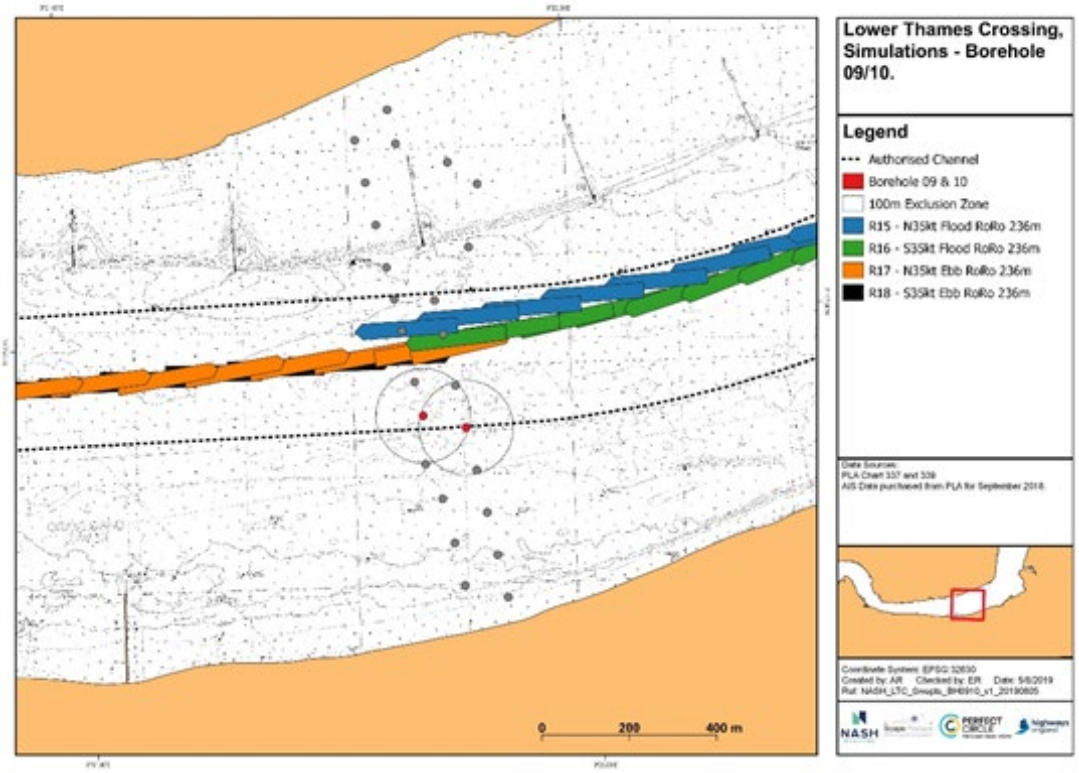

Figure 22: Swept Path from Simulations with Borehole 9 and 10.

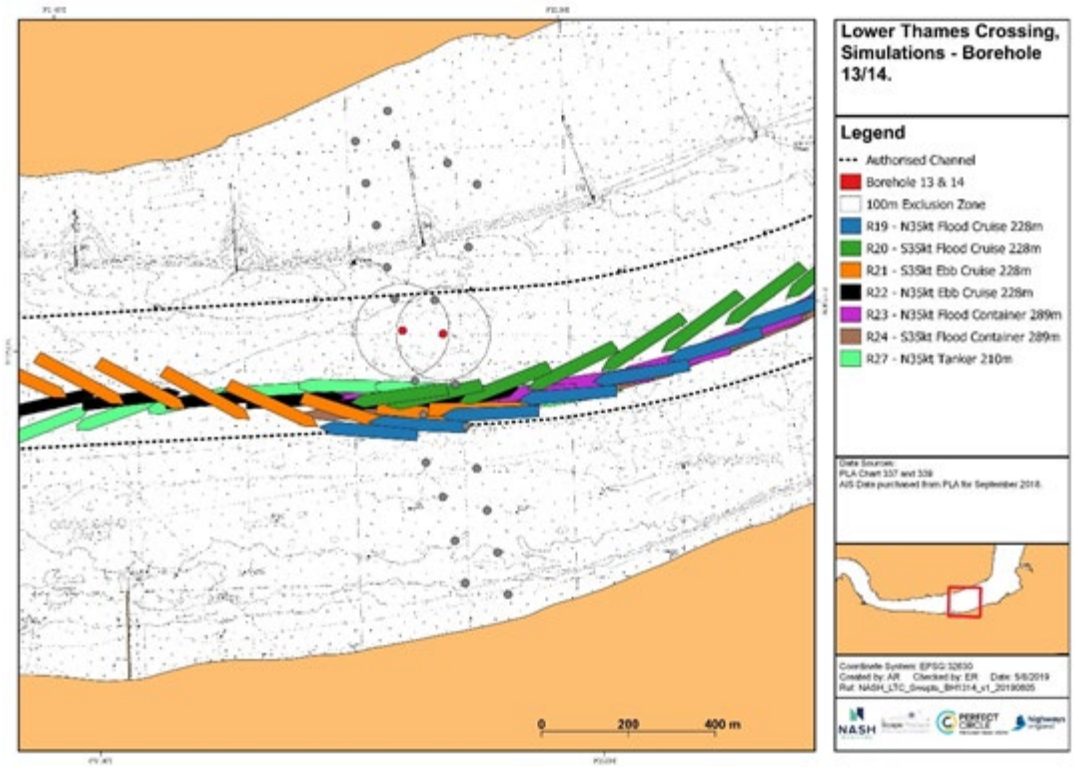

Figure 23: Swept Path from Simulations with Borehole 13 and 14.

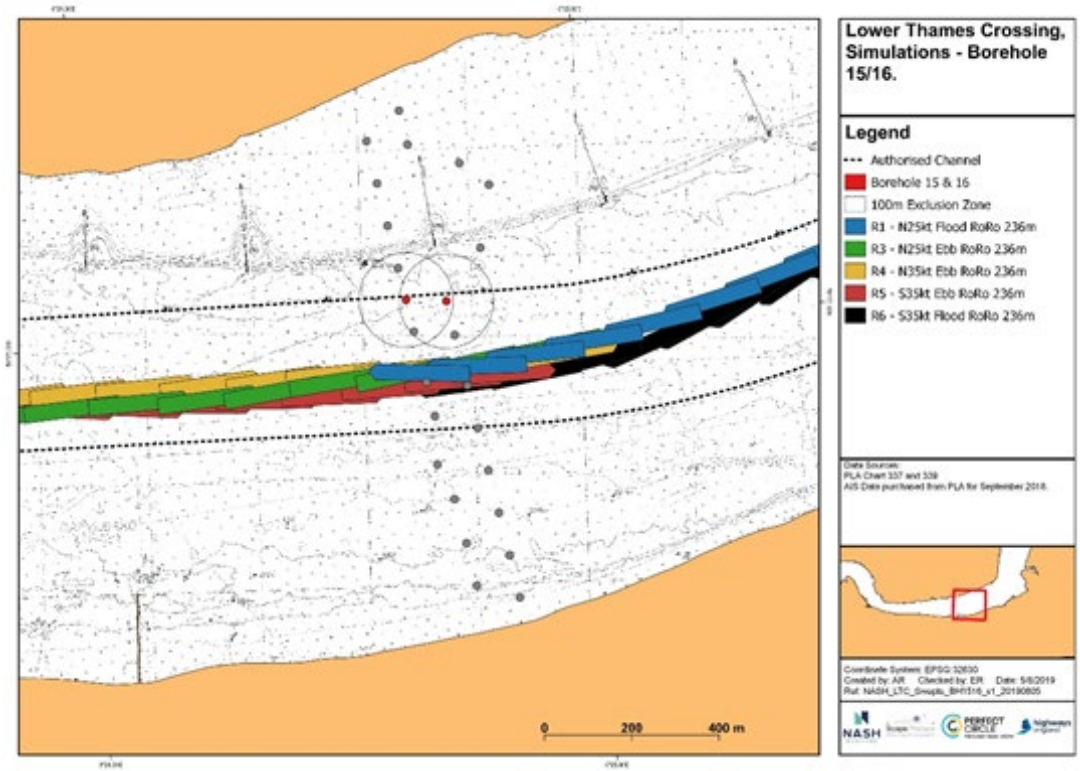

Figure 24: Swept Path from Simulations with Borehole 15 and 16

8. Navigation Risk Assessment Methodology

The PLA have developed a standardised NRA methodology for River Works Licence applications which has been adopted as the basis for this assessment in order to reflect the relatively short duration of the works and complexity.

The methodology follows the principles and guidelines of the Port Marine Safety Code (PMSC) and its associated Guide to Good Practice, as well as the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) methodology for risk assessments. It comprises the following stages (see Table 3).

The methodology uses the following definitions:

- Risk is a measure of the likelihood and consequence of a hazard occurring
- Hazard is an occurrence that can create an unsafe situation.
- Initial (Baseline) Risk is a measure of risk prior to additional risk controls being added (i.e. existing risk controls are considered included/embedded within this assessment)
- Residual Risk is a measure of risk once additional risk controls have been added that were not in place at the time of the assessment

8.1 Assessment of Risk

Risk is the product of the consequence and the likelihood of an unwanted event – a Hazard. The IMO Guidelines define a hazard as "*something with the potential to cause harm, loss or injury*", the realisation of which results in an incident or accident. The potential for a hazard to be realised can be combined with an estimated or known consequence of outcome. This combination is termed 'risk'. Risk is therefore a measure of the likelihood and consequence of a particular hazard occurring.

To assess frequency and, to a lesser extent, consequence, it is necessary to use a combination of historical incident (including near miss data), local stakeholder judgement, vessel traffic analysis and professional judgement of the project personnel.

The combination of consequence and frequency of occurrence of a hazard, to produce a risk score, is undertaken using a risk matrix (see Table 3 which enables hazards to be scored and ranked). The resulting scale can be divided into three general categories as informed by the grading shown in Table 3 and Table 4:

- Acceptable
- As Low As Reasonably Practicable (ALARP)
- Intolerable

The PLA, as the statutory harbour authority implement and maintain a wide range of strategic and local risk controls within an overarching navigation risk register to reduce, manage and maintain navigation risk and marine safety. This NRA is premised on the ongoing administration of these risk controls which are therefore considered embedded within the baseline risk assessment.

8.2 Risk Reduction

Risk controls aim to reduce the risk of a hazard and can affect both the likelihood or consequence of that hazard (for example buoyage reduces the likelihood of vessel grounding whereas lifeboats can be said to reduce the consequences if a grounding occurs). It is possible to estimate or calculate the effectiveness a risk control is at reducing the risk of a hazard occurring and thereby determine risk control effectiveness. This is beneficial in determining the merits (either absolute or relative) of implementing risk controls, which can also lead on to effective cost benefit analysis.

Table 3: PLA's Risk Assessment Matrix.

RISK ASSESSMENT MATRIX: RISK CRITERIA		FREQUENCY				
		Level 1	Level 2	Level 3	Level 4	Level 5
		Rare	Unlikely	Possible	Likely	Almost Certain
		Very unlikely / Has rarely occurred in industry	Unlikely	Possible to occur	Could likely to occur during works	Will occur during works
Consequence	5 – Loss of vessel or severe damage to vessel. Multiple fatalities International news coverage. Serious long-term impact on environment and/or permanent damage.	Moderate (5)	High (10)	Extreme (15)	Extreme (20)	Extreme (25)
	4 – Major damage to vessel. Single Fatality. National news coverage. Significant impact on environment with medium to long term effects	Minor (4)	Moderate (8)	High (12)	Extreme (16)	Extreme (20)
	3 – Moderate damage to vessel. Moderate / major injury Regional news coverage. Limited impact on environment with short-term or long-term effects	Minor (3)	Moderate (6)	Moderate (9)	High (12)	Extreme (15)
	2 - Minor or superficial damage to vessel. Minor injuries and local news coverage. Minor impact on environment with no lasting effects	Slight (2)	Minor (4)	Moderate (6)	Moderate (8)	High (10)
	1 - Insignificant or no damage to vessel / equipment. No injuries. Insignificant impact on environment	Slight (1)	Slight (2)	Minor (3)	Minor (4)	Moderate (5)

Table 4: Action Key

ACTION KEY		
	Slight (1 – 2)	No Action is required
	Minor (3 – 4)	No additional controls are required, monitoring is required to ensure no changes in circumstances
	Moderate (5 – 9)	Efforts should be made to reduce risk to 'As low as reasonably practicable' (ALARP), but activity may be undertaken
	High (10 – 14)	Efforts should be made to reduce risk to 'As low as reasonably practicable' (ALARP). Activity can only be undertaken with further additional controls.
	Extreme (15 – 25)	Intolerable risk. Activity not authorised

The effectiveness of additional risk controls is assessed against a nominal scale, which applies differing percentage reductions, based on their estimated effectiveness. The percentage reduction is then made to either / or both, the likelihood or consequence values, essentially entailing a further calculation using the risk matrix, and a "residual" risk score is calculated.

As an example, take a hazard with a consequence score equivalent to £100,000. An additional risk control judged to reduce the consequence of this hazard by 20% will generate a residual consequence value, equivalent to £80,000, and the risk matrix is used to determine the residual risk score. The combined risk score in terms of likelihood and consequence is calculated the same as for baseline risk.

The application of additional risk control measures is assessed using a compound calculation. From the example above, a further risk control could be applied at 20%, which would reduce the consequence cost, from £80,000 to £64,000. A third risk control, with 10% effectiveness, would reduce the same property cost from £64,000 to £57,600, and so on. The residual risk score, with all these risk control measures in place, would therefore utilise the £57,600 consequence value in the calculation of risk. In terms of the final risk score the order that risk controls are added does not effect the final score.

It should be noted that as risk by definition is a non-dimensional number (being a combination of likeliness and consequence), as, for example, a 50% reduction in frequency of hazard occurrence will not result in a 50% reduction in risk, because no similar reduction in consequences has been applied.

Also, it can be difficult to determine the exact effectiveness of risk controls in a dynamic and changing system such as a port, and, as such, a significant degree of subjectivity is commonly used where quantitative methods are not available or are prohibitively expensive to assess. However, given that a standardised framework is applied across all hazards, then the resulting scores can be used to judge the relative and absolute merits of implementing additional risk controls.

8.3 Hazard Identification

As noted above, a hazard is defined by IMO as "*something with the potential to cause harm, loss or injury*" and is an important element of the definition of 'risk' which is a combination of the likelihood of that hazard occurring combined with the consequence.

Hazard identification follows a structured and logical process to ensure that hazards of appropriate likelihood (ranging from common to potential hazards) and consequence are considered.

8.3.1 Hazard Categories

Following a review of the GI operations, vessel traffic and incidents in Lower Hope Reach and Gravesend Reach and consultation with local stakeholders, the project team categorised hazards as shown in Table 5 which are considered relevant.

Table 5: Hazard Categories

Hazard Category	Definition
Collison	When two or more vessels make physical contact with each other whilst underway
Contact	When one or more vessel makes physical contact with a fixed structure or moored object (e.g. JUB in location, buoy or moored vessel)
Grounding	When a vessel makes unintended contact with the seabed or riverbed

8.3.2 Vessel Categories

In order to appropriately focus the assessment, the project team grouped vessel types (as analysed in Section 5.3) into 4 key vessel types relevant to the assessment and based on usage of the study area

as shown in Table 6. Notable, with respect to larger vessels, was a delineation based on whether the vessel is subject to pilotage in accordance with the PLA Pilotage Directions 2017.

Table 6: Vessel Categories

ID	Vessel Type	Grouped Vessel Type for Risk Assessment
1	JUB & Attendant Vessels	JUB & Attendant Vessels in location
2	Inland Freight/Cargo	Small Commercial Vessels
3	Inland Passenger Vessel	Small Commercial Vessels
4	Recreational Vessel	Recreational Vessels
5	Seagoing Commercial Vessel	Vessels subject to compulsory pilotage (>80m, >50m Specified Vessels) - "Piloted vessel"
6	Seagoing Passenger Vessel	Vessels subject to compulsory pilotage (>80m, >50m Specified Vessels) - "Piloted vessel"
7	Tug and Service Vessel	Small Commercial Vessels

8.3.3 Identified Hazards

It was determined to assess two principle scenarios given the differentiation of risk with each profile and with respect to risk to navigation.

- Scenario 1: When 1 or more JUB's are on location within the authorised channel
- Scenario 2: When 1 or more JUB's are on location outside the authorised channel

Consideration of when the JUB's are on transit to/from the site (during mobilisation and demobilisation) and during shifting and jacking is presented within the Contractor document HE540039-PCI-GEN-GEN-REP-SAF-00007.

When considered in relation to each of the vessel types and hazard types there are therefore a total of 18 individual hazards identified which are summarised in Figure 25 (9 hazards for Scenario 1 and Scenario 2).

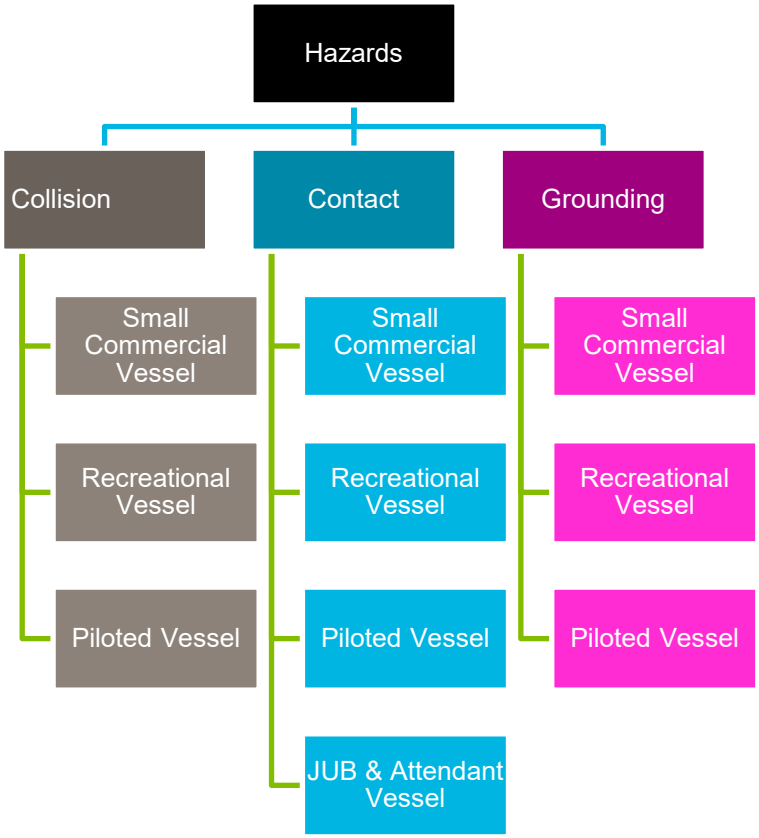

Figure 25: Hazard Types

Table 7 summarises the existing hazards and possible impacts of the works on navigational safety in Gravesend Reach, whether positive or negative.

Table 7: Potential Impacts in Gravesend Reach

Hazard	Existing Causes of Hazards	Potential Impact of Works on Existing Risks
Collison	Master/skipper error Excessive speed Density of traffic Incorrect use of authorised channel/adherence to CoP Steering/Mechanical Failure Adverse conditions/visibility	JUB condenses vessel traffic into reduced area of river width leading to a collision Maneuvering vessels on/off JUB and to/from layby mooring impede other vessels Increase in vessel traffic in vicinity of site
Contact	Master/skipper error Excessive speed Density of traffic Steering/Mechanical Failure Adverse conditions/visibility Avoidance of another vessel	Passing vessels contact JUB or other fixed structures Avoidance of manoeuvring vessels results in contact with JUB or other fixed structure Vessels alongside at JUB and/or layby mooring impede passing vessels
Grounding	Master/skipper error Steering/Mechanical Failure Misjudgement of tide Avoidance of another vessel	Vessel grounds as a result of avoiding JUB or other associated vessels. Vessel grounds as a results of increased passing distances

8.4 Hazard Scoring

A hazard scoring workshop was convened by Nash Maritime personnel, in which each of the identified hazards, were scored for hazard likelihood and hazard consequence, using the PLA methodology and based on:

- Review of project description
- Review of vessel traffic analysis data
- Review of bridge navigation simulation exercise
- Review of vessel traffic incident data
- Review of consultation meetings with local stakeholders and PLA
- Expertise of project personnel

The workshop was undertaken based on a structured approach as follows:

- Map identified hazards into the adapted PLA Excel Risk Assessment Proforma Template
- Review credible hazard outcomes
- Review hazard causes
- Assess hazard likelihood
- Assess hazard consequence
- Score hazards for “Baseline Assessment” - marine works with no risk controls in place
- Review identified risk controls measures for inclusion and applicability for each individual hazard.
- Score hazard for “Residual Assessment” - marine works with risk controls in place

9. Risk Control Measures

Risk controls aim to reduce the risk of a hazard and can affect both the likelihood or consequence of that hazard. Risk controls, additional to those that will be adopted as standard were identified through a combination of stakeholder consultation, expert judgement and industry knowledge and experience.

This section identifies and defines the optional additional risk controls that could be implemented to reduce risk levels to acceptable levels of ALARP or lower. Description includes qualitative commentary on the contribution of each risk control to risk reduction in terms of likelihood or consequence.

Risk Controls are summarised within Appendix B.

9.1 RC ID #1 - Safety Boat

The GI Contractor intends to utilise one Oyster RIB per JUB to provide safety boat, rescue boat and crew boat services (together with attendant support during JUB jacking/moving operations). At 6.8m length, 2.7m beam and with a shallow draught the vessels are able to operate in deep and shallow water and provide rapid response. The safety boat will operate from Denton Wharf and be moored alongside or recovered onto the JUB when not in use with a suitable response time.

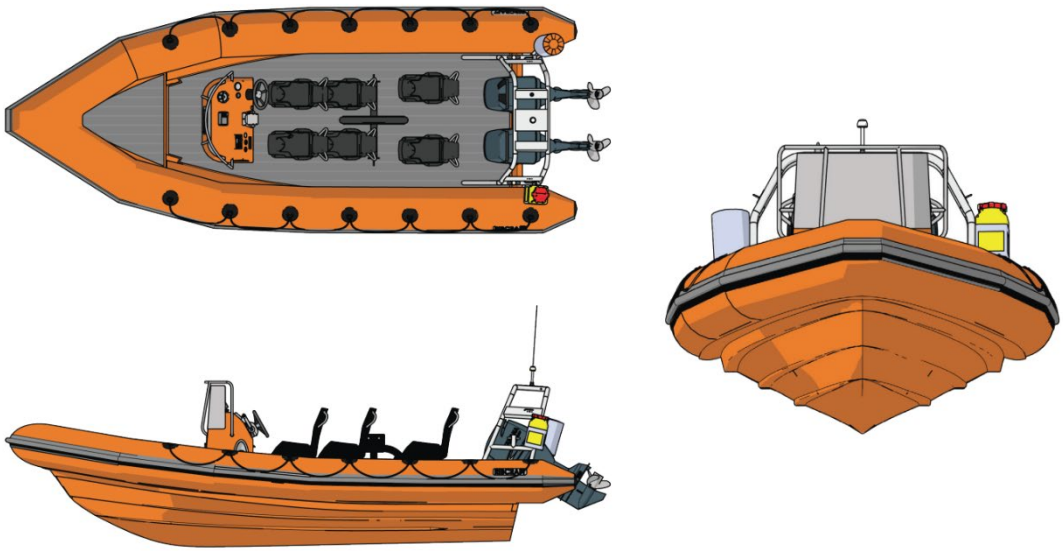

Figure 26: Safety Boat: Oyster RIB (Source: Fugro)

Based on a PLA supplied specification a Safety Boat would be:

- Focused on the alerting of Category 1 and Category 2 responders in event of persons or objects falling into river from the works
- To be MCA coded Cat D or to PLA Specification
- To provides a recovery response for falling persons
- Not to provide local control navigation or guard duties
- In full communication with works contractors and the appropriate PLA VTS Control Centre
- To alert works contractors of impending breach of non intrusion area by errant craft
- Generally sited downstream of the protected works or moored downstream of the protected works with an agreed response time from notification to deployment
- Shallow draught, low freeboard (for rescue of recreational craft and persons) and equipped with basis safety equipment

- Crewed by 2 persons with the minimum qualifications of RYA Safety Boat Certificate for the helmsman/person in charge and the second person being RYA Power Boat Level 2 or International Certificate of Competence (ICC)

This risk control is considered to reduce the consequence in the event of a hazard occurring.

9.2 RC ID #2 - Exclusion Zone / Minimum Safe Passing Distance

The concept of an exclusion zone from the JUB and a minimum passing distance of transiting vessels was identified at an early stage with the PLA, particularly in relation to periods when the JUB's are located within the authorised channel and the potential of contact risk is heightened. Initial qualitative judgements of between 50m and 100m were considered with 50m being considered likely to be marginal. Passing distances were explored and assessed within the PLA bridge simulator, as reported separately, and then subsequently reviewed with the Contractor .

A minimum passing distance of 100m from the JUB to all vessels is proposed (when the JUB is in position and during any shifting/jacking operations) which strikes a balance between an appropriate safety zone together with ensuring that sufficient sea room is maintained to safely manoeuvre large (and smaller) vessels. This shall be represented as an exclusion zone, applicable at all times and to all vessels and will likely be communicated through NTM's.

During consultation with the PLA and the GI Contractor it was proposed that, whilst 100m shall apply to borehole locations within the authorised channel, this could be kept under review with an option to reduce the zone to 50m for boreholes outside the authorised channel recognising that large commercial vessels do not routinely navigate outside the authorised channel and transit numbers reduce with distance away from the boundary. Figure 27 shows the applied safety zones to borehole locations.

This risk control is considered to have a high effectiveness in reducing the likelihood of a hazard occurring.

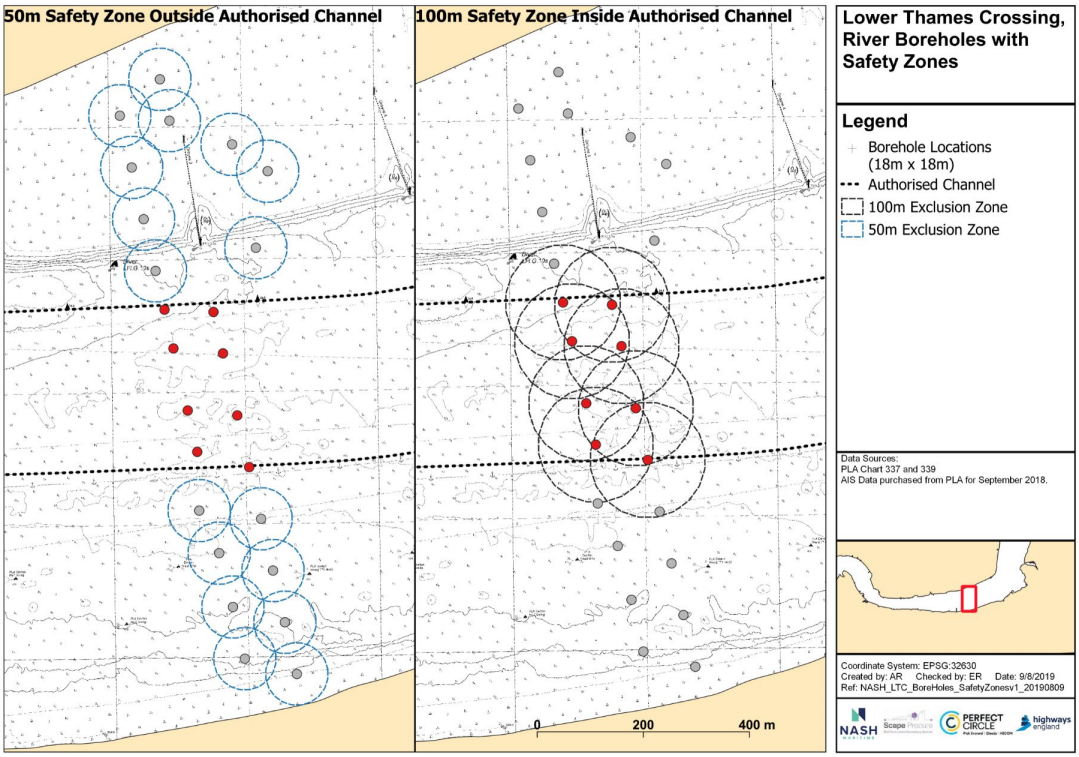

Figure 27: 100m and 50m Safety Zone (note only two borehole positions will be occupied at any one time by the two JUBs working in accordance with the approach described in Section 9.8 below)

9.3 RC ID #3 - Traffic Protocols and VTS Control

The concept of traffic protocols was considered in parallel with minimum passing distances within the bridge navigation simulation. Two aspects were reviewed by the team.

9.3.1 One way working / Two way working

The concept of implementing one way working for large vessels (i.e. not allowing overtaking or head on passing vessels) when JUB's are located within the authorised channel was assessed in relation to the available sea room once the 100m exclusion zone was applied. Figure 27 and Table 5 provide a graphical and tabulated summary of these indicative distances of sea room. The distances are indicative as some adjustments to borehole locations will occur, due to other constraints being evaluated including ground-based archaeology and unexploded ordnance, moving the actual positions to 'clean' locations as close as possible to those indicated here. These adjusted positions will be agreed with PLA. It is noted that in addition to the distance to the formal designated authorised channel boundary, the additional distance is provided to the north (as represented by Diver and Groynes) and to the south (as represented by the 8m contour and Denton layby moorings). It should be noted that although this additional sea room is available for use, it should only be used when safe to do so and subject to the vessel type, size and manoeuvrability of the vessel and comfort of the Master.

The bridge navigation simulation concluded that one way working would be necessary when a jack up barge is positioned at any of the 4 central locations (Boreholes 11 & 12 and 13 & 14) where between 100 and 115m of sea room is available (once the 100m exclusion zone is applied). Whilst opportunity for two way working at Boreholes 9 & 10 and Boreholes 15 & 16 was identified where 180 and 190m of sea room is available respectively it was subsequently concluded that one way working should be applicable to all 8 borehole locations within the authorised channel which provides for a clear protocol which can be administered in a straightforward manner by the PLA avoiding confusion amongst marine users on vessels of differing type, manoeuvrability and size.

The one way working protocol will be developed by the PLA and implemented in a Traffic Management Plan from which details will be promulgated to relevant users. The PLA will also seek, where safe to do

so, to utilise the opposite side where one way working is not employed for diversion of non reporting vessels as per the General Directions for Navigation in the Port of London 2016.

This risk control is considered to have a medium to high effectiveness in reducing the likelihood of a collision occurring.

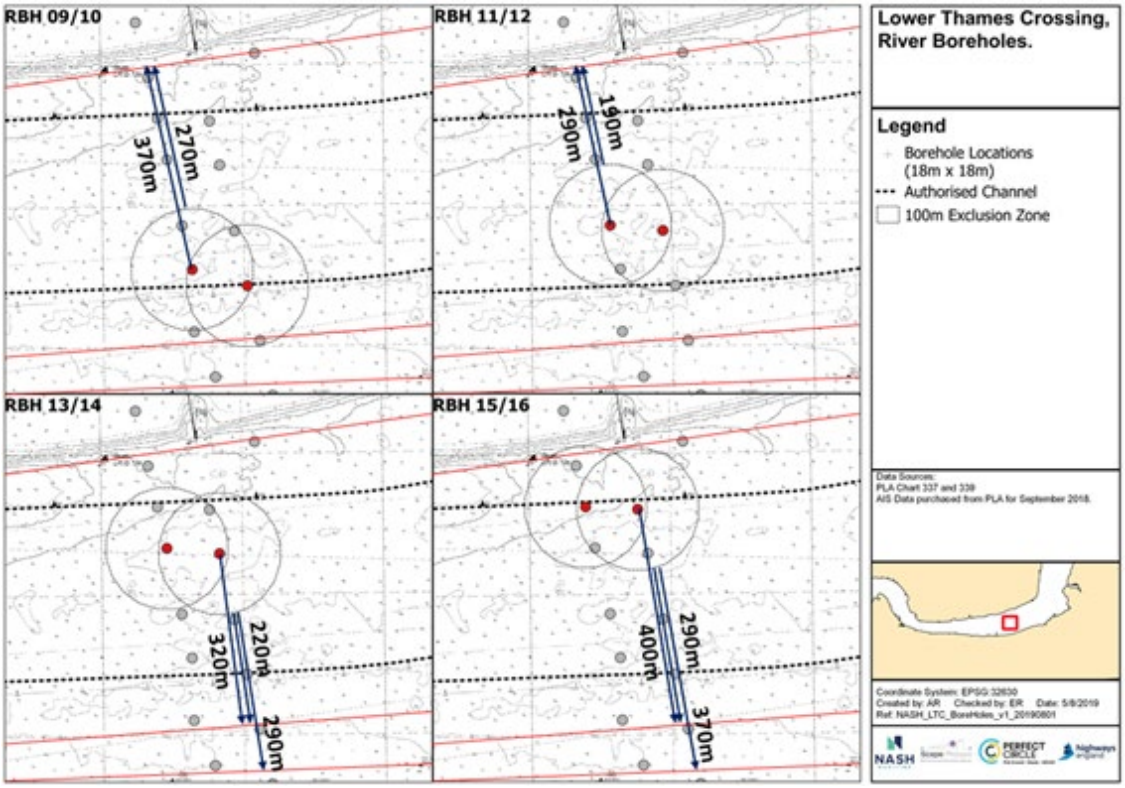

Figure 28: **Indicative passing distances and 100m clearances from jack-ups. North marker is Diver and Groynes, southern limits are 8m contour and Denton moorings.**

Table 8: Distances from JUB/100m exclusion zone to authorised channel/closest obstruction

Borehole ID	Location	Indicative Distance (m)			
		to authorised channel boundary	to authorised channel boundary - 100m	to obstruction	to obstruction -100m
RBH 09 & 10	South	280	180	370	270
RBH 11 & 12	South/centre	200	100	290	190
RBH 13 & 14	North/centre	215	115	320	220
RBH 15 & 16	North	290	190	400	290/370

9.3.2 PLA VTS and Control

The consideration of control by PLA was reviewed during simulation and it was concluded that local traffic control (most likely to be administered through a guard boat) would not be necessary. However, the following aspects of control will be adopted

- Proceed with Caution (VHF CH68 as per Permanent NTM P4)
- International Code Flags ‘Romeo Yankee’ to be displayed on each JUB

- Information broadcast
- VTS Management/Monitoring/Control to be defined in a Traffic Management Plan (to implement one way working)

The application of these risk controls work across a variety of hazards to reduce likelihood of the hazard occurring.

9.4 RC ID #4 – Weather and Metocean Limits

The consideration of metocean limits that apply to third party vessels was reviewed for larger commercial vessels during the bridge navigation simulation.

Upper wind speed limits (from a direction of north and south i.e. across channel) of 35kts were considered appropriate. This is precautionary in that wind speed berthing limits are lower than this although it is recognised that vessels may often be transiting outside these limits at times.

During periods of restricted visibility, it was considered that the following limits shall apply in terms of liaison with PLA and evacuation of the JUB. Any additional limits, if identified, should be considered through application of individual risk assessment.

- Visibility <0.5nm: Liaison with Duty Port Controller/VTS to review deteriorating condition
- Visibility <2 cables (circa 360m): JUB to be evacuated

Additionally, it is noted that the GI Contractor is applying environmental limitations which are shown at Table 6.

Table 9: Environmental Limitations (Source: Table 7.1 of G3365_MS002)

Item No	Description	Sea state Hmax (m)	Min water depth (m)	Wind speed Beaufort scale Force	Wind speed (m/s and mph)	Current (Knots)
1	Crew Evacuations	1.5	n/a	Wind Force 6	12m/s (27mph)	n/a
2	Crew Changes	1.2	0.5	Wind Force 6	12m/s (27mph)	1-4 Note; depending on local/site environmental conditions
3	Moving Between BH locations, jacking up/down & setting casing	0.8	2.5	Wind Force 5	10m/s (22mph)	1 Note; moves will generally be timed for periods of slack hig
4	Drilling operations	1.5	n/a	Wind Force 6	12m/s (27mph)	6 Note; setting and retrieving casing up to 1 knot
5	Towing jack-up	0.8	2.5	Wind Force 5	10m/s (22mph)	1-4 Note; depending on local/site environmental conditions
6	Equipment/Sample transfer to/from jack-up	1.0	2.5	Wind Force 4	8m/s (18mph)	2 Note; depending on orientation of vessel
7	Fog / Restricted Visibility Note; distances are approximate	Towing operations - Visibility of less than 500m. Moving and positioning operations - Visibility of less than 50m. Crew transfer operations - Visibility of less than 50m. Support vessel operations - Visibility of less than 100m.				
	Note; A combination of the above factors (all below the tabled limits) may combine to create a situation that is unsafe. The Bargemaster's / vessel master's decision shall always be final when considering the safety of the vessel and crew.					

9.5 RC ID #5 – Aids to Navigation

All project vessels that, at all times utilise and display:

- Lights, shapes and signals
- AIS

The Shornmead Sector light is located to the east of the development and is utilised by vessels navigating within the authorised channel. It was noted during the bridge navigation simulation that, due to transiting vessels positioning themselves differently laterally in the channel, the light will read differently to the mariner. It remains a useful aid to navigation and therefore should not be temporarily amended/extinguished but attention drawn to it through NTM.

9.6 RC ID #6 – PLA Pilot and PEC Holders Communication and Controls

The bridge navigation simulation provided benefit to identifying and understanding hazards associated with the operations and also in familiarisation of the participants to the works and development of procedures and protocols.

It is therefore recommended that the all PLA Pilots (and PEC Holders for large vessels e.g. Cobelfret vessels) are provided with information relating to the bridge navigation simulation and the risk assessment so they can consider the works in passage planning. Provision of, for example, a summary supplementary note and/or briefing material would be appropriate as part of the PLA's Traffic Management Plan.

The application of this risk controls work across a variety of hazards to reduce likelihood of the hazard occurring.

9.7 RC ID #7 – Promulgation and Dissemination of Information (external parties)

Local Notices to Mariners (NTM), issued by the PLA, contain important navigational information such as chart updates, changes in buoyage, prior warning of activities such as dredging, exclusion zones, harbour closures and byelaws etc… It is intended that the PLA will issue NTM for the works and these will likely be issued in between 1 and 3 editions to reflect the phasing of the works.

The application of this risk control ensures that the activities are bought to the attention of marine users and are explained in a manner that allows them to consider the works in their own activities and plan accordingly.

In addition, it is proposed that the project provides direct information to relevant stakeholders who may either not normally review NTM's and/or would benefit from additional information. This was expressed by a number of stakeholders during consultation. A short weekly update would consist of:

- Project status/activities
- Activities over previous period
- Planned activities in next period (1 – 3 week rolling programme)
- Points of contact

The update would be issued by a central project point of contact to a named point of contact at the following organisations:

- PLA (inc. Pilots)
- Port of Tilbury
- Tilbury2
- Gravesend Rowing Club
- Gravesend Sailing Club
- Embankment Marina
- Denton Wharf
- National Sea Training Centre

9.8 RC ID #8 – JUB Occupancy of Authorised Channel

It is recognised that risk is heightened in the baseline risk scenario when JUB's are present within the authorised channel (versus when located outside of the authorised channel) and in relation to the impact on large commercial vessels in particular. Accordingly, the Contractor is seeking to:

- Minimise the footprint when located within the authorised channel
- Optimise the schedule to ensure these operations are for the shortest duration of time possible.

The Contractor will therefore ensure that JUBs will not concurrently occupy more than one of the red boxes as shown in Figure 29 at any one time. Noting also that if one JUB is located in any red box that it would also not be preferable for the second JUB to be located at Borehole ID 07 & 08 or 17 & 18 (those to immediate north and south outside authorised channel) as shown in Figure 27.

This risk control therefore ensures that the minimum impeded footprint of the authorised channel and thus ensuring that the exclusion zones and one way working of Risk Control ID's 2 and 3 can be implemented.

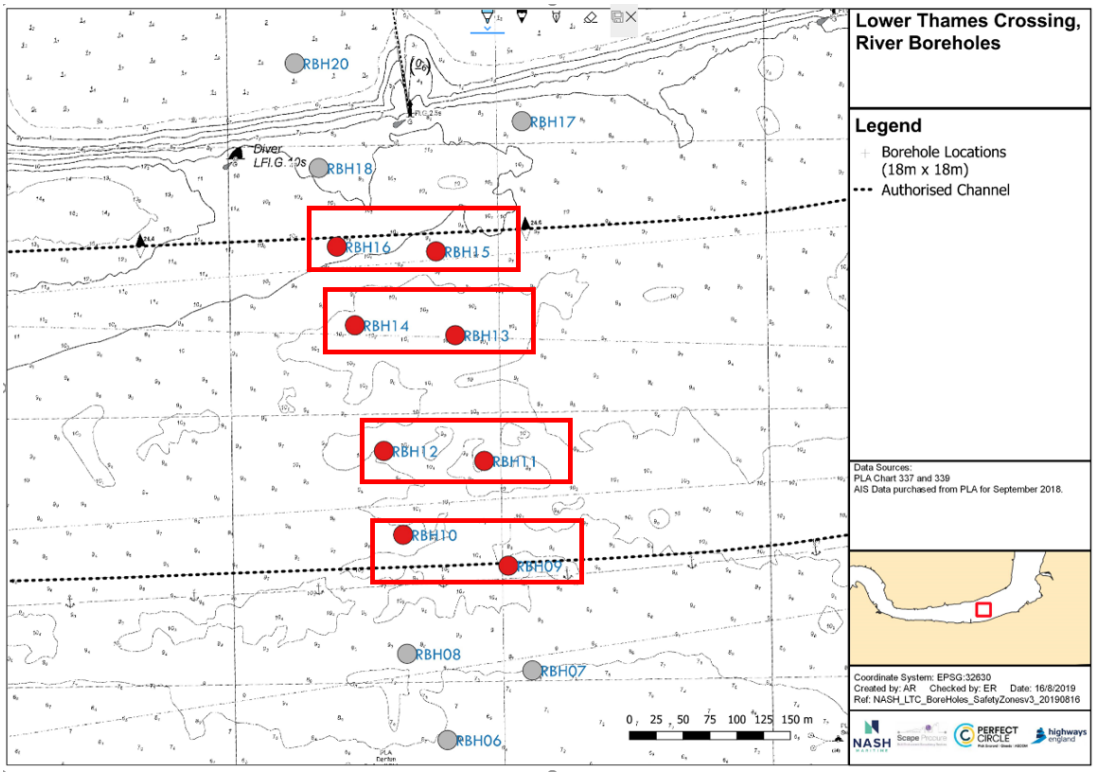

Figure 29: Authorised Channel Occupancy

The programme, HE540039-PCI-GEN-GEN-PRG-GEO-00007 and embedded sequencing schedule, will be optimised to ensure that initial boreholes will be undertaken outside the authorised channel in order to allow familiarisation of the operational teams with the working approaches and environment before moving into the channel. Additionally, within the flexibility required by the Contractor, and through ongoing liaison with the PLA, the schedule will seek to minimise the overall duration of time that the authorised channel is occupied.

9.9 RC ID #9 – Layby Mooring and Buoyage Optimisation

During initial consultation and simulations, the presence of the layby moorings located at the southern end of the site was queried as they are regularly occupied (See Figure 1). When occupied these buoys restrict the available sea room to the south of the authorised channel and, given that the use of this area is considered appropriate and required to promote two way usage, this was reviewed. Additionally, there is perceived hazard relating to contact with vessels and barges located at the buoys

and potential contact with third party vessels coming and off the works has been reviewed and, as a result, the following buoys will be vacated for the duration (but not dropped):

- No. 8 PLA Denton Small Ship
- No. 33 PLA Denton Swing [TTT No. 32]

The No. 27 PLA Denton No. 1 Swing Mooring will be available for use exclusively by the GI Contractor to allow attendant vessels to moor in close proximity to the operations. Any possible conflict with usage will be internally managed.

9.10 RC ID #10 – Guard Boat and provision of local traffic control

The application of a guard boat and provision of local traffic control (active direction of traffic provided by PLA from a project located harbour service launch vessel) was carefully considered and not felt to be necessary during the navigation simulation or through discussions/consultation and or risk scores and other risk controls (in particular risk control ID 3).

It was considered that due to the primary users being large commercial vessels, that other risk controls and the presence of the works themselves will serve to ensure that users area aware of the works. It is also noted that the range of attendant vessels including the muticat tugs and safety/crew change boats will provide a supporting role in this regard.

9.11 RC ID #11 – Schedule Optimisation and Deconfliction

The Construction Phase Plan and Method Statements providing information on rig moves and work approaches. Through consultation and the navigation simulation (and analysis of movements in relation to tidal time it was identified that rig moves can be better deconflicted with large vessel movements through being undertaken at slack water periods. The Contractor is seeking to undertake moves at periods of low water flow in any case (and when current speeds are as per Table 6).

It is preferable, where possible, to undertake these at low water slack periods – which contain less movements rather than over high water slacks

9.12 Other Risk Controls

Other risk controls which were reviewed and discussed included escalation of towage. However, it was considered that given the area remains navigable to vessels as simulated, that additional towage requirements (beyond those currently employed) would be reviewed on a case by case basis through individual risk assessment and these decisions would also involve the Master and Pilot and therefore give consideration to the works.

10. Navigation Risk Assessment Results

The following section details the findings of the NRA as it relates to:

- Baseline Assessment – results of the NRA for the GI Works without any additional risk controls in place
- Residual Assessment – results of the NRA for the GI Works with additional risk controls in place

10.1 Baseline Results

The results of the NRA are summarised in Table 10 and show the baseline risk with no risk controls in place.

Table 10: Summary Hazard Log showing Baseline Assessment of Risk

Hazard ID	Baseline Hazard Rank	JUB Location	Hazard Title	Baseline Risk	Baseline Level
3	1	1 or more JUBs in Authorised Channel	Piloted vessel contacts JUB	15.0	Extreme
2	2	1 or more JUBs in Authorised Channel	Recreational vessels contacts JUB	9.0	Moderate
4	3	1 or more JUBs in Authorised Channel	Small commercial vessel collides as a result of avoiding JUB	8.0	Moderate
5	3	1 or more JUBs in Authorised Channel	Recreational vessels collides as a result of avoiding JUB	8.0	Moderate
14	3	0 JUBs in Authorised Channel	Recreational vessels collides as a result of avoiding JUB	8.0	Moderate
10	3	0 JUBs in Authorised Channel	Small commercial vessels contacts JUB	8.0	Moderate
1	3	1 or more JUBs in Authorised Channel	Small commercial vessels contacts JUB	8.0	Moderate
6	3	1 or more JUBs in Authorised Channel	Piloted vessel collides as a result of avoiding JUB	8.0	Moderate
11	9	0 JUBs in Authorised Channel	Recreational vessels contacts JUB	6.0	Moderate
9	9	1 or more JUBs in Authorised Channel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	6.0	Moderate
12	11	0 JUBs in Authorised Channel	Piloted vessel contacts JUB	5.0	Moderate
13	12	0 JUBs in Authorised Channel	Small commercial vessel collides as a result of avoiding JUB	4.0	Minor
15	12	0 JUBs in Authorised Channel	Piloted vessel collides as a result of avoiding JUB	4.0	Minor
7	12	1 or more JUBs in Authorised Channel	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor
17	12	0 JUBs in Authorised Channel	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor
8	12	1 or more JUBs in Authorised Channel	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor
18	17	0 JUBs in Authorised Channel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	3.0	Minor
16	18	0 JUBs in Authorised Channel	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	2.0	Slight

The baseline assessment of risk shows one hazard scoring 'Extreme' risk which is *HAzID#3: Piloted Vessel Contact with JUB (when 1 or more JUBs are located in Authorised Channel)*, that has a score of 15 / 25. This falls into the '*Intolerable Risk. Activity Not Authorised'* action key category. The magnitude and sensitivity of this hazard emerged through early consultation, analysis of vessel traffic data and the bridge navigation simulation exercise (prior to implantation of any risk controls). It was assessed that the likelihood of this was *Level 3 'Possible to Occur'* and with a consequence *Level 5 Loss of vessel or severe damage to vessel. Multiple Fatalities, international news coverage. Serious long term impact on environment and/or permanent damage'*. It is noted that for the equivalent hazard

when *'0 JUBs are located in the authorised channel'* this scores 5 / 25 which falls into the '*Moderate Risk (Risk Score 5 – 9) - Efforts should be made to reduce risk to 'As low as reasonably practicable' (ALARP), but activity may be undertaken'* due to its likelihood falling to *Level 1 'Very Unlikely'.*

A further 10 hazards are scored in the *'Moderate' (Risk Score 5 – 9) - Efforts should be made to reduce risk to 'As low as reasonably practicable' (ALARP), but activity may be undertaken*' risk category. Of the 7 hazards between 8.0 and 9.0 it is noted that 6 involve small commercial and recreational vessels and the highest relates to Contact *HAzID#2: Recreational Vessel Contacts JUB (when 1 or more JUBs are located in Authorised Channel)*.

A further 7 hazards are scored within the '*Minor (Risk Score 3 - 4) No additional controls are required, monitoring is required to ensure no changes in circumstances'* or *'Slight (1 - 2) No action is required.*

10.2 Residual Results

Risk Control measures, as determined and refined within Section 9, are applied to mitigate any increase in navigation risk brought about by the project. The result for the residual assessment risk, where selected risk controls have been applied to hazards as summarized in Table 11 and are also provided in full within the hazard logs at Appendix C.

It is important to note that risk controls may work in tandem with each other such that controls together work more effectively than the sum of their parts. Where risk controls have been applied they have been assessed as providing following level of effectiveness across the likelihood or consequence of a hazard occurring:

- High Effectiveness - 50% Risk Reduction
- Moderate Effectiveness - 30% Risk Reduction
- Low Effectiveness - 15% Risk Reduction
- No Effectiveness - 0% Risk Reduction

The results of the residual assessment of risk (Table 11) show that all hazards are reduced to the category *'Moderate' (Risk Score 5 – 9) - Efforts should be made to reduce risk to 'As low as reasonably practicable' (ALARP), but activity may be undertaken*' or lower. The highest scoring three hazards are when 1 or more JUBs are located within the Authorised Channel. The highest residual scoring hazard is *'HazID#2 Recreational vessel contacts JUB'* with a risk score of *6.7 / 25* (reducing from 9 / 25 in the baseline) through the implementation of the following risk controls:

- RC ID#1: Safety Boat – likelihood effectiveness 0%, consequence effectiveness 50%
- RC ID#2: Exclusion Zone / Minimum Safe Passing Distance – likelihood effectiveness 15%, consequence 0%
- RC ID#3: Traffic Protocols and VTS Controls – likelihood effectiveness 15%, consequence 0%
- RC ID#5: Aids to Navigation – likelihood effectiveness 15%, consequence 0%
- RC ID#7: Promulgation and Dissemination of Information – likelihood effectiveness 30%, consequence 0%
- RC ID#8: JUB occupancy of authorised channel – likelihood effectiveness 15%, consequence 0%
- RC ID#11: Schedule Optimisation / Deconfliction – likelihood effectiveness 15%, consequence 0%

The second highest residual scoring hazard is *'HazID#4 Small commercial vessel collides as a result of avoiding JUB'* with a risk score of *6 / 25* (reducing from 8 / 25 in the baseline) through the implementation of the following risk controls:

- RC ID#1: Safety Boat – likelihood effectiveness 0%, consequence effectiveness 30%
- RC ID#3: Traffic Protocols and VTS Controls – likelihood effectiveness 15%, consequence 0%
- RC ID#5: Aids to Navigation – likelihood effectiveness 15%, consequence 0%
- RC ID#7: Promulgation and Dissemination of Information – likelihood effectiveness 15%, consequence 0%
- RC ID#8: JUB occupancy of authorised channel – likelihood effectiveness 30%, consequence 0%
- RC ID#11: Schedule Optimisation / Deconfliction – likelihood effectiveness 15%, consequence 0%

The third highest scoring hazard *HAzID#3: Piloted Vessel Contact with JUB (when 1 or more JUBs are located in Authorised Channel)* was also the highest scoring baseline hazard *(15 / 25)* and shows the largest risk reduction with the score decreasing to *5.9 / 25.* This was due to the extensive and wide-ranging risk controls:

- RC ID#1: Safety Boat – likelihood effectiveness 0%, consequence effectiveness 30%
- RC ID#2: Exclusion Zone / Minimum Safe Passing Distance – likelihood effectiveness 50%, consequence 0%
- RC ID#3: Traffic Protocols and VTS Controls – likelihood effectiveness 50%, consequence 0%
- RC ID#4: Weather/Metocean Limits – likelihood effectiveness 15%, consequence 0%
- RC ID#5: Aids to Navigation – likelihood effectiveness 15%, consequence 0%
- RC ID#6: Pilot/PEC Holder Communications/Controls – likelihood effectiveness 50%, consequence 0%
- RC ID#7: Promulgation and Dissemination of Information – likelihood effectiveness 15%, consequence 0%
- RC ID#8: JUB occupancy of authorised channel – likelihood effectiveness 50%, consequence 0%
- RC ID#9: Layout Mooring/Buoyage Optimisation – likelihood effectiveness 15%, consequence 0%
- RC ID#11: Schedule Optimisation / Deconfliction – likelihood effectiveness 15%, consequence 0%

Table 11: Summary Hazard Log showing Baseline and Residual Assessment of Risk

Hazard ID	Baseline Hazard Rank	Residual Hazard Rank	JUB Location	Hazard Title	Baseline Risk	Baseline Level	Residual Risk	Residual Level	Risk Reduction
2	2	1	1 or more JUBs in Authorised Channel	Recreational vessels contacts JUB	9.0	Moderate	6.7	Moderate	2.3
4	3	2	1 or more JUBs in Authorised Channel	Small commercial vessel collides as a result of avoiding JUB	8.0	Moderate	6.0	Moderate	2.0
3	1	3	1 or more JUBs in Authorised Channel	Piloted vessel contacts JUB	15.0	Extreme	5.9	Moderate	9.1
5	3	4	1 or more JUBs in Authorised Channel	Recreational vessels collides as a result of avoiding JUB	8.0	Moderate	5.8	Moderate	2.2
14	3	4	0 JUBs in Authorised Channel	Recreational vessels collides as a result of avoiding JUB	8.0	Moderate	5.8	Moderate	2.2
10	3	6	0 JUBs in Authorised Channel	Small commercial vessels contacts JUB	8.0	Moderate	5.2	Moderate	2.8
12	11	7	0 JUBs in Authorised Channel	Piloted vessel contacts JUB	5.0	Moderate	4.8	Moderate	0.2
1	3	8	1 or more JUBs in Authorised Channel	Small commercial vessels contacts JUB	8.0	Moderate	4.5	Moderate	3.5
11	9	9	0 JUBs in Authorised Channel	Recreational vessels contacts JUB	6.0	Moderate	4.0	Minor	2.0
13	12	10	0 JUBs in Authorised Channel	Small commercial vessel collides as a result of avoiding JUB	4.0	Minor	3.8	Minor	0.2
6	3	11	1 or more JUBs in Authorised Channel	Piloted vessel collides as a result of avoiding JUB	8.0	Moderate	3.7	Minor	4.3
15	12	11	0 JUBs in Authorised Channel	Piloted vessel collides as a result of avoiding JUB	4.0	Minor	3.7	Minor	0.3
9	9	13	1 or more JUBs in Authorised Channel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	6.0	Moderate	2.9	Minor	3.1
18	17	13	0 JUBs in Authorised Channel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	3.0	Minor	2.9	Minor	0.1
7	12	15	1 or more JUBs in Authorised Channel	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor	2.9	Minor	1.1
17	12	16	0 JUBs in Authorised Channel	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor	2.8	Minor	1.2
8	12	17	1 or more JUBs in Authorised Channel	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor	2.6	Minor	1.4
16	18	18	0 JUBs in Authorised Channel	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	2.0	Slight	1.9	Slight	0.1

11. Study Findings

11.1 Conclusions

A marine Navigation Risk Assessment (NRA) has been undertaken for the over water Ground Investigation (GI) works for the Lower Thames Crossing Project to meet the requirements of the Temporary River Works Licence Application being made to the Port of London Authority (PLA) to understand the effects of the GI on marine safety to navigation.

The assessment has been undertaken in accordance with an adapted PLA authorised methodology, encompassing analysis of traffic data, review of historical incident data, consultation with identified stakeholders (including bridge navigation simulation) and qualified judgement in order to identify and assess navigation hazards for the proposed works.

A total of 18 hazards were identified and categorised by collision, contact and grounding. The analysis of the baseline (i.e. the proposed works with no additional risk controls in place) demonstrated one hazard within the *'Extreme'* risk category (HAZ ID#3 - Piloted vessel contacts the JUB when 1 or more JUBs are in the authorised channel) with a risk score of 15 / 25.

The remaining hazards fell within the *'Moderate'* to *'Slight'* categories and principal hazards were associated with contact and collision when the JUBs are located within or outside the authorised channel which was consistent with the input from stakeholders, navigation simulation and correlated to historical incident patterns.

Risk control measures were identified that could be utilised to mitigate any increase in navigation risk brought about by the project. Application of these risk controls reduced the *'Extreme'* hazard to *'Moderate'* and provided for a range of general further reductions to those hazards scoring *'Moderate'* in the baseline assessment.

11.2 Recommendations and Agreed Risk Controls

It is recommended that the risk controls identified within Section 9 (and summarised below and detailed in the table within Appendix B) are reviewed and the definitions optimised in agreement with the Contractor, PLA and relevant stakeholders for adoption and prior to commencement of the works.

- RC ID#1: Safety Boat
- RC ID#2: Exclusion Zone / Minimum Safe Passing Distance
- RC ID#3: Traffic Protocols and VTS Controls
- RC ID#4: Weather/Metocean Limits
- RC ID#5: Aids to Navigation
- RC ID#6: Pilot/PEC Holder Communications/Controls
- RC ID#7: Promulgation and Dissemination of Information
- RC ID#8: JUB occupancy of authorised channel
- RC ID#9: Layout Mooring/Buoyage Optimisation
- RC ID#11: Schedule Optimisation / Deconfliction

11.3 Summary Risk Statement

In consideration of all of the evidence collected and assessed in this report, the conclusions are that the over water Ground Investigation (GI) works for the Lower Thames Crossing Project does not pose an unacceptable risk to navigation in the area and that all hazards can be reduced to As Low As Reasonably Practicable (ALARP) through application of the identified risk controls.

Appendix A – Consultation Letter

AECOM Limited,
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T +44 (0)161 601 1700
aecom.com

12th July 2019

By email

Re: Pre-Application Stakeholder Consultation on Navigation Impacts for the Ground Investigation Works for the Lower Thames Crossing

Dear Sir, Madam,

Highways England (HE) has been tasked with construction of the Lower Thames Crossing that will create a fixed link across the River Thames to the east of London connecting the A2 and the M25. The Lower Thames Crossing Project is proposed for the easement of congestion at the existing Dartford Crossing. The scheme consists of approximately 4km of twin bore tunnels under the River Thames and approximately 20km of new dual carriageway. The preferred route for the scheme crosses beneath the River Thames east of Tilbury in Essex and Gravesend in Kent and comprises a new road north of the river which will join the M25 between junctions 29 and 30 near North Ockendon and meet the A13 at Orsett. A new road south of the river which will join the A2 east of Gravesend (Western Southern Link), crossing under the river via a bored tunnel. Further information is available at https://highwaysengland.co.uk/lower-thames-crossing-ground-investigations/.

To support the development of the scheme design, an Overwater Ground Investigation (GI) is to be undertaken within the River Thames in the area of Gravesend to Tilbury, across a stretch of river around 1.5km wide.

Proposed works

The aim of the ground investigation is to obtain sufficient ground condition information for the design of the Lower Thames Crossing tunnel. Ground condition information provided by the ground investigation will facilitate the development of a ground model for the site.

The scope of the works includes 25 overwater boreholes to a maximum depth of 85m below ground level (BGL, sea bed level). Cable percussion would be used initially within soft or loose sediments whilst rotary coring would be used within the underlying bedrock. The GI is proposed to be carried out upstream of Thames Gateway and within the tidal section of the river, located between 22km and 40km east of central London covering the area under which the tunnel will be located. The attached drawing show the exploratory borehole locations, positioned within the River Thames.

The proposed works would be undertaken using two temporarily positioned Jack-Up Barges (JUBs) positioned within the river channel. JUBs are four-legged, floating, self-elevating platforms which are maneuvered into each borehole position by tug boat and remain on station for approximately 5 days prior to relocation to other borehole locations. Each JUB will measure approximately 25m x 40m in size and comprise of four circular legs spanning approximately one metre (1m) in diameter which extend down vertically from the four corners of the barge. The barges will be lit with both working lighting directed towards platform deck level and safety lighting directed outwards to warn other vessels of their presence. The distance between the two JUBs during operations is expected to be around 200 m.

The GI works are scheduled to be carried out between late August 2019 and late November 2019 and it is anticipated that operations would be 24 hours a day, seven days a week.

These GI works require a Temporary River Works Licence, for which this Navigational Risk Assessment (NRA) is being prepared.

Navigation Risk Assessment and Stakeholder Consultation

In consultation with the Port of London Authority (PLA) your organisation has been identified as a key stakeholder and we therefore invite you to participate in the stakeholder consultation.

The Navigation Risk Assessment is being undertaken in accordance with industry guidance, best practice and requirements of the PLA. The process requires identification of potential impacts that the GI works could have on shipping, navigation and marine users, and to ensure consultation is carried out in a consistent and comprehensive fashion. Our team has extensive knowledge of undertaking these assessments coupled with commercial and recreational experience, and familiarity with this area of the River Thames. In order to analyse marine navigation movements in the area, Thames Automatic Identification System (AIS) data has been acquired which will feed into the assessment.

A real time bridge navigation simulation has also been undertaken with the PLA and PLA Pilots in order to examine the spatial requirements for continued safe navigation to large commercial vessels when the jack up barges are located at the 8 boreholes which are at the boundary of, and within, the authorised navigation channel. We would be grateful if you could provide us with any written comments or feedback prior to Mon-29-July (using the contact details above, Victoria Barnett). Alternatively, we intend to visit the site area during week commencing Mon-22-July or Mon-29-July and are happy to meet with you for a face-to-face meeting; if you would like to meet us then please advise on your preferred availability during these weeks. Depending on availability and responses from other consultees we may seek to combine stakeholder meetings at a mutually convenient location. As an alternative to the on site meeting we would happily set up a phone/video-conference if this is more convenient.

The objectives of the consultation are to ensure that all navigation-related hazards and impacts are identified, risks are appropriately assessed, and risk control measures are identified which eliminate risk, or reduce it to acceptable levels. In view of this we are keen to hear your views on the following:

New navigation-related hazards that could emerge during the GI works (e.g. collision, contact, breakout, grounding)

Likelihood and the potential consequence of hazards (i.e. risks) to people, property, business and the environment

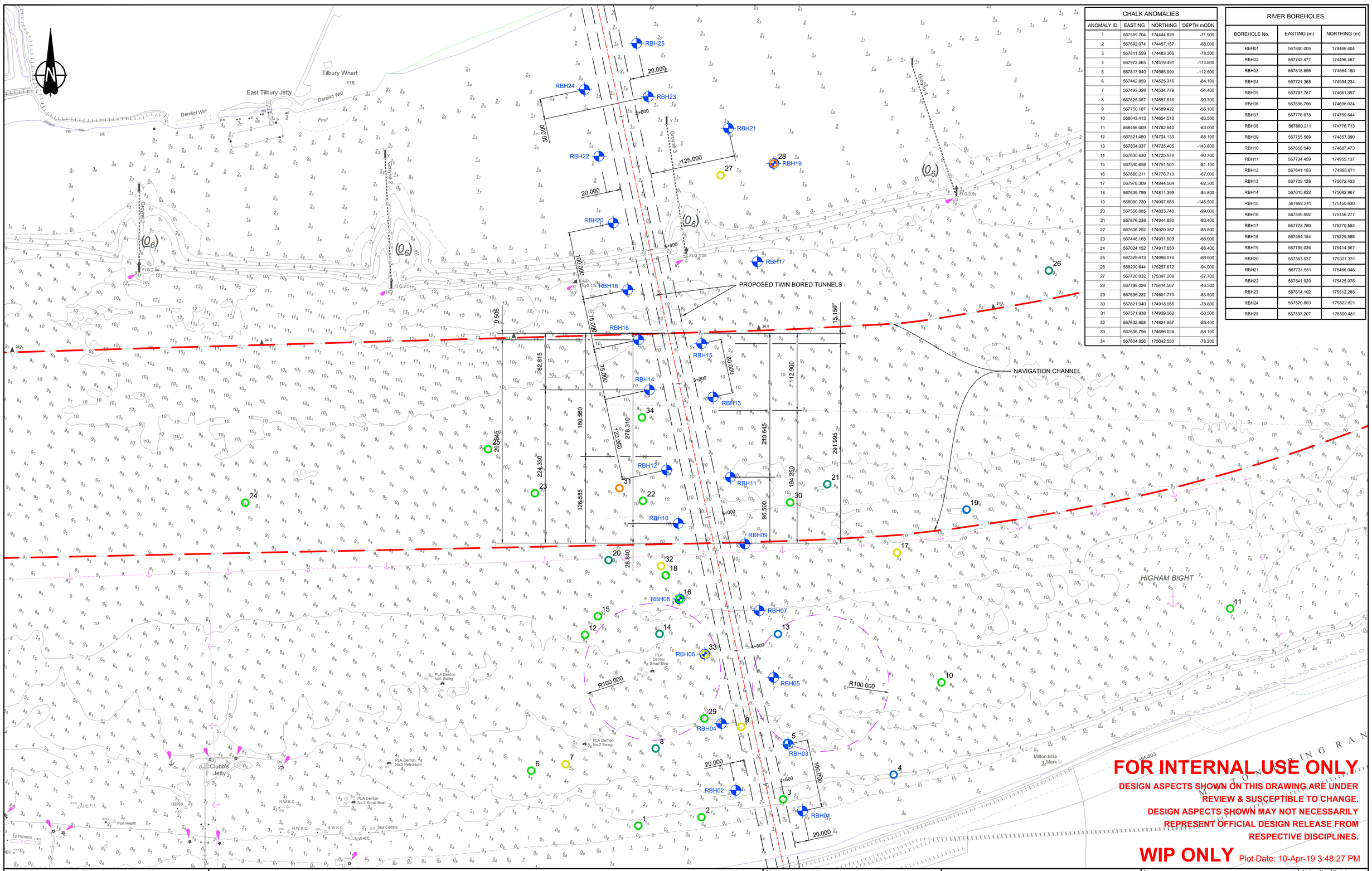
Views on suitable means to mitigate the risks (e.g. risk controls such as markings, exclusion zones, procedures and communication).

If you intend to provide a written submission, please provide as much detail as you can so we can ensure that your views are taken into account during the assessment. Should you require any further information to support your written submission then please do not hesitate to contact us.

Yours faithfully,

Victoria Barnett

Principal Geotechnical Engineer
AECOM Limited



CHALK ANOMALIES			
ANOMALY ID	EASTING	NORTHING	DEPTH mODN
1	567599.704	174444.829	-71.900
2	567692.074	174457.157	-68.000
3	567811.559	174483.366	-78.500
4	567973.465	174519.491	-113.800
5	567817.940	174565.990	-112.500
6	567442.859	174525.315	-84.100
7	567493.328	174534.779	-54.400
8	567625.057	174557.816	-90.700
9	567750.187	174589.422	-56.100
10	568043.413	174654.570	-83.500
11	568466.009	174762.640	-63.000
12	567521.480	174724.130	-88.100
13	567804.037	174725.405	-143.800
14	567630.630	174725.578	-90.700
15	567540.658	174751.501	-81.100
16	567660.211	174776.713	-67.000
17	567978.309	174844.564	-62.300
18	567639.799	174811.399	-84.800
19	568080.239	174907.660	-148.500
20	567556.085	174833.740	-99.000
21	567876.238	174944.830	-93.400
22	567606.292	174920.362	-85.800
23	567448.165	174931.603	-66.000
24	567024.152	174917.650	-88.400
25	567379.613	174996.074	-68.600
26	568200.644	175257.672	-94.000
27	567720.032	175397.208	-57.700
28	567798.026	175414.567	-46.500
29	567696.222	174601.770	-83.500
30	567821.940	174918.066	-78.800
31	567571.938	174939.062	-50.500
32	567632.858	174824.957	-55.400
33	567696.796	174696.024	-58.100
34	567604.956	175042.550	-78.200

RIVER BOREHOLES		
BOREHOLE No.	EASTING (m)	NORTHING (m)
RBH01	567840.005	174466.404
RBH02	567742.477	174496.487
RBH03	567818.896	174564.150
RBH04	567721.368	174594.234
RBH05	567797.787	174661.897
RBH06	567696.796	174696.024
RBH07	567776.678	174759.644
RBH08	567660.211	174776.713
RBH09	567755.569	174857.390
RBH10	567658.040	174887.473
RBH11	567734.459	174955.137
RBH12	567641.153	174965.671
RBH13	567709.128	175072.433
RBH14	567615.822	175082.967
RBH15	567692.241	175150.630
RBH16	567599.992	175156.277
RBH17	567773.780	175270.553
RBH18	567584.154	175229.586
RBH19	567798.026	175414.567
RBH20	567563.037	175327.331
RBH21	567731.561	175466.046
RBH22	567541.920	175425.076
RBH23	567614.102	175512.285
RBH24	567520.803	175522.821
RBH25	567597.207	175590.481

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DESIGN ASPECTS SHOWN MAY NOT NECESSARILY REPRESENT OFFICIAL DESIGN RELEASE FROM RESPECTIVE DISCIPLINES.

WIP ONLY Plot Date: 10-Apr-19 3:48:27 PM

Rev	Status	Rev. Date	Purpose of revision	Drawn	Chck'd	Apprv'd
P01.2	S0	10/04/2019		TMG		

NOTES:-

1. ALL MEASUREMENTS ARE IN METRES UNLESS NOTES OTHERWISE.
2. ALL LEVELS ARE IN METRES RELATIVE TO PLA CHART DATUM.
3. BOREHOLES CONSIDERED IN CONSTRUCTION OF THE PRELIMINARY SUBSURFACE GROUND MODEL WERE OBTAINED FROM THE BGS NATIONAL GEOSCIENCE DATA CENTRE. AVAILABLE UNDER OPEN GOVERNMENT LICENCE. ALIGNMENT PROFILE STRATIGRAPHY BASED UPON RECORDS PROVIDED BY BRITISH GEOLOGICAL SURVEY (NERC).
4. PROPOSED HIGHWAY ALIGNMENT SHOWN BASED ON MODEL FILE HE540039-CJV-HML-S2P_ML000000_Z-M2-CH-00001 LTC Preferred Route DR2.8

0 50 100 150 200
SCALE 1:2500 (A1) METRES

Client: highways england

LOWER THAMES CROSSING
5th Floor Beaufort House
15 St Botolph Street
London EC3A 7DT

Project: LOWER THAMES CROSSING DEVELOPMENT PHASE

Drawing title: SKETCH LOCATION OF RIVER BOREHOLES

Status		Original Size	Revision
S0	Initial Status or WIP	A1	P01.2
		Scale	1:2500
Drawn	TMG	Date -	10/04/2019
Checked		Date -	
Approved		Date -	

Drawing number: HE540039-CJV-VGT-S3P_BH000000_-SK-VG-00365

HE540039-CJV-VGT-S3P_BH000000_-SK-VG-00365.dwg

Appendix B – Risk Control Table

ID	Title	Spec/Notes	Status/Adopted
1	Safety Boat	Safety Boat provision by 1x RIB per JUB (with rescue capability/duties)	Yes
2	Exclusion Zone / Minimum Safe Passing Distance	Minimum 100m of third party vessels to JUB (derived via Nav Sim w PLA Pilots and confirmed with GI Contractor) during: • Tow/Position/Jacking • At borehole location Commence operations with 100m exclusion to all locations – with monitoring/review to potential relaxation to 50m for borehole locations outside of authorised channel (ie to non reporting vessels) subject to PLA and Contractor agreement.	Yes
3	Traffic Protocols and VTS Control	Protocols: • Confirm 1 way working (no passing ship [O/T or head-on]) for JUB locations at Borehole ID 9 & 10, 11 & 12, 13 & 14 and 15 & 16 • To remain under reviewed at ID 9 & 10 and 15 & 16 (utilising sea room to N and S in conjunction with RC ID# 2) Control: VTS input may be required (local traffic control via guard boat deemed not necessary via Nav Sim). To inc: • 'Proceed with Caution' (VHF Ch68 as per Perm NTM P4) • Int Code Flags 'Romeo Yankee 'to be displayed on JUB • Information broadcast (to be defined) • VTS Management/Monitoring/Control (to be defined) through Traffic Management Plan	Yes
4	Weather/Metocean Limits	Third Party (large) Vessel transits: • Wind: No specific restriction above 35kts TWS (noting exceeds PLA berthing limits) • Restricted Visibility < 0.5nm Liaison with Duty Port controller/VTS to review deterioration • Restricted Visibility <2 cables (circa 360m): JUB to be evacuated JUB and Attendant Vessels • Refer & Apply GI Contractor Environmental Limitations (Table 7.1)	Yes
5	Aids to Navigation	All Project vessels shall utilise/display: • Lights, shapes as standard • AIS Shornmead Sector Light to remain (but noted in NTM that it should be considered)	Yes
6	PLA Pilot and PEC Holders Communication/Controls	PLA Pilots and PEC Holders to be briefed on Nav Sim, NRA and Risk Controls to consider in passage planning (to define mechanism beyond NTM with PLA)	Yes
7	Promulgation and Dissemination of Information (external parties)	NTM (likely 3 phases/issues – content to be defined with PLA) Weekly information activity deliverable to relevant stakeholders PLUS PEC HOLDERS • Project status • Past activities • Planned activities (1wk and 3 wk rolling) Project Point of Contact	Yes
8	JUB occupancy of authorised channel	Concurrent JUB locations to be at borehole ID's 9&10 **OR** 11&12 **OR** 13&14 **OR** 15&16 and not in concurrent areas at same time. Minimise overall duration of time within authorised channel (schedule)	Yes
9	Layby Mooring/Buoyage optimisation	Vacate following moorings (to maximise usable area to south of authorised channel and promote 2 way working where safe to do so): • No. 8 PLA Denton Small Ship • No. 33 PLA Denton Swing [TTT No. 32] Utilise following mooring for attendant vessels • No. 27 PLA Denton No. 1 Swing	Yes
10	Guard Boat (and Local Traffic Control)	Nav Sim and further assessment concluded not required	Not required
11	Schedule Optimisation / Deconfliction	Slack tide usage (circa <1kt) for Tow/Shift Position/Jacking (HW/LW +/- 1hr) to deconflict with large vessels • Preferable usage of LW slacks rather than HW on slack tides for 8x boreholes within authorised channel	Yes

Appendix C – Hazard Logs

Project:	Lower Thames Crossing	Site / Location:	Lower Thames Crossing: Site Investigations	Nash Maritime	Revision:	Rev 02-00

Hazard ID	Baseline Hazard Rank	Residual Hazard Rank	JUB Location	Hazard Category	Hazard Title	Baseline Risk - with existing risk controls in place			Risk Reduction								Results
						Likelihood	Consequence	Baseline Risk	Risk Control ID.	Additional Risk Control (RC) Measures	Include Risk Control	% Likelihood Reduction	% Consequence Reduction	Residual Consequence Score	Individual Control Risk Score	Cumulative Risk Score	
1	3	8	1 or more JUBs in Authorised Channel	Small Commercial Vessels	Small commercial vessels contacts JUB	2	4	8.0		Baseline with no additional risk controls				4.00	8.0	8.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	3.85	7.7	7.7	8.0
									2	Exclusion Zone / Minimum Safe Passing Distance	Yes	50%	0%	4.00	6.8	6.5	
									3	Traffic Protocols and VTS Control	Yes	30%	0%	4.00	7.4	5.9	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			5.9	Moderate
									5	Aids to Navigation	Yes	15%	0%	4.00	7.7	5.7	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			5.7	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	4.00	7.7	5.4	4.5
									8	JUB occupancy of authorised channel	Yes	30%	0%	4.00	7.4	4.8	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			4.8	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			4.8	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	4.00	7.7	4.5	Moderate
									12		No	0%	0%			4.5	
									13		No	0%	0%			4.5	Risk Reduction
									14		No	0%	0%			4.5	3.5
									15		No	0%	0%			4.5	
2	2	1	1 or more JUBs in Authorised Channel	Recreational Vessels	Recreational vessels contacts JUB	3	3	9.0		Baseline with no additional risk controls				3.00	9.0	9.0	Baseline Risk
									1	Safety Boat	Yes	0%	50%	2.70	8.1	8.1	9.0
									2	Exclusion Zone / Minimum Safe Passing Distance	Yes	15%	0%	3.00	8.8	7.9	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	3.00	8.8	7.7	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			7.7	Moderate
									5	Aids to Navigation	Yes	15%	0%	3.00	8.8	7.5	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			7.5	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	30%	0%	3.00	8.5	7.1	6.7
									8	JUB occupancy of authorised channel	Yes	15%	0%	3.00	8.8	6.9	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			6.9	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			6.9	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	3.00	8.8	6.7	Moderate
									12		No	0%	0%			6.7	
									13		No	0%	0%			6.7	Risk Reduction
									14		No	0%	0%			6.7	2.3
									15		No	0%	0%			6.7	
3	1	3	1 or more JUBs in Authorised Channel	Piloted Vessel	Piloted vessel contacts JUB	3	5	15.0		Baseline with no additional risk controls				5.00	15.0	15.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	4.85	14.5	14.5	15.0
									2	Exclusion Zone / Minimum Safe Passing Distance	Yes	50%	0%	5.00	13.5	13.1	
									3	Traffic Protocols and VTS Control	Yes	50%	0%	5.00	13.5	11.6	Baseline Level
									4	Weather/Metocean Limits	Yes	15%	0%	5.00	14.6	11.3	Extreme
									5	Aids to Navigation	Yes	15%	0%	5.00	14.6	10.9	
									6	Pilot/PEC Holder Communication/Controls	Yes	50%	0%	5.00	13.5	9.5	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	5.00	14.6	9.1	5.9
									8	JUB occupancy of authorised channel	Yes	50%	0%	5.00	13.5	7.7	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	5.00	14.6	7.3	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			7.3	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	50%	0%	5.00	13.5	5.9	Moderate
									12		No	0%	0%			5.9	
									13		No	0%	0%			5.9	Risk Reduction
									14		No	0%	0%			5.9	9.1
									15		No	0%	0%			5.9	
4	3	2	1 or more JUBs in Authorised Channel	Small Commercial Vessels	Small commercial vessel collides as a result of avoiding JUB	2	4	8.0		Baseline with no additional risk controls				4.00	8.0	8.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	3.85	7.7	7.7	8.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			7.7	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	4.00	7.7	7.4	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			7.4	Moderate
									5	Aids to Navigation	Yes	15%	0%	4.00	7.7	7.1	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			7.1	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	4.00	7.7	6.9	6.0
									8	JUB occupancy of authorised channel	Yes	30%	0%	4.00	7.4	6.3	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			6.3	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			6.3	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	4.00	7.7	6.0	Moderate
									12		No	0%	0%			6.0	
									13		No	0%	0%			6.0	Risk Reduction
									14		No	0%	0%			6.0	2.0
									15		No	0%	0%			6.0	
5	3	4	1 or more JUBs in Authorised Channel	Recreational Vessels	Recreational vessels collides as a result of avoiding JUB	2	4	8.0		Baseline with no additional risk controls				4.00	8.0	8.0	Baseline Risk
									1	Safety Boat	Yes	0%	50%	3.70	7.4	7.4	8.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			7.4	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	4.00	7.7	7.1	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			7.1	Moderate
									5	Aids to Navigation	Yes	15%	0%	4.00	7.7	6.9	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			6.9	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	30%	0%	4.00	7.4	6.3	5.8
									8	JUB occupancy of authorised channel	Yes	15%	0%	4.00	7.7	6.0	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			6.0	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			6.0	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	4.00	7.7	5.8	Moderate
									12		No	0%	0%			5.8	
									13		No	0%	0%			5.8	Risk Reduction
									14		No	0%	0%			5.8	2.2
									15		No	0%	0%			5.8	
6	3	11	1 or more JUBs in Authorised Channel	Piloted Vessel	Piloted vessel collides as a result of avoiding JUB	2	4	8.0		Baseline with no additional risk controls				4.00	8.0	8.0	Baseline Risk
									1	Safety Boat	Yes	0%	50%	3.70	7.4	7.4	8.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			7.4	
									3	Traffic Protocols and VTS Control	Yes	50%	0%	4.00	6.8	6.3	Baseline Level
									4	Weather/Metocean Limits	Yes	15%	0%	4.00	7.7	6.0	Moderate
									5	Aids to Navigation	Yes	15%	0%	4.00	7.7	5.8	
									6	Pilot/PEC Holder Communication/Controls	Yes	50%	0%	4.00	6.8	4.6	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	4.00	7.7	4.4	3.7
									8	JUB occupancy of authorised channel	Yes	50%	0%	4.00	6.8	3.7	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	4.00	7.7	3.7	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			3.7	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	50%	0%	4.00	6.8	3.7	Minor

Project:	Lower Thames Crossing	Site / Location:	Lower Thames Crossing: Site Investigations	Nash Maritime	Revision:	Rev 02-00

Hazard ID	Baseline Hazard Rank	Residual Hazard Rank	JUB Location	Hazard Category	Hazard Title	Baseline Risk - with existing risk controls in place			Risk Reduction								Results
						Likelihood	Consequence	Baseline Risk	Risk Control ID.	Additional Risk Control (RC) Measures	Include Risk Control	% Likelihood Reduction	% Consequence Reduction	Residual Consequence Score	Individual Control Risk Score	Cumulative Risk Score	
									12		No	0%	0%			3.7	Minor
									13		No	0%	0%			3.7	Risk Reduction
									14		No	0%	0%			3.7	4.3
									15		No	0%	0%			3.7	
7	12	15	1 or more JUBs in Authorised Channel	Small Commercial Vessels	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	2	2	4.0		Baseline with no additional risk controls				2.00	4.0	4.0	Baseline Risk
									1	Safety Boat	Yes	0%	15%	1.93	3.9	3.9	4.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			3.9	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	2.00	3.9	3.7	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			3.7	Minor
									5	Aids to Navigation	Yes	15%	0%	2.00	3.9	3.6	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			3.6	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	2.00	3.9	3.5	2.9
									8	JUB occupancy of authorised channel	Yes	30%	0%	2.00	3.7	3.2	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	2.00	3.9	3.0	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			3.0	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	2.00	3.9	2.9	Minor
									12		No	0%	0%			2.9	
									13		No	0%	0%			2.9	Risk Reduction
									14		No	0%	0%			2.9	1.1
									15		No	0%	0%			2.9	
8	12	17	1 or more JUBs in Authorised Channel	Recreational Vessels	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	2	2	4.0		Baseline with no additional risk controls				2.00	4.0	4.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	1.85	3.7	3.7	4.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			3.7	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	2.00	3.9	3.6	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			3.6	Minor
									5	Aids to Navigation	Yes	15%	0%	2.00	3.9	3.4	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			3.4	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	30%	0%	2.00	3.7	3.1	2.6
									8	JUB occupancy of authorised channel	Yes	30%	0%	2.00	3.7	2.9	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	2.00	3.9	2.7	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			2.7	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	2.00	3.9	2.6	Minor
									12		No	0%	0%			2.6	
									13		No	0%	0%			2.6	Risk Reduction
									14		No	0%	0%			2.6	1.4
									15		No	0%	0%			2.6	
9	9	13	1 or more JUBs in Authorised Channel	Piloted Vessel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	2	3	6.0		Baseline with no additional risk controls				3.00	6.0	6.0	Baseline Risk
									1	Safety Boat	Yes	0%	15%	2.93	5.9	5.9	6.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			5.9	
									3	Traffic Protocols and VTS Control	Yes	30%	0%	3.00	5.5	5.4	Baseline Level
									4	Weather/Metocean Limits	Yes	15%	0%	3.00	5.8	5.2	Moderate
									5	Aids to Navigation	Yes	15%	0%	3.00	5.8	5.0	
									6	Pilot/PEC Holder Communication/Controls	Yes	50%	0%	3.00	5.1	4.1	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	3.00	5.8	3.9	2.9
									8	JUB occupancy of authorised channel	Yes	50%	0%	3.00	5.1	3.0	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	3.00	5.8	2.9	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			2.9	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	50%	0%	3.00	5.1	2.9	Minor
									12		No	0%	0%			2.9	
									13		No	0%	0%			2.9	Risk Reduction
									14		No	0%	0%			2.9	3.1
									15		No	0%	0%			2.9	
10	3	6	0 JUBs in Authorised Channel	Small Commercial Vessels	Small commercial vessels contacts JUB	2	4	8.0		Baseline with no additional risk controls				4.00	8.0	8.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	3.85	7.7	7.7	8.0
									2	Exclusion Zone / Minimum Safe Passing Distance	Yes	50%	0%	4.00	6.8	6.5	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	4.00	7.7	6.3	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			6.3	Moderate
									5	Aids to Navigation	Yes	15%	0%	4.00	7.7	6.0	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			6.0	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	4.00	7.7	5.7	5.2
									8	JUB occupancy of authorised channel	Yes	15%	0%	4.00	7.7	5.4	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			5.4	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			5.4	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	4.00	7.7	5.2	Moderate
									12		No	0%	0%			5.2	
									13		No	0%	0%			5.2	Risk Reduction
									14		No	0%	0%			5.2	2.8
									15		No	0%	0%			5.2	
11	9	9	0 JUBs in Authorised Channel	Recreational Vessels	Recreational vessels contacts JUB	2	3	6.0		Baseline with no additional risk controls				3.00	6.0	6.0	Baseline Risk
									1	Safety Boat	Yes	0%	50%	2.70	5.4	5.4	6.0
									2	Exclusion Zone / Minimum Safe Passing Distance	Yes	15%	0%	3.00	5.8	5.2	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	3.00	5.8	5.0	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			5.0	Moderate
									5	Aids to Navigation	Yes	15%	0%	3.00	5.8	4.8	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			4.8	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	30%	0%	3.00	5.5	4.4	4.0
									8	JUB occupancy of authorised channel	Yes	15%	0%	3.00	5.8	4.2	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			4.2	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			4.2	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	3.00	5.8	4.0	Minor
									12		No	0%	0%			4.0	
									13		No	0%	0%			4.0	Risk Reduction
									14		No	0%	0%			4.0	2.0
									15		No	0%	0%			4.0	
12	11	7	orised Channel	Piloted Vessel	Piloted vessel contacts	1	5	5.0		Baseline with no additional risk controls				5.00	5.0	5.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	4.85	4.8	4.8	5.0
									2	Exclusion Zone / Minimum Safe Passing Distance	Yes	50%	0%	5.00	3.5	4.8	
									3	Traffic Protocols and VTS Control	Yes	50%	0%	5.00	3.5	4.8	Baseline Level
									4	Weather/Metocean Limits	Yes	15%	0%	5.00	4.6	4.8	Moderate
									5	Aids to Navigation	Yes	15%	0%	5.00	4.6	4.8	
									6	Pilot/PEC Holder Communication/Controls	Yes	50%	0%	5.00	3.5	4.8	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	5.00	4.6	4.8	

Project:	Lower Thames Crossing	Site / Location:	Lower Thames Crossing: Site Investigations	Nash Maritime	Revision:	Rev 02-00

Hazard ID	Baseline Hazard Rank	Residual Hazard Rank	JUB Location	Hazard Category	Hazard Title	Baseline Risk - with existing risk controls in place			Risk Reduction								Results
						Likelihood	Consequence	Baseline Risk	Risk Control ID.	Additional Risk Control (RC) Measures	Include Risk Control	% Likelihood Reduction	% Consequence Reduction	Residual Consequence Score	Individual Control Risk Score	Cumulative Risk Score	
12	11	7	0 JUBs in Authc	Piloted Vessel	JUB	1	5	5.0	8	JUB occupancy of authorised channel	Yes	15%	0%	5.00	4.6	4.8	4.8
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	5.00	4.6	4.8	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			4.8	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	50%	0%	5.00	3.5	4.8	Moderate
									12		No	0%	0%			4.8	
									13		No	0%	0%			4.8	Risk Reduction
									14		No	0%	0%			4.8	0.2
									15		No	0%	0%			4.8	
13	12	10	0 JUBs in Authorised Channel	Small Commercial Vessels	Small commercial vessel collides as a result of avoiding JUB	1	4	4.0		Baseline with no additional risk controls				4.00	4.0	4.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	3.85	3.8	3.8	4.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			3.8	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	4.00	3.7	3.8	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			3.8	Minor
									5	Aids to Navigation	Yes	15%	0%	4.00	3.7	3.8	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			3.8	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	4.00	3.7	3.8	3.8
									8	JUB occupancy of authorised channel	Yes	15%	0%	4.00	3.7	3.8	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			3.8	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			3.8	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	4.00	3.7	3.8	Minor
									12		No	0%	0%			3.8	
									13		No	0%	0%			3.8	Risk Reduction
									14		No	0%	0%			3.8	0.2
									15		No	0%	0%			3.8	
14	3	4	0 JUBs in Authorised Channel	Recreational Vessels	Recreational vessels collides as a result of avoiding JUB	2	4	8.0		Baseline with no additional risk controls				4.00	8.0	8.0	Baseline Risk
									1	Safety Boat	Yes	0%	50%	3.70	7.4	7.4	8.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			7.4	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	4.00	7.7	7.1	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			7.1	Moderate
									5	Aids to Navigation	Yes	15%	0%	4.00	7.7	6.9	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			6.9	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	30%	0%	4.00	7.4	6.3	5.8
									8	JUB occupancy of authorised channel	Yes	15%	0%	4.00	7.7	6.0	
									9	Layout Mooring / Buoyage Optimisation	No	0%	0%			6.0	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			6.0	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	4.00	7.7	5.8	Moderate
									12		No	0%	0%			5.8	
									13		No	0%	0%			5.8	Risk Reduction
									14		No	0%	0%			5.8	2.2
									15		No	0%	0%			5.8	
15	12	11	0 JUBs in Authorised Channel	Piloted Vessel	Piloted vessel collides as a result of avoiding JUB	1	4	4.0		Baseline with no additional risk controls				4.00	4.0	4.0	Baseline Risk
									1	Safety Boat	Yes	0%	50%	3.70	3.7	3.7	4.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			3.7	
									3	Traffic Protocols and VTS Control	Yes	50%	0%	4.00	2.8	3.7	Baseline Level
									4	Weather/Metocean Limits	Yes	15%	0%	4.00	3.7	3.7	Minor
									5	Aids to Navigation	Yes	15%	0%	4.00	3.7	3.7	
									6	Pilot/PEC Holder Communication/Controls	Yes	50%	0%	4.00	2.8	3.7	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	4.00	3.7	3.7	3.7
									8	JUB occupancy of authorised channel	Yes	15%	0%	4.00	3.7	3.7	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	4.00	3.7	3.7	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			3.7	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	50%	0%	4.00	2.8	3.7	Minor
									12		No	0%	0%			3.7	
									13		No	0%	0%			3.7	Risk Reduction
									14		No	0%	0%			3.7	0.3
									15		No	0%	0%			3.7	
16	18	18	0 JUBs in Authorised Channel	Small Commercial Vessels	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	1	2	2.0		Baseline with no additional risk controls				2.00	2.0	2.0	Baseline Risk
									1	Safety Boat	Yes	0%	15%	1.93	1.9	1.9	2.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			1.9	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	2.00	1.9	1.9	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			1.9	Slight
									5	Aids to Navigation	Yes	15%	0%	2.00	1.9	1.9	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			1.9	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	2.00	1.9	1.9	1.9
									8	JUB occupancy of authorised channel	Yes	15%	0%	2.00	1.9	1.9	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	2.00	1.9	1.9	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			1.9	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	2.00	1.9	1.9	Slight
									12		No	0%	0%			1.9	
									13		No	0%	0%			1.9	Risk Reduction
									14		No	0%	0%			1.9	0.1
									15		No	0%	0%			1.9	
17	12	16	0 JUBs in Authorised Channel	Recreational Vessels	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	2	2	4.0		Baseline with no additional risk controls				2.00	4.0	4.0	Baseline Risk
									1	Safety Boat	Yes	0%	30%	1.85	3.7	3.7	4.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			3.7	
									3	Traffic Protocols and VTS Control	Yes	15%	0%	2.00	3.9	3.6	Baseline Level
									4	Weather/Metocean Limits	No	0%	0%			3.6	Minor
									5	Aids to Navigation	Yes	15%	0%	2.00	3.9	3.4	
									6	Pilot/PEC Holder Communication/Controls	No	0%	0%			3.4	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	30%	0%	2.00	3.7	3.1	2.8
									8	JUB occupancy of authorised channel	Yes	15%	0%	2.00	3.9	3.0	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	2.00	3.9	2.9	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			2.9	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	15%	0%	2.00	3.9	2.8	Minor
									12		No	0%	0%			2.8	
									13		No	0%	0%			2.8	Risk Reduction
									14		No	0%	0%			2.8	1.2
									15		No	0%	0%			2.8	
										Baseline with no additional risk controls				3.00	3.0	3.0	Baseline Risk
									1	Safety Boat	Yes	0%	15%	2.93	2.9	2.9	3.0
									2	Exclusion Zone / Minimum Safe Passing Distance	No	0%	0%			2.9	
									3	Traffic Protocols and VTS Control	Yes	30%	0%	3.00	2.5	2.9	Baseline Level

Project:	Lower Thames Crossing	Site / Location:	Lower Thames Crossing: Site Investigations	Nash Maritime	Revision:	Rev 02-00

Hazard ID	Baseline Hazard Rank	Residual Hazard Rank	JUB Location	Hazard Category	Hazard Title	Baseline Risk - with existing risk controls in place			Risk Reduction								Results
						Likelihood	Consequence	Baseline Risk	Risk Control ID.	Additional Risk Control (RC) Measures	Include Risk Control	% Likelihood Reduction	% Consequence Reduction	Residual Consequence Score	Individual Control Risk Score	Cumulative Risk Score	
18	17	13	0 JUBs in Authorised Channel	Piloted Vessel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	1	3	3.0	4	Weather/Metocean Limits	Yes	15%	0%	3.00	2.8	2.9	Minor
									5	Aids to Navigation	Yes	15%	0%	3.00	2.8	2.9	
									6	Pilot/PEC Holder Communication/Controls	Yes	50%	0%	3.00	2.1	2.9	Residual Risk
									7	Promulgation and Dissemination of Information (external)	Yes	15%	0%	3.00	2.8	2.9	2.9
									8	JUB occupancy of authorised channel	Yes	15%	0%	3.00	2.8	2.9	
									9	Layout Mooring / Buoyage Optimisation	Yes	15%	0%	3.00	2.8	2.9	
									10	Guard Boat (and Local Traffic Control)	No	0%	0%			2.9	Residual Level
									11	Schedule Optimisation / Deconfliction	Yes	50%	0%	3.00	2.1	2.9	Minor
									12		No	0%	0%			2.9	
									13		No	0%	0%			2.9	Risk Reduction
									14		No	0%	0%			2.9	0.1
									15		No	0%	0%			2.9	

Hazard ID	Baseline Hazard Rank	Residual Hazard Rank	JUB Location	Hazard Title	Baseline Risk	Baseline Level	Residual Risk	Residual Level	Risk Reduction
2	2	1	1 or more JUBs in Authorised Channel	Recreational vessels contacts JUB	9.0	Moderate	6.7	Moderate	2.3
4	3	2	1 or more JUBs in Authorised Channel	Small commercial vessel collides as a result of avoiding JUB	8.0	Moderate	6.0	Moderate	2.0
3	1	3	1 or more JUBs in Authorised Channel	Piloted vessel contacts JUB	15.0	Extreme	5.9	Moderate	9.1
5	3	4	1 or more JUBs in Authorised Channel	Recreational vessels collides as a result of avoiding JUB	8.0	Moderate	5.8	Moderate	2.2
14	3	4	0 JUBs in Authorised Channel	Recreational vessels collides as a result of avoiding JUB	8.0	Moderate	5.8	Moderate	2.2
10	3	6	0 JUBs in Authorised Channel	Small commercial vessels contacts JUB	8.0	Moderate	5.2	Moderate	2.8
12	11	7	0 JUBs in Authorised Channel	Piloted vessel contacts JUB	5.0	Moderate	4.8	Moderate	0.2
1	3	8	1 or more JUBs in Authorised Channel	Small commercial vessels contacts JUB	8.0	Moderate	4.5	Moderate	3.5
11	9	9	0 JUBs in Authorised Channel	Recreational vessels contacts JUB	6.0	Moderate	4.0	Minor	2.0
13	12	10	0 JUBs in Authorised Channel	Small commercial vessel collides as a result of avoiding JUB	4.0	Minor	3.8	Minor	0.2
6	3	11	1 or more JUBs in Authorised Channel	Piloted vessel collides as a result of avoiding JUB	8.0	Moderate	3.7	Minor	4.3
15	12	11	0 JUBs in Authorised Channel	Piloted vessel collides as a result of avoiding JUB	4.0	Minor	3.7	Minor	0.3
9	9	13	1 or more JUBs in Authorised Channel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	6.0	Moderate	2.9	Minor	3.1
18	17	13	0 JUBs in Authorised Channel	Piloted vessel grounds / makes contact with obstacle as a result of avoiding JUB	3.0	Minor	2.9	Minor	0.1
7	12	15	1 or more JUBs in Authorised Channel	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor	2.9	Minor	1.1
17	12	16	0 JUBs in Authorised Channel	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor	2.8	Minor	1.2
8	12	17	1 or more JUBs in Authorised Channel	Recreational vessel grounds / makes contact with obstacle as a result of avoiding JUB	4.0	Minor	2.6	Minor	1.4
16	18	18	0 JUBs in Authorised Channel	Small commercial vessel grounds / makes contact with obstacle as a result of avoiding JUB	2.0	Slight	1.9	Slight	0.1

Appendix G Emails from PLA and PoTLL

From: Nick Evans [redacted]
Sent: 25 May 2021 07:30
To: Chris Hutchings [redacted]
Subject: RE: pNRA HAZID scoring - Minutes and Assessment

Good Morning Chris,

Apologies for the delay.

I have been through the attached, my only comment is on doc. 20-NASH-0068_PLA_Meeting_220510-R01-00.

Section 3 – Vessel Traffic Data, Analysis and Review.

It is stated: Marine usage of future facilities (design and vessel type/size etc…) is yet to be defined.

Projections for usage including predicted vessel type were sent with the Tilbury 2/3 projections 2022-2029 12/04/21. The rest of the statement, in that vessels are likely to arrive/depart in a similar way I have no issue with.

Kind Regards,

Nick.

Nick Evans |Asset Manager Marine| Port of Tilbury London Limited

Marine Department | Tilbury | Essex | RM18 7EH

[redacted]

[redacted]

Sent: 12 May 2021 09:12
To: Cathryn Spain; Nick Evans
Cc: Silvia To; Jamie Holmes; Ian Mockett (LTC)
Subject: pNRA HAZID scoring - Minutes and Assessment

Cathryn, Nick,

Thank you for attending the pNRA HAZID and risk scoring workshop on Monday.

As agreed, please find attached the risk assessment s/sheet for your further review and consideration. Per the minutes, please can you provide any comments by 21 May.

Also attached are minutes of the meeting/workshop. Please can you review/comment/approve these.

Finally, I have attached a copy of the presentation which you may find helpful.

Regards,

Chris

Chris Hutchings | Project Manager

[redacted]

NASH MARITIME Navigation & Shipping Consultants

[redacted]
Sent: 30 July 2021 14:22
[redacted]
Subject: RE: RE: Lower Thames Crossing - pNRA HAZID scoring - Minutes and Assessment

Good afternoon Chris,

I confirm that we do not have any further comments on the NRA.

Kind regards,

Cathryn

Cathryn Spain
Senior Harbour Master

Port of London Authority
T: +44 1474 562212 | M: +44 7715 812692

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[redacted]

Subject: RE: Lower Thames Crossing - pNRA HAZID scoring - Minutes and Assessment

This message originated from outside your organisation

Cathryn,

I realise it's rather a long time since you sent the email below in response to our LTC HAZID scoring, but I have been asked to get your confirmation that following your review on Monday (24 May) you did indeed have no further comments.

Thanks.

Chris

Chris Hutchings | Project Manager

[redacted]

From: Cathryn Spain[redacted]
Sent: 21 May 2021 14:10
To: [redacted]
Subject: RE: pNRA HAZID scoring - Minutes and Assessment

Hello Chris,

I have attached details of our Explosives Licence and the safeguarding distances for the anchorages.

I have attached a printout of the Higham Bight Anchorage use, extracted form POLARIS, which is for the previous 2 years.

For information on the use of the moorings, please contact Barbara in our Marine Services department:

[redacted]

I have been in touch with Barbara so she is aware.

The Tilbury 2 CMAT berth will soon be in operation and will see aggregate vessels such as the YEOMAN BONTRUP, which is 250m LOA, DWT 96772T

Gray's Terminal last upgrade allows for tankers of approximately 235m LOA and DWT 80,000T, although we are not currently seeing that size of vessel.

Northfleet Hope Container Terminal takes vessel of up to 348m LOA. The Cap San Class of vessels have been risk assessed for NHCT and they are 333m LOA and DWT 124,453T

Nick Evans and I have reviewed the NRA and don't have any comments. I do intend to give it a final once over on Monday though, so I can view it on a large screen rather than a laptop, to make sure I haven't missed anything.

Kind regards,

Cathryn

Cathryn Spain
Senior Harbour Master

Port of London Authority
[redacted]

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From: Chris Hutchings [redacted]
Sent: 19 May 2021 11:26
To: Cathryn Spain [redacted]
Cc: Jamie Holmes <j.holmes@nashmaritime.com>
Subject: RE: pNRA HAZID scoring - Minutes and Assessment

This message originated from outside your organisation

Cathryn,

In advance of receiving your comments on the workshop minutes and scoring, are you able to provide the information we discussed during the meeting regarding anchorages – specifically the actions noted as below? Many thanks for your help in this.

A1: CS to provide POLARIS extract/details of usage inc key vessel parameters where known

A2: CS to forward any relevant details of Explosives Licence to NASH Maritime

A3: CS to provide introduction to Barbara Juist from PLA Marine Services for information on any mooring rental/intra-port usage

A4: CS to provide information on largest vessel transiting over tunnel route for emergency anchoring potential (length and DWT would be helpful)

Regards,

Chris

Chris Hutchings | Project Manager

t: +44 (0) 7806 801 729 | e: c.hutchings@nashmaritime.com | w: nashmaritime.com

From: Chris Hutchings
Sent: 12 May 2021 09:12
[redacted]
Cc: Silvia To <Silvia.To@lowerthamescrossing.co.uk>; Jamie Holmes
[redacted]
Subject: pNRA HAZID scoring - Minutes and Assessment

Cathryn, Nick,

Thank you for attending the pNRA HAZID and risk scoring workshop on Monday.

As agreed, please find attached the risk assessment s/sheet for your further review and consideration. Per the minutes, please can you provide any comments by 21 May.

Also attached are minutes of the meeting/workshop. Please can you review/comment/approve these.

Finally, I have attached a copy of the presentation which you may find helpful.

Regards,

Chris

Chris Hutchings | Project Manager

t: **+44 (0) 7806 801 729 |** e: **c.hutchings@nashmaritime.com |** w: **nashmaritime.com**

Appendix H Emails between NASH Maritime and PLA relating to the inclusion of the temporary works are to the pNRA scope

[redacted]
Sent: 19 August 2022 15:42
To: Sam Anderson-Brown <S.AndersonBrown@nashmaritime.com>
Subject: RE: Lower Thames Crossing Preliminary Navigation Risk Assessment

Hello Sam,

On this basis I'm happy that the existing pNRA sufficiently covers this. However, it will need to be re-visited if the methodology for construction changes from that proposed below and previously assessed.

Kind regards,

Cathryn

Cathryn Spain
Senior Harbour Master

Port of London Authority
T: +44 1474 562212 | M: +44 7715 812692

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[redacted]

Sent: 18 August 2022 15:33

[redacted]

Subject: RE: Lower Thames Crossing Preliminary Navigation Risk Assessment

This message originated from outside your organisation

Hi Cathryn,

Thanks for your email, appreciate you taking the time to look at this.

Apologies, I should have included some further information relating to the installation of the coffer dam. The assumed plant required for construction of the coffer dam will include the following:

- **Dumb barge/Jack up barge or pontoon**
- Vibrating Hammer attachment on an excavator, or similar
- Crane – if servicing from land
- Excavator
- **Multi Cat with lifting capacity**
- **Supply barge (for sheet piles)**

The above list of required craft mirrors the list of craft required for the installation of the temporary pipeline (assessed as part of the original pNRA construction phase).

The following construction phase hazards were assessed (based on the use of the above plant) as part of the original pNRA:

Haz Id #:6 Collision of Project pipeline/outfall construction vessels with passing seagoing commercial and passenger vessels

Haz Id #:7 Collision of Project pipeline/outfall construction vessels with passing recreational vessels.

Haz Id #:8 Collision of Project pipeline/outfall construction vessels with passing tug and service, inland freight/cargo and inland passenger

Haz Id #:9 Collision between any 3rd party vessels caused as a result of avoiding Project pipeline/outfall construction vessels on site.

Haz Id #:10 Grounding of Project pipeline/outfall construction vessels during construction.

Haz Id #:11 Grounding of non-project vessels as a result of avoiding Project pipeline/outfall construction vessels on site during construction (All types).

Haz Id #:12 Breakout of Project pipeline/outfall construction vessels during construction when anchored/moored on site.

Haz Id #:13 Contact/grounding of Project pipeline/outfall construction vessels with existing structures

Haz Id #:14 Collision of Project pipeline/outfall construction vessels with passing vessels outside the defined construction area

Haz Id #:15 Collision between any 3rd party vessel caused as a result of avoiding Project pipeline/outfall construction vessels transiting to/from site.

Haz Id #:16 Grounding of Project pipeline/outfall construction vessels whilst on passage to site outside the defined construction area.

Haz Id #:17 Grounding of non-project vessels as a result of avoiding Project pipeline/outfall construction vessels on passage (All types).

As mentioned in my previous email, I see all the above hazards as relevant to the installation of the coffer dam and establishment of the temporary works area and will update the hazard titles to reflect this. However, given that the craft involved in the coffer dam installation are of the same type as those assessed in the original PNHA and the coffer dam location is considerably further north (away from the authorised channel) I don't perceive that there would be any increase in the existing construction phase hazard consequence and likelihood scores.

I have outlined the construction methodology below:

Construction Method
It is envisaged that in total construction would be up to 12 weeks in duration. It is assumed that all works within the intertidal area would be restricted to periods of low water.

Construction and excavation of coffer dam
A sheet-piled coffer dam would be constructed to isolate the section of the flood defence in which the structure is to be installed. Isolation via the coffer dam allows the flood defence to be "breached" for the installation of the structure. Piling works for the coffer dam would be undertaken from a dumb barge with spud legs or anchors on winches, with a 30 to 50 tonne 360 excavator and a multi cat that has a 5 tonne lifting capacity to set anchors as required.

The main piling barge may be serviced by a second dumb feeder barge carrying sheet piles. Alternatively, depending on the final siting of the sluice structure, servicing could be achieved via crane access from the landward side of the defence.

The short sheet piles would be vibro-piled into place (circa 6m "driven" in 4m below trench base) with small vibrating hammer

[redacted]

would be installed along either side of the proposed working area forming the coffer dam. Indicatively, the coffer dam would be approximately 10m x 15m, and would not extend beyond the maximum working area defined for the construction works. Excavation of the section of flood defence would take place within the coffer dam to the required depth.

Excavated arisings would be retained within the coffer dam or stored on a support barge or on land. Arisings would not be side cast within the inter-tidal area.

Installation of structure
The proposed structure selected to convey the water flow would be installed in the location of the flood defence "breach". Due to uncertainty over ground conditions, this may require additional foundation works and therefore piling has been assumed.

Construction Constraints

In line with best practice, the works to construct the self-regulating Water Inlet with self-regulating valve or equivalent structure should be programmed for April – August (to avoid disturbance to passage and overwintering birds associated with European designated sites)where this would not delay the completion of the habitat creation works at the earliest date.

All works requiring access to the inter-tidal zone would be completed to suit tidal cycle and at periods of low water.

All piling works would be completed during periods of low water to avoid transmission of underwater noise.

All piling works would utilise soft start piling and other best practice techniques, asper the JNCC 2010 guidance (Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise), to help avoid noise and vibration impacts.

Excavated arisings would be retained within the coffer dam or stored on a support barge.

No tracking on the upper foreshore area would be carried out

Hopefully the above provides the necessary detail that you are after. More than happy to discuss on the phone if you have any further queries / concerns.

Kind regard,

Sam

Sam Anderson-Brown | Principal Consultant

[redacted]

From: Cathryn Spain[redacted]
Sent: 18 August 2022 14:16
To: Sam Anderson-Brown[redacted]
Subject: RE: Lower Thames Crossing Preliminary Navigation Risk Assessment

Hi Sam,

It would be difficult to say whether the temporary works changes the navigational risk profile, as we don't know how the works will take place. We were a little surprised at the plan to install a cofferdam, rather than working from the shore and we currently don't know how many or what vessels/plant will be involved in undertaking the work, particularly in relation to installing the cofferdam.

Kind regards,

Cathryn

Cathryn Spain
Senior Harbour Master

Port of London Authority
[redacted]

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From: Sam Anderson-Brown
Sent: 11 August 2022 14:09
To: Cathryn Spain [redacted]
Subject: Lower Thames Crossing Preliminary Navigation Risk Assessment

Afternoon Cathryn,

I Hope all is well?

You may remember inputting to a hazard workshop relating to the Lower Thames Crossing preliminary Navigation Risk Assessment (pNRA) in May 21. I appreciate this was some time ago now so I have attached the meeting minutes as an aide memoir. NASH has been instructed to update the original pNRA to take into account an additional component to the temporary construction works and I am writing to seek your view on whether you feel this additional element changes the hazards previously identified and/or the hazard risk profile agreed in the workshop (see attached minutes).

Since the hazard workshop there has been a minor change to the project DCO limits to accommodate a temporary works area. This area is required to facilitate the installation of a permanent self-regulating Water Inlet with self-regulating valve and associated pipeline to provide a direct supply of water from the River Thames. This Water Inlet with self-regulating valve will maintain a range of depths within a proposed ecological habitat mitigation site in proximity to Coalhouse Fort. The temporary works area is 20m (longitudinally to the flood defence) and 35m (extending into the Thames) and is depicted in blue in the attached plot, I have also included the current and previous DCO boundaries in the plot to show the suggested change.

The Water Inlet with self-regulating valve itself is not considered navigationally relevant due to its location in the existing flood defence above mean high water. This location is not only outside the navigation channel but out of the river in all but high tides. However, the temporary works area is considered to be navigationally relevant because of its location within the intertidal zone.

I have reviewed the original risk assessment and the hazards that were outlined during the workshop. Taking in to account the location of the temporary works area, well inshore and some distance from the navigable channel and passing traffic, NASH's view is that the its inclusion in the pNRA does not result in any additional hazards or any change to the existing hazard severity and consequence scores identified. As such we plan to update the pNRA to take the temporary works area in to account but do not see a requirement to add additional hazards or to revisit hazard scoring.

I'd be interested to get your view as to whether you feel the temporary works area fundamentally changes the navigational risk profile. Are there any additional hazards you feel should be considered in addition to those already discussed in the workshop?

More than happy to discuss on the phone or over Teams if that would be useful. Please do let me know if you have any questions.

Kind regards,

Sam

Sam Anderson-Brown | Principal Consultant

[redacted]

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