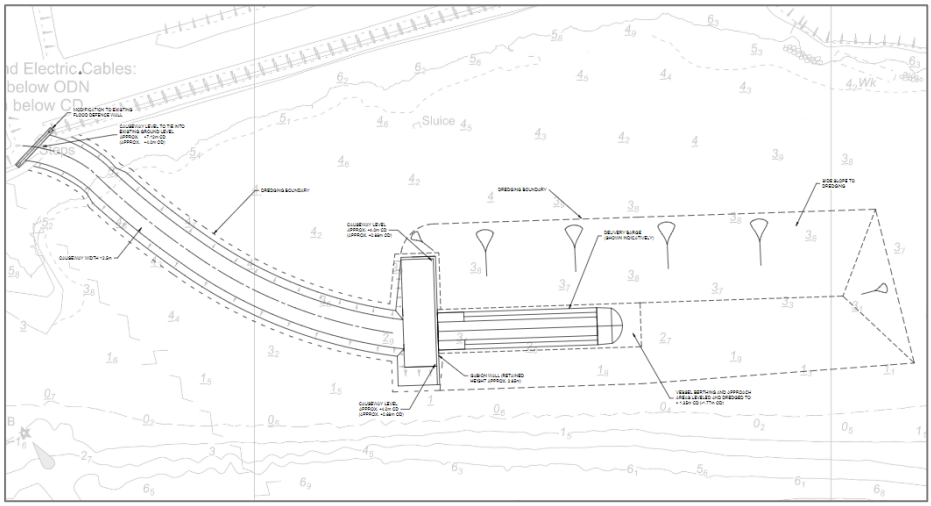
THURROCK FLEXIBLE POWER GENERATION PLANT CAUSEWAY – PRELIMINARY NAVIGATION RISK ASSESSMENT



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STATERA ENERGY

Preliminary Navigation Risk Assessment for the operation of the Thurrock Flexible Power Generation Plant Causeway.

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REPORT TITLE: THURROCK FLEXIBLE POWER GENERATION PLANT CAUSEWAY – PRELIMINARY NAVIGATION RISK ASSESSMENT

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1. INTRODUCTION

NASH Maritime Ltd have been instructed by Statera Energy Ltd to conduct a Preliminary Navigation Risk Assessment (NRA) for the proposed Thurrock Flexible Power Generation Plant Causeway. The initial objective of the study was to assess and quantify the navigation risk posed by the Causeway and marine operation, particularly with regards to vessels arriving and departing Tilbury 2.

The Preliminary NRA supports a Development Consent Order (DCO) submission and subsequent Planning Inspectorate Examination for the wider Thurrock Flexible Power Generation Plant Scheme. **Figure 1** shows the location of the proposed Thurrock Causeway on the north bank of the River Thames - Tilbury 2 is shown to the west of the proposed Causeway.

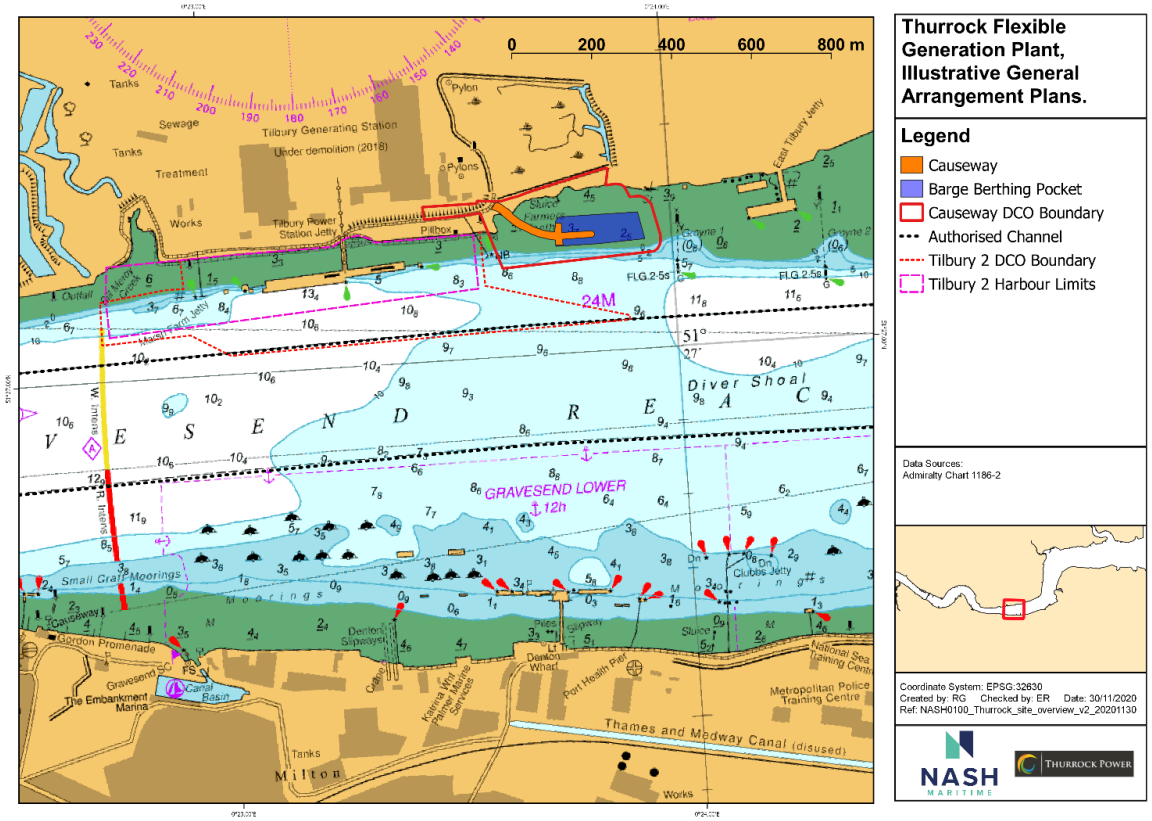


Figure 1: Indicative Causeway, Tilbury 2 and DCO boundaries.

1.1. DOCUMENT PURPOSE AND SCOPE

This report aims to satisfy the requirements of the Port of London Authority (PLA) (and also a request from the Port of Tilbury (POT)) to undertake a study to assess navigation risk posed by the Thurrock Flexible Power Generation Plant Causeway on existing vessel traffic navigating the Thames in the vicinity of the Causeway. The study also considers the possible wider impacts to navigation from the passage of heavy lift barges navigating to and from the Causeway. The study considers the need for additional risk control measures to ensure any

residual risk posed by the Causeway remains tolerable and acceptable to the navigation regulator (PLA) and navigation stakeholders (e.g., POT).

1.2. LEGISLATIVE FRAMEWORK AND GUIDANCE

The NRA has been conducted principally following the guidance set out within the Port Marine Safety Code and is based on a risk assessment methodology provided by the PLA. The methodology is fundamentally based on the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) approach to risk management and utilises quantitative analysis such as vessel track, density and incident analysis; and qualitative judgement through stakeholder engagement and expert judgement to determine navigational risk for the project.

1.3. BASIS OF ASSESSMENT

Consultation correspondence was undertaken with the PLA and POT in late August and early September 2020 and it was agreed that the following existing datasets, review of information and consultation would be an appropriate basis for the NRA:

- Review project details / drawings, documents and parameters – e.g., Causeway construction / operation
- Vessel traffic analysis of passing vessels (particularly those bound to/from Tilbury 2)
- Stakeholder consultation with PLA and POT
- Navigation assessment to:
    - Determine navigation risk to passing vessels and proposed marine operation
    - Identify mitigation measures if required

The assessment is preliminary in nature, pending the final details of the Causeway and associated marine operation. It is therefore envisaged that this assessment will be updated based on the finalised details of the Causeway and associated marine operations and will be reviewed and approved by the PLA.

1.4. CHARTS

All cartography in this report, unless otherwise stated, is to WGS84 UTM Zone 30N standard. All marine charts are in a Mercator projection. Charts are not suitable for navigational purposes.

1.5. REFERENCE DOCUMENTS

The following project documents and drawings were reviewed and / or developed to support the assessment:

- Causeway Concept Report and Design Drawing (DCO Examination Library Ref APP-130) – dated Feb 2020
- MTS Passage Plan for the transit of the *Terra Marique* on the Tidal Thames– developed as part of the NRA (including example Towage Manual) (see **Annex A to D)**
- *Terra Marique* Causeway design drawings showing mooring and offloading details (see **Annex E & F**)

2. THUROCK FLEXIBLE POWER GENERATION PLANT CAUSEWAY

2.1. PROPOSED OPERATION

The Thurrock Flexible Power Generation Development will require delivery of certain large indivisible loads that are of a scale that are difficult to transport on the highway network, with the largest gas engine blocks likely to weigh approximately 330 tonnes. The existence of obstructions that limit weight, height, and width for the transport of Abnormal Indivisible Loads (AIL's) by road, means that transportation of these loads along the highway is not considered practical or cost effective.

Therefore, AILs will be delivered by a roll-on, roll-off (Ro-Ro) Heavy Lift Barge to a Causeway constructed in the Thames. There will be a maximum of 60 barge deliveries over a planned 6-month period, with potentially only 20-30 delivers depending on the number of AIL's transported on each transit to the Causeway. These deliveries will be at intervals of one to three days or more during the construction programme. The Ro-Ro Heavy Lift Barge, most likely to be the *Terra Marique* (see **Figure 3**), will transit on to the Causeway during high tide and will wait in situ. When the tide begins to turn the vessel will ballast down and settle on to the prepared bed of the Causeway.

Delivering the AILs to the Causeway will involve a multi-staged marine operation composed of a number of phases:

1. A seagoing Heavy Lift Ship will transit the AILs to a transhipment site on the river Thames. The POT has been identified as an appropriate site, but several options are being considered and the transhipment site has not been finalised at this stage.
2. A roll-on, roll-off Heavy Lift Barge (possibly *the Terra Marique* or similar vessel) will mobilise to the AIL transhipment site.
3. The AIL will be offloaded from the seagoing Heavy Lift Ship to the Heavy Lift Barge at the AIL transhipment site.
4. The Heavy Lift Barge will transit from the AIL transhipment site to the Causeway.
5. The Heavy lift Barge will berth at the Causeway.
6. The AILs will be unloaded at the Causeway site and transported on to the development site via road.
7. The Heavy Lift Barge will depart the Causeway site.
8. The Heavy Lift Barge will transit from the Causeway site to the transhipment site.

This report considers phases four to eight of the above outlined marine operation. The arrival of the seagoing Heavy Lift Ship at the transhipment site and the unloading of the AILs on to the Heavy Lift Barge will occur within the chosen transhipment sites port waters and will therefore be subject to that ports standard operating procedures (including appropriate Risk Assessment Method Statements (RAMS)). In summary, the scope of the report covers the passage of the Heavy Lift Barge from the chosen transhipment terminal to the Causeway, the berthing and unloading of the AIL's and return of the Heavy Lift Barge to the transhipment terminal.

NASH Maritime Ltd have worked in collaboration with local operators and experts who are familiar with Gravesend Reach and the *Terra Marique* (proposed Heavy Lift Barge) in order to provide the necessary detail regarding the Causeway operation. Contributors include:

a. Peter Wynn - Managing Director of Wynn & Son's Ltd (owners of the *Terra Marique*).

b. Chris Livett – Managing Director of Livett's Group (Thames towage specialist).

c. Chris Evans - Marine Operations Superintendent - Marine & Towage Services Group Ltd (specialists in towing of barges).

In order to accurately identify and highlight the relevant navigation risks as part of the above defined marine operations the NRA considers navigation risk within two defined areas. The first identified as the Heavy Lift Barges passage from the transhipment site to the Causeway and the second identified as the approach to and operation of the Causeway itself. The study area assessed as part of the NRA is shown by the blue continuous line in **Figure 2** and hazards identified within the area outlined in blue are defined as being associated with the passage of the *Terra Marique*. The red line highlights the area in which navigation risk has been identified and is related specifically to the approach to and operation of the Causeway itself.

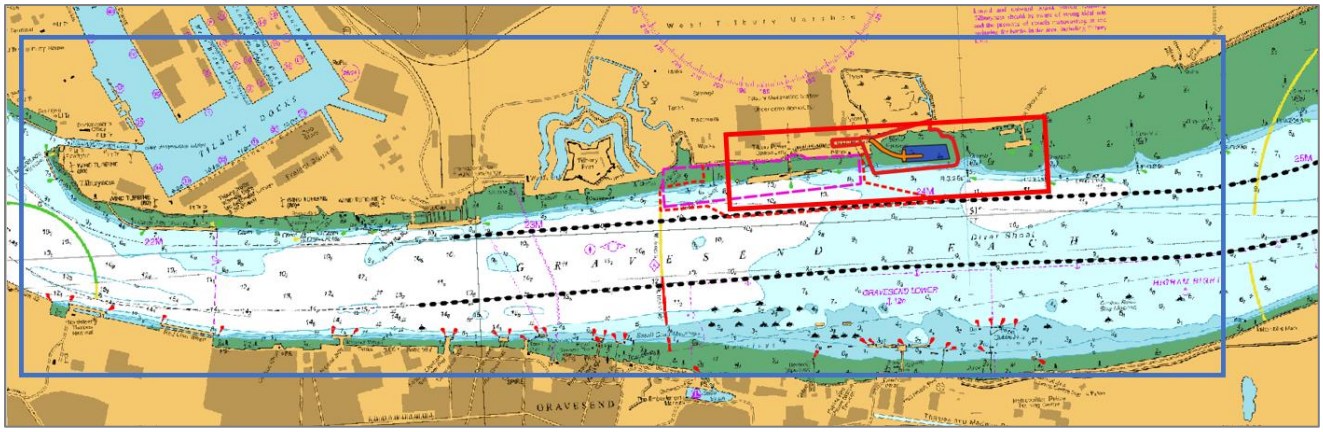


Figure 2: Defined Areas Within NRA Study Area

2.2. DESIGN VESSELS

For the purposes of this report, it is assumed that the *Terra Marique* (see **Figure 3**) will be the vessel utilised as the Heavy Lift Barge. This report therefore refers to the design vessel throughout as the *Terra Marique*.

Throughout her passage to and from the Causeway the *Terra Marique* will be assisted by tugs, one acting as a tow tug and the second acting to assist the *Terra Marique* in close manoeuvres such as arriving and departing the Causeway. For the purpose of this study the *MTS Valour* and *Thames Vixen* are named as the vessels that will assist the *Terra Marique* throughout the marine operation, the use of these two vessels will be subject to availability at the time of the operation. If the *MTS Valour and Thames Vixen* are not available at the time of operation, then similar vessels will be utilised.

Table 1 summarises the key characteristics of the design vessels and qualifications of the respective crews. Images of the three design vessels can be seen in **Figure 3**.

Table 1: Summary of Design Vessel Characteristics

Terra Marique **(Motorised Barge)**	• Motorised heavy lift barge (100AT) (Cat D waters) • LOA 80m / Beam 16.5m / Draught (loaded) 2.8m • Speed Forwards 4.75 kn / Transverse 1.5kn • Mooring – 2 x spud poles and 4-point Mooring system • Crew: Boat Master Tier 1/2 (1 Barge Master, 2 Engineers, 2 AB and Load Master)
MTS Valour (or similar +15t bp) (Primary Tug)	• BV - Tug Coastal Area / MCA Cat 1 • LOA 23m / Beam 9.65m / Draught 2.99m • Bollard pull 23 ton • Crew: Boat Master
Thames Vixen (Berthing tug)	• Ship & Craft towage (MCA Cat 2) • LOA 16.5m / Beam 5.18m / Draught 2.3m • Bollard pull 10ton • Crew: Boat Master

Figure 3: Top Left Terra Marique, Top Right MTS Valour and Bottom Centre Thames Vixen

2.3. DEPARTURE FROM AIL TRANSHIPMENT SITE

The *Terra Marique* will depart the transhipment site with her engines running and available for use should they be required - the *MTS Valour* will act as the main tow tug, whilst the *Thames Vixen* will assist with manoeuvres when required. The AIL transhipment port will have their own requirements regarding the arrival and departure of the vessel - for example, POT have indicated that an independent risk assessment will be required to determine the exact requirements for the *Terra Marique's* passage in and out of the port. This is consistent with the POT's operating procedures that mandate any vessel over 16m in beam to have two tugs whilst in transit through the lock and that any vessel over 80 metres will need to be independently risk assessed before utilising the lock.

For the purposes of this report is assumed that other transhipment ports will have similar requirements, the *MTS Valour* and *Thames Vixen* will therefore be on hand to assist with the operation as the *Terra Marique* departs the transhipment port.

Throughout the operation the vessels will keep in close communication with the transhipment port on VHF radio. MTS, owners of the *MTS Valour*, who regularly tow the *Terra Marique* and frequently perform tows on the tidal Thames have provided an indicative passage plan to provide further clarity regarding the *Terra Marique' s* passage to the Causeway, the relevant sections of this passage plan are shown in **Table 2**.

For the purposes of the report MTS produced a passage plans using the POT and London Gateway as example transhipment ports. The full passage plans for both of these exemplar transhipment ports can be viewed in **Annex A to D**

Table 2: Indicative Passage Plan Showing Departure from Example Transhipment Site.

Way Point	Way Point Name	Position Lat	Position Long	Course / Leg	Distance	Remarks
0	Tilbury Basin	51° 27.274 N	000° 20.798 E			Keep Look out for outbound / inbound vessels to/from Lock & movements in basin Call Tilbury Dock VHF CH 17/ CH 04
1	Enter Tilbury Lock	51° 27.270 N	000° 20.653 E	267.5° 0.08 NM	0.08 NM	Keep Look out for outbound / inbound vessels to/from Lock Call Tilbury Dock VHF CH 17/ CH 04
2	Exit Tilbury Lock	51° 27.295 N	000° 20.322 E	276.9° 0.21 NM	0.30 NM	Keep Look out for outbound / inbound vessels to/from Lock Call Tilbury Dock VHF CH 17/ CH 04

2.4. PASSAGE OF THE THAMES TO THE CAUSEWAY SITE

The *Terra Marique* will depart the transhipment port on the rising tide, leaving adequate time for her arrival at the Causeway site to be around one hour before high tide. It is acknowledged that this may not always be possible and that in some instances the *Terra Marique* may have to await the high tide in a safe location outside

the Authorised Channel. In order that the *Terra Marique* can safely await the high tide two holding areas have been identified - these being a "layby area", shown by the broken blue line and a "waiting area" shown by the broken green line in in Error! Reference source not found..

It is envisaged that the *Terra Marique* will utilise the waiting area, just south of the Causeway site and north of the Authorised Channel when a short delay occurs. For longer delays, it is envisaged that the *Terra Marique* will utilise the layby area to the south of the Authorised Channel. If conditions deteriorate to a level where the operation is no longer considered to be safe or an incident occurs the *Terra Marique* will use the layby area as a safe refuge.

The *Terra Marique* will be assisted by the *MTS Valour and Thames Vixen* on her passage of the river Thames to the Causeway site and will have her engines ready should they be required. The *MTS Valour* will act as the primary tug using a stern tow configuration as per **Figure 4**, whilst the *Thames Vixen* will remain in attendance ready to assist if required.

The *Terra Marique* is classified as 100AT, meaning she is certified to operate in Category D waters, defined as "*tidal rivers and estuaries where the significant wave height could not be expected to exceed 2 metres at any time*". The tidal Thames is categorised by the Maritime Coastguard Agency as a 'Category C waterway down as far as Gravesend, this increases to Category D downstream of Gravesend.

The *Terra Marique* is a highly manoeuvrable vessel but her speed is limited to 4.75 knots, given that ebb stream on the Thames may reach 3 knots at maximum spring rates there is a risk that if transiting under her own engines the *Terra Marique's* slow passage could impact other vessels and increase the risk of collisions occurring within the Authorised Channel as passing vessels look to overtake.

Therefore, whilst the *Terra Marique* is certified to operate independently in anything up to Category D waters, it has been deemed prudent for her to be towed during her passage of the river Thames to the Causeway. This towage provision has therefore been classified as "*supplementary towage*" as it is not currently a requirement under either PLA or POT legislation / procedures.

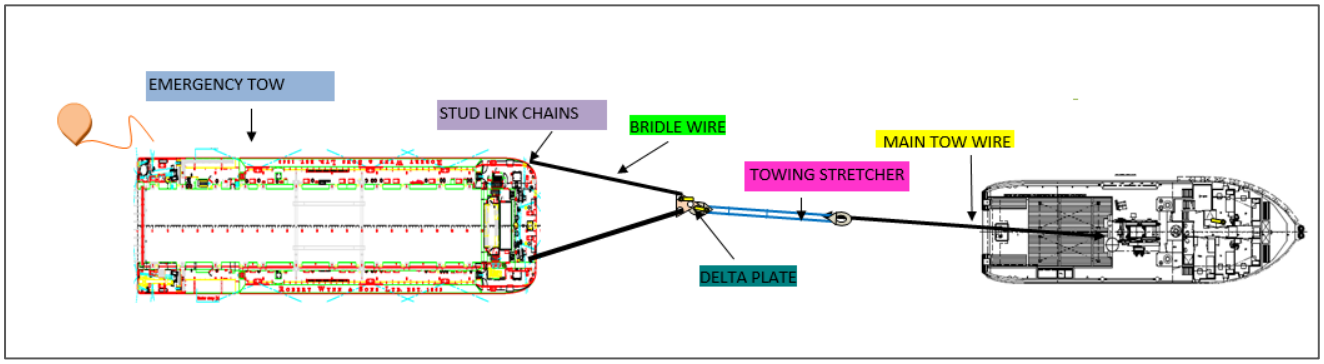


Figure 4: MTS Valour Stern Tow Configuration

The waypoints from the indicative passage plans provided by MTS have been plotted on the relevant PLA charts enabling the indicative passage plan routes to be shown in Error! Reference source not found. (Tilbury to C auseway) and Error! Reference source not found. (London Gateway to Causeway).

Error! Reference source not found. shows the indicative passage plan for the *Terra Marique's* passage from Tilbury t o the Causeway site and the reverse passage from the Causeway back to Tilbury. On the outward leg the *Terra Marique* will exit the POT and cross the Authorised Channel before navigating west on the starboard side of the channel (southern side). She will then transit north and cross the Authorised Channel when adjacent with the Causeway site. On the return leg she will join the Authorised Channel and transit east on the starboard side of the channel (northern side) before re-entering the POT.

Error! Reference source not found. shows the indicative passage plan for the *Terra Marique's* passage from London G ateway to the Causeway site and the reverse passage from the Causeway site back to London Gateway. On the outward leg the *Terra Marique* will join the Authorised Channel and transit upstream on the starboard side of the channel, she will then exit the Authorised Channel to the north when adjacent to the Causeway site and make her approach to the Causeway berthing area. On the return transit she will cross the Authorised Channel transiting on the starboard side of the channel to the west. When adjacent to London Gateway she will cross the channel and transit north to re-enter the Port.

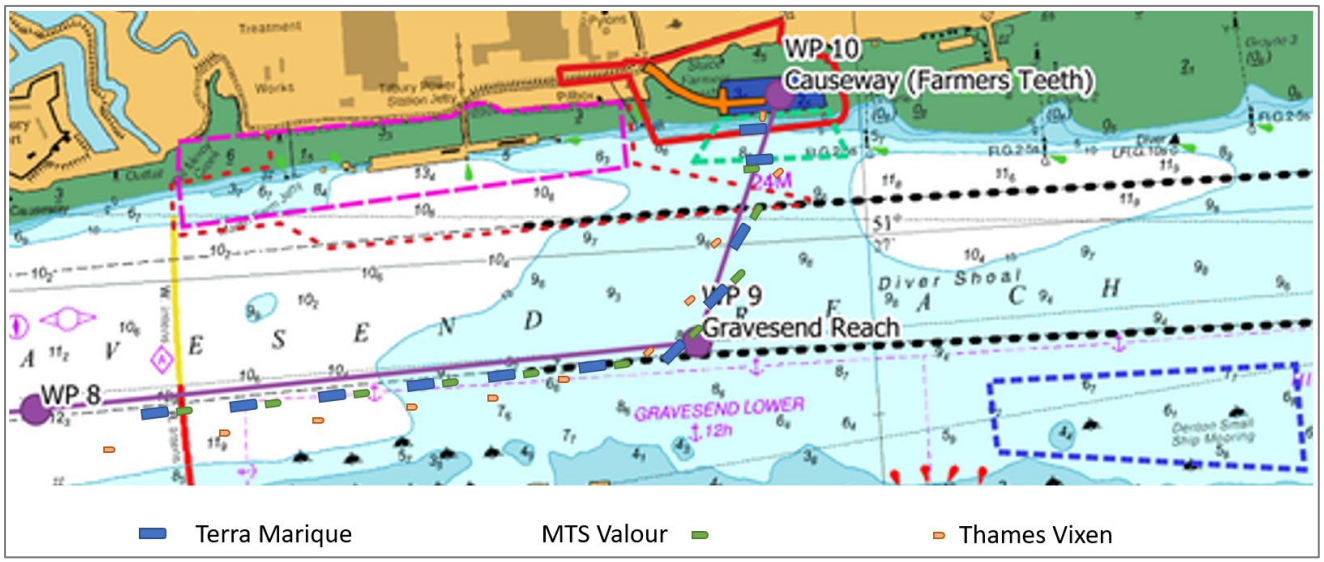


Figure 5: Tow Configuration During Passage

Figure 5 shows the suggested tow configuration developed for the *Terra Marique* 's passage of the Thames (in this instance it is assumed that the *Terra Marique* is approaching the Causeway form Tilbury) with the *MTS Valour* acting as the main tug (with the *Terra Marique* as a stern tow) and the *Thames Vixen* in attendance to provide assistance when required. Upon arrival at the waiting area the *MTS Valour* will either decouple and remain in attendance whilst the *Terra Marique* manoeuvres on to the berth under her own power, with assistance from the *Thames Vixen* or will remain attached to assist the *Terra Marique* on to the berth with assistance from the *Thames Vixen*.

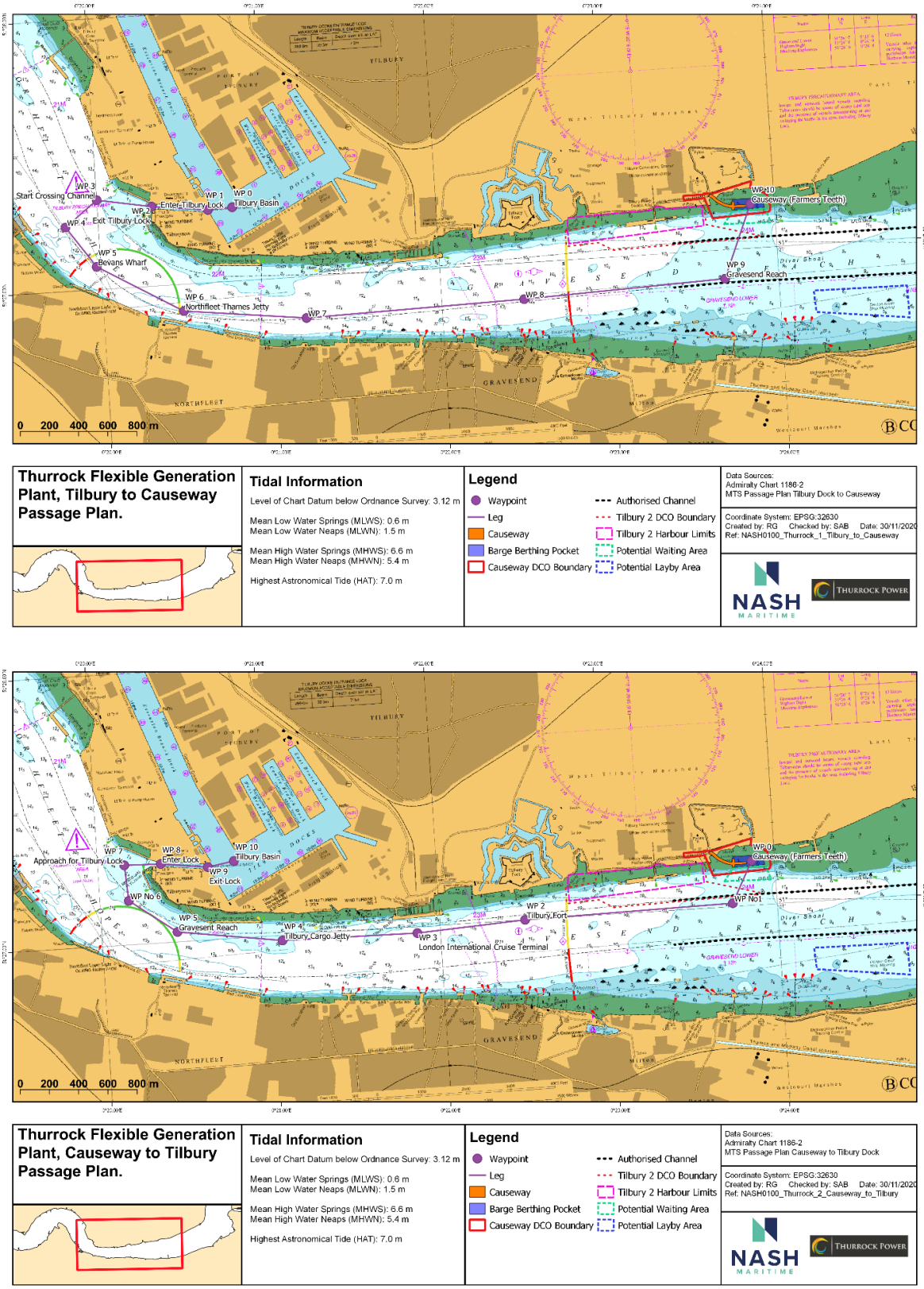


Figure 6: Outline passage plan – Terra Marique Tilbury to Causeway (top) and Causeway to Tilbury (bottom).

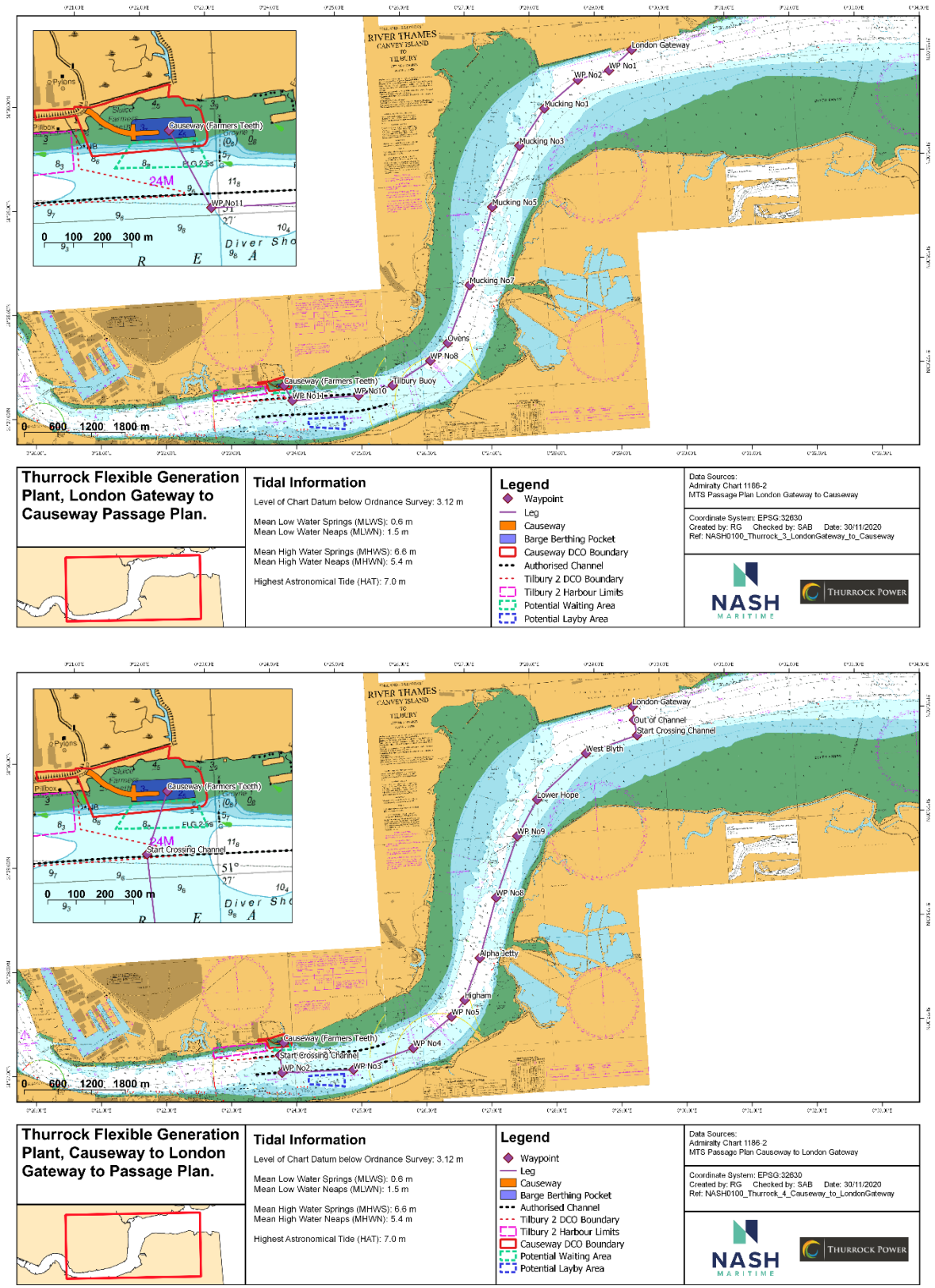


Figure 7: Outline passage plan – Terra Marique London Gateway to Causeway (top) and Causeway to London Gateway (bottom).

In **Figure 5** the *MTS Valour* decouples and assists the *Terra Marique* to hold station in the waiting area (area shown by the broken green line) whilst the high tide is awaited. The *Terra Marique* will then manoeuvre in to position under her own power with assistance from the *Thames Vixen*.

The two berthing operation plans are described in detail in **section 2.5**.

2.5. CAUSEWAY BERTHING AT THE CAUSEWAY

Two suggested options have been identified to allow for the safe berthing of the *Terra Marique* at the Causeway site and it is envisaged that the pilot and barge / tow master will decide which berthing operation option to utilise when developing the detailed port passage plan.

Weather limitations will need to be agreed as part of the safe operating procedures.

2.5.1. BERTHING OPTION 1

Berthing option 1 requires the *MTS Valour* to decouple from the *Terra Marique* as she manoeuvres on to the berth under her own power with assistance from the *Thames Vixen* when appropriate. The *MTS Valour* will remain in attendance to provide assistance if necessary. It is suggested that berthing option 1 is broken down into the following steps:

1. The *Terra Marique* is towed utilising a conventional stern tow to the waiting area off berth, it is envisaged that the arrival at the waiting area should be at approximately HW-1/-0.5hr (see **Figure 8**).
2. The *Terra Marique* engages her engines and bow / stern thrusters.
3. The *Thames Vixen*, acting as berthing assistance tug, will attach to the *Terra Marique*. (**Figure 9**)
4. The *MTS Valour* will decouple from the *Terra Marique* and take up a standby position.
5. When under keel clearance is greater than 0.5m the *Terra Marique* will then manoeuvre on to the Causeway berth, eventually resting against the Causeway itself. It is anticipated that temporary piles may be utilised to mark the berth to aid this manoeuvre. The *Thames Vixen* will assist with the positioning of the *Terra Marique* (**Figure 10**).
6. Once the *Terra Marique* is in position with temporary markers the spud anchors will be dropped and the Thames Vixen decouples.
7. The *Terra Marique* ballasts down (at a rate of 13t per cm) to take the ground.
8. The *Thames Vixen* and *MTS Valour* standby until the *Terra Marique* is safely aground.

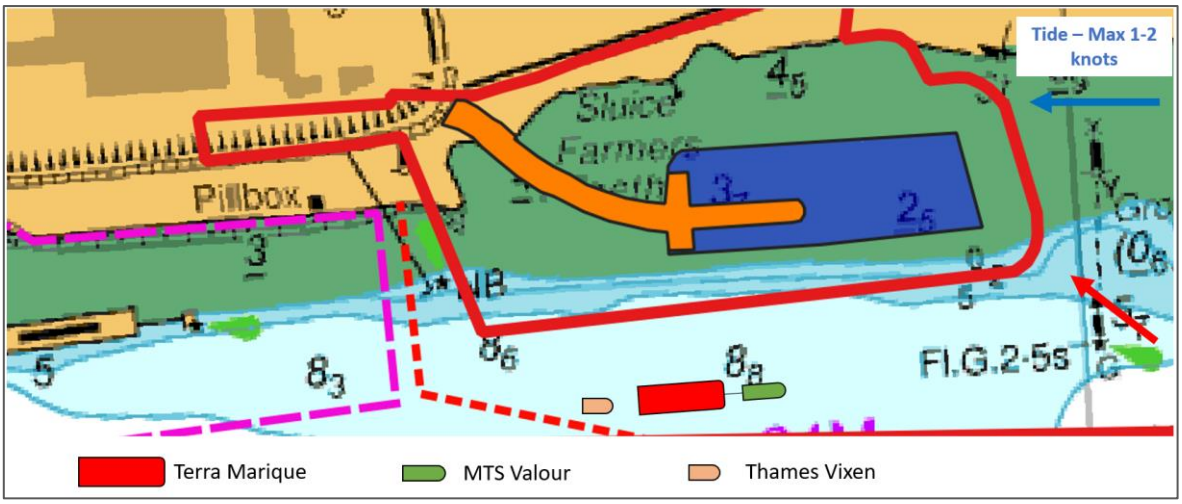


Figure 8: Arrival at Waiting Area

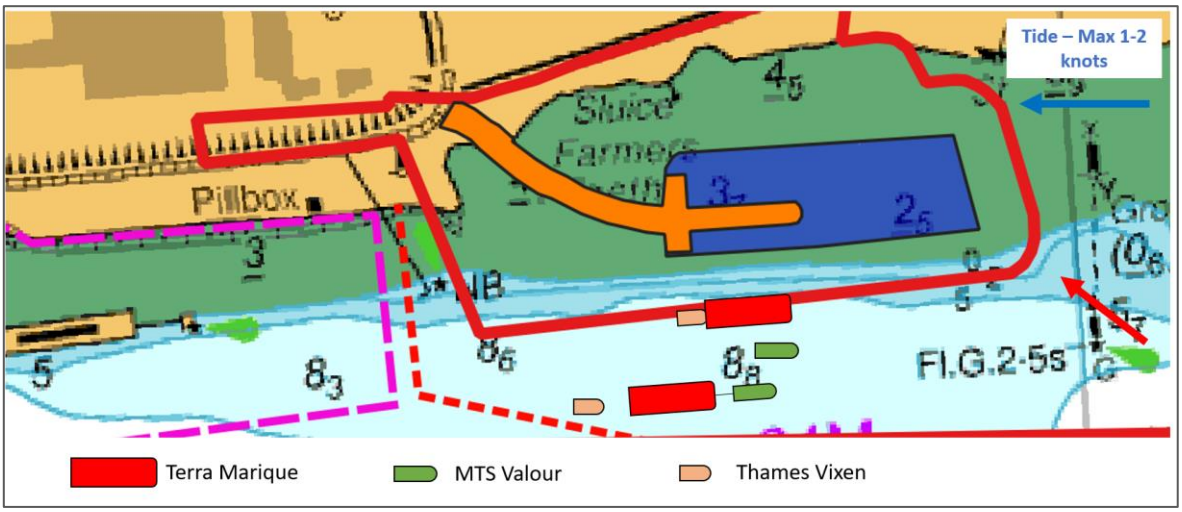


Figure 9: MTS Valour Decouples and Thames Vixen Attached to Stern

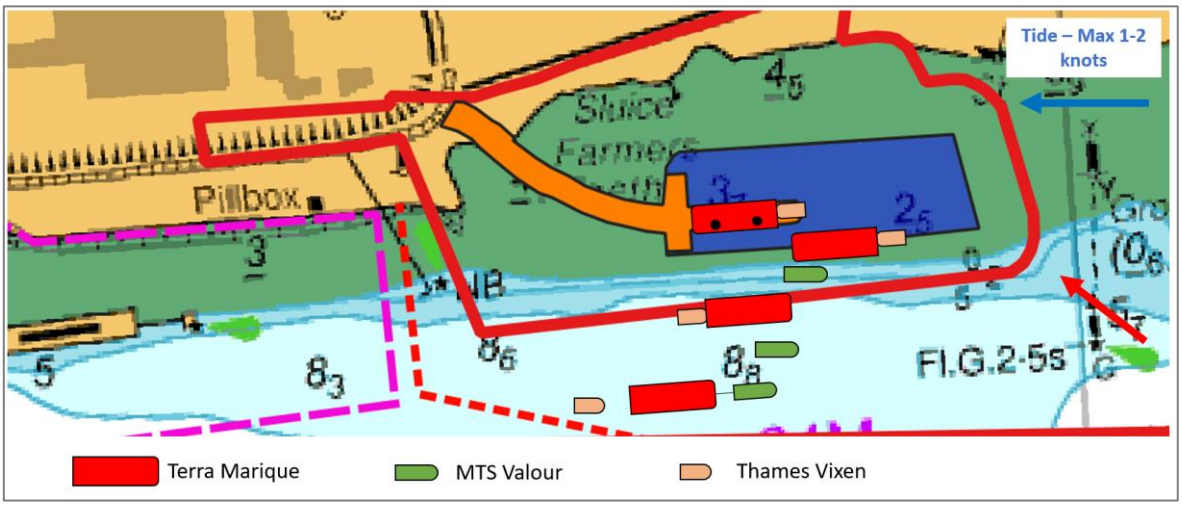


Figure 10: Terra Marique Manoeuvres on to Causeway, Assistance provided by Thames Vixen

2.5.2. BERTHING OPTION 2

Berthing option 2 requires that the *MTS Valour* remain attached to the *Terra Marique* in order to manoeuvre her on to the Causeway berthing area. The *Terra Marique's* engines will be ready and available should they be required but she will manoeuvre on to the berthing area with the tug's assistance rather than under her own power.

1. The *Terra Marique* is towed utilising a conventional stern tow to the waiting area off the berth, it is envisaged that the arrival at the waiting area will be approximately HW-1/-0.5hr (see **Figure 8**).
2. The *Terra Marique* engages her engines.
3. The *Thames Vixen*, acting as berthing assistance tug will remain detached and provide assistance if / when required.
4. The *MTS Valour* will remain attached to the *Terra Marique* and manoeuvre her into position. (see **Figure 11**).
5. When under keel clearance is greater than 0.5m the *Terra Marique* will then be positioned over the Causeway berth, eventually resting against the Causeway itself. It is anticipated that temporary piles will be utilised to mark the berth to aid this manoeuvre. The *Thames Vixen* will assist with the positioning of the *Terra Marique* (see **Figure 12**).
6. Once the *Terra Marique* is in position with temporary markers the spud anchors are dropped and the *MTS Valour* decouples.
7. The *Terra Marique* ballasts down (at a rate of 13t per cm) to take the ground.
8. The *Thames Vixen* and *MTS Valour* standby until the *Terra Marique* is safely aground.

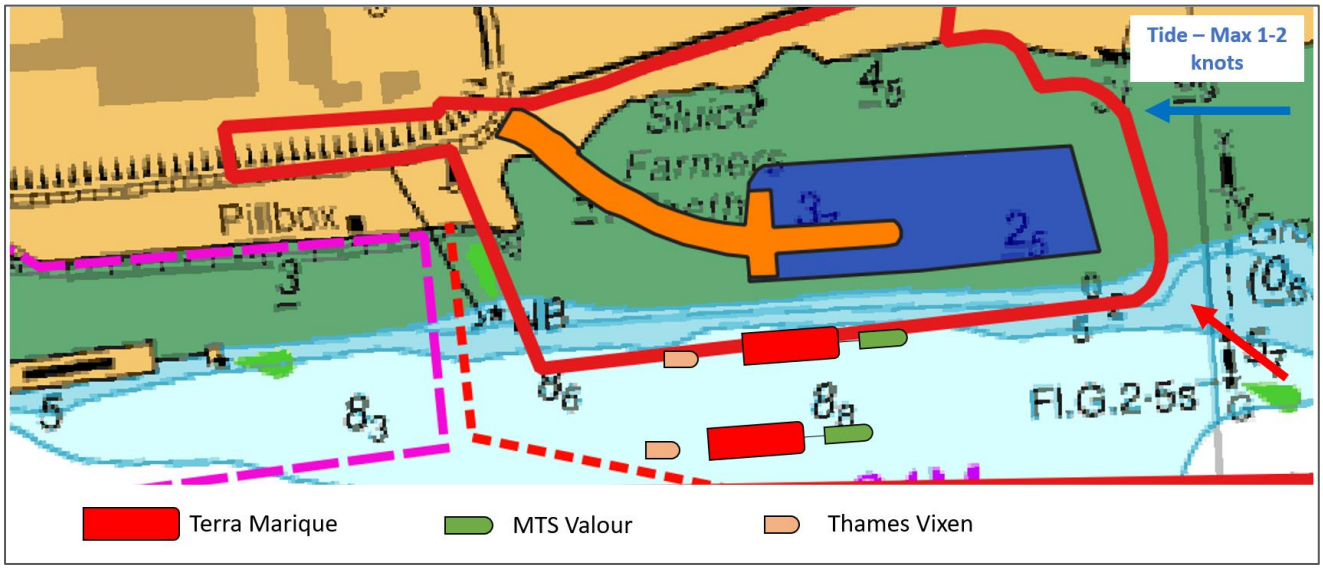


Figure 11: MTS Valour Remains Coupled, Thames Vixen on Standby to assist

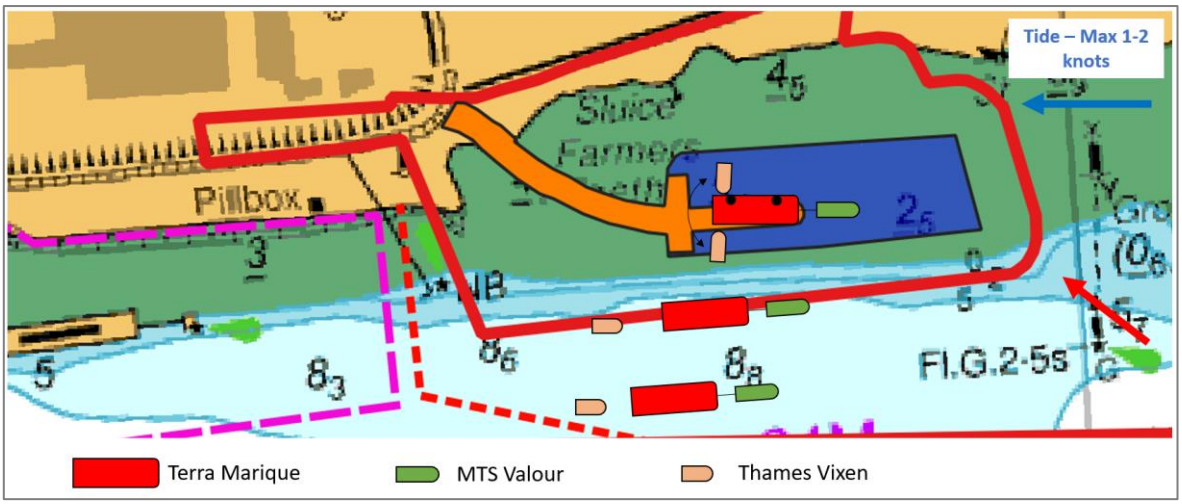


Figure 12: MTS Valour and Thames Vixen Assist Terra Marique on to Berth

2.5.3. *TERRA MARIQUE* TRANSITION TO SAFELEY AGROUND

Once safely in position above the Causeway berth and "spudded in" the *Terra Marique* will need to ballast down and transition from floating to being safely aground. The *Terra Marique* will have a draught of 2.8m and is capable of ballasting down at a rate of 3cm a minute. **Figure 13** shows the *Terra Marique* in position at high water for a Neap tide and Spring Tide arrival at the Causeway.

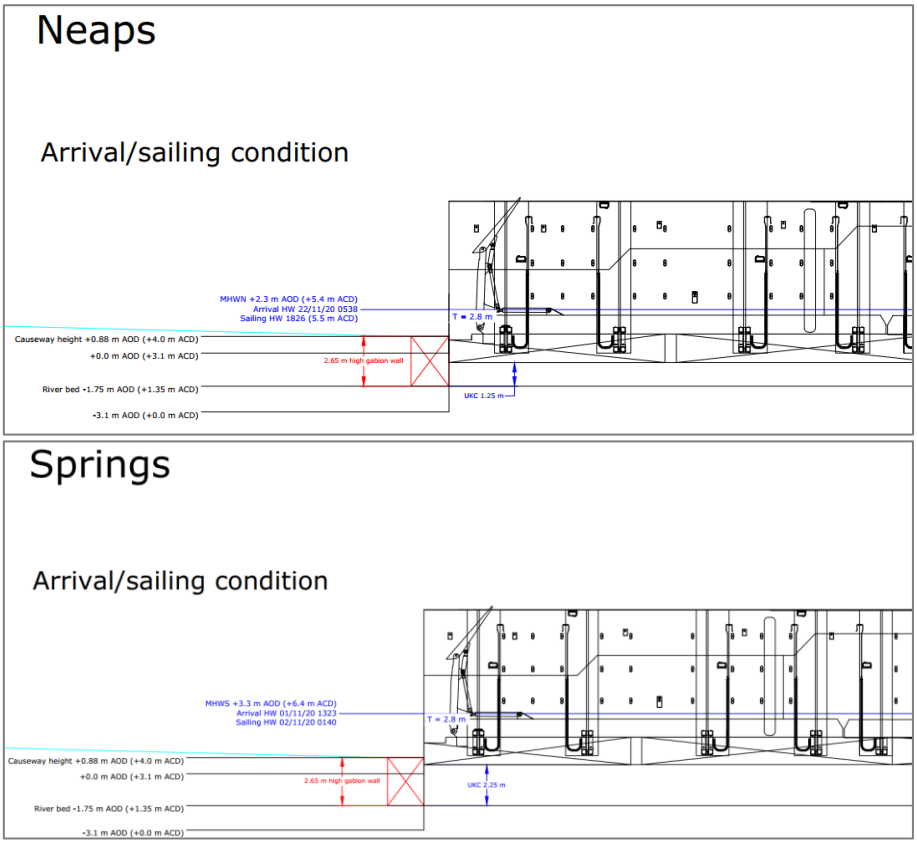


Figure 13: Terra Marique position relevant to Causeway at MHWN and MHWS

Prior to commencement of the ballasting down operation the *Terra Marique* will deploy her spud anchors and begin to ballast down as the ebb tide begins. She will remain floating and will ballast down gradually, the rate of the ebb tide will accelerate the process. When under-keel clearance reaches +0.5m the transition to safely aground is considered to begin, this is the stage at which the *Terra Marique* will potentially be vulnerable to the impacts of wash caused by passing vessels.

Once safely aground the *Terra Marique* will continue to take on water and will ballast down until safely aground as the tide continues to ebb and water level decrease. Safely aground is defined as the *Terra Marique* having an under-keel clearance of -0.5m. The rate at which this will occur will be dependent on the tidal cycle, a summary is outlined in **Table 3**. The transition from safely afloat to safely aground will take between 20 – 30 minutes, depending whether it is a Neap or a Spring tide.

Table 3: Estimated time elapsed for Terra Marique to transition from safely afloat to safely aground.

Operation	Neap Arrival		Spring Arrival	
	UKC [m] Neaps	Duration [mins]	UKC [m]	Duration [mins]
Positioned above berth (spuds dropped)	+1.25	0	+2.25	0
Transition commenced	+0.5	25	+0.5	46
Transition - aground	0	39	0	57
Transition completed - safely aground	-0.5	52	-0.5	68

2.6. UNLOADING

Once the *Terra Marique* has settled on the Causeway berth, the *MTS Valour* and *Thames Vixen* will depart and the AIL's will be unloaded when the Causeway is operational (i.e., clear of water). A gate installed within the flood defence wall at the top of the Causeway will be opened allowing a mobile crane to travel down the Causeway to one of the crane pads adjacent to the barge. This crane will assist with deployment of the barge ramp to form a transition between the barge and the Causeway. A self-propelled trailer or transporter will then travel on to the Causeway from the *Terra Marique* via the barge ramp and onwards to the construction site. The crane will return to disassemble the barge ramp and the vessel will await the rising tide, when there is sufficient under keel clearance *Terra Marique* will transit away from the berth in a reverse of the berthing operation with the assistance of the *MTS Valour* and *Thames Vixen*.

2.7. THE CAUSEWAY AND BERTHING AREA

The Causeway will be constructed of crushed rock, laid directly on to the riverbed. The current soft foreshore sediment will be scraped back by approximately 0.5m, the crushed rock will then be placed directly on to a geotextile membrane liner. Layers of crushed rock and geotextile membrane will then be built up to form the Causeway itself. Rock filled reno-mattresses will protect the sides of the Causeway from erosion.

The Causeway itself will be 12.5m wide in order facilitate the arrival of the largest AIL's. At the outer end of the Causeway, two crane pad areas are provided to accommodate the crane required to assemble the barge ramp structure. **Figure 14** shows a typical cross section of the Causeway.

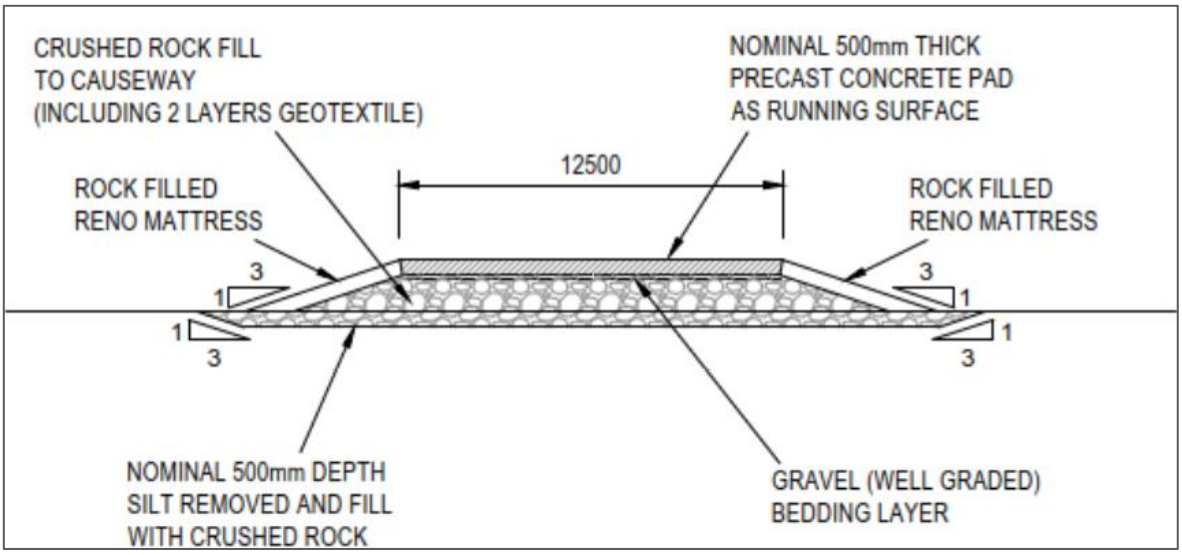


Figure 14: A typical Cross Section of the Causeway

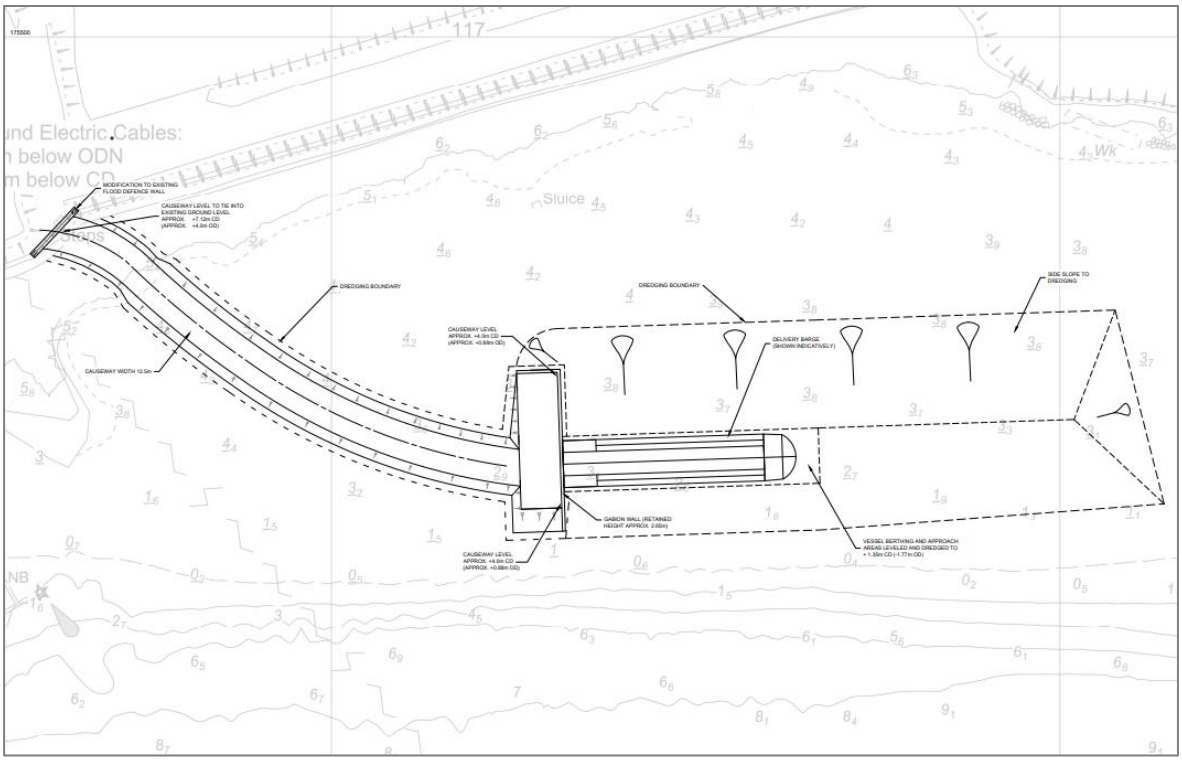


Figure 15: Causeway and Dredged Pocket Area.

The berthing area will be prepared to allow the safe grounding of the *Terra Marique*, the bed will need to be levelled off to remove any high spots and any low spots will need to be filled in. Large obstructions will need to be removed to create a safe, flat surface. The berthing area and approaches to the berthing area will be

dredged to 1.35m above chart datum allowing for the Causeway to be operational at high water on Spring and Neap tides. **Figure 15** shows the Causeway and dredged pocket area.

3. NAVIGATION OVERVIEW

3.1. VESSEL TYPES AND USES

The proposed Causeway site is situated in the middle of the Gravesend Reach on the River Thames. The River Thames is used by a wide variety of vessel types including general cargo vessels, tankers, ro-ro vessels, service vessels of all kinds (e.g., tugs engaged in ship towage, pilot launches, survey vessels, workboats, etc.), intra port trade vessels (cargo and passengers), recreational vessels and less regular users such as non-routine tows and naval vessels.

The 'Authorised Channel[1]' in which most commercial traffic operates is marked by pecked lines on PLA charts and runs parallel past the Causeway and berthing site. Recreation vessels such as yachts, and motorboats also operate in Gravesend Reach, which has sailing clubs located along its banks. The recommended track for recreational vessels is 15m to the north or south of the Authorised Channel.

3.2. NAVIGATIONAL FEATURES AND INFRASTRUCTURE

The main navigational features in the immediate vicinity and surrounding of the Causeway are outlined below (also see **Figure 4**):

- The Divers Shoal, the shallowest part of which lies outside the 'Authorised Channel' and is well marked by a lit, starboard hand buoy and groynes, is located downstream of Tilbury 2; these groynes on the outer ends are lit by starboard hand light beacons. The shoal extends into the 'Authorised Channel' giving a least depth of 9.1 metres as reported by the PLA on 22 Oct 2020.
- There are 6 groynes immediately to the east of the proposed Causeway site, each marked as described above and marking the Divers Shoal.
- Approximately 400m to the east of the Causeway is the East Tilbury Jetty, which is currently used by the tugs "*GPS India*" and "*GPS Ionia*" discharging spoil from various infrastructure projects along the Thames.
- Tilbury 2 terminal is approximately 300m to the west of the proposed Causeway. Tilbury 2 currently operates as a ro-ro cargo terminal facilitating on average two arrivals and departures a day by two vessels.
- PLA mini-plot 150, registered on 23 Sep 2019 shows a shoal with a least depth of 7.4 metres opposite the Tilbury 2 terminal, on the southern side of the 'Authorised Channel'. This depth will not be dredged but it is regularly surveyed and reported by the PLA.

[1] The Authorised Channel should not be obstructed by any permanent works, and temporary obstruction or closure of the Authorised Channel for sporting or cultural events may be permitted only in exceptional circumstances or for significant public events.

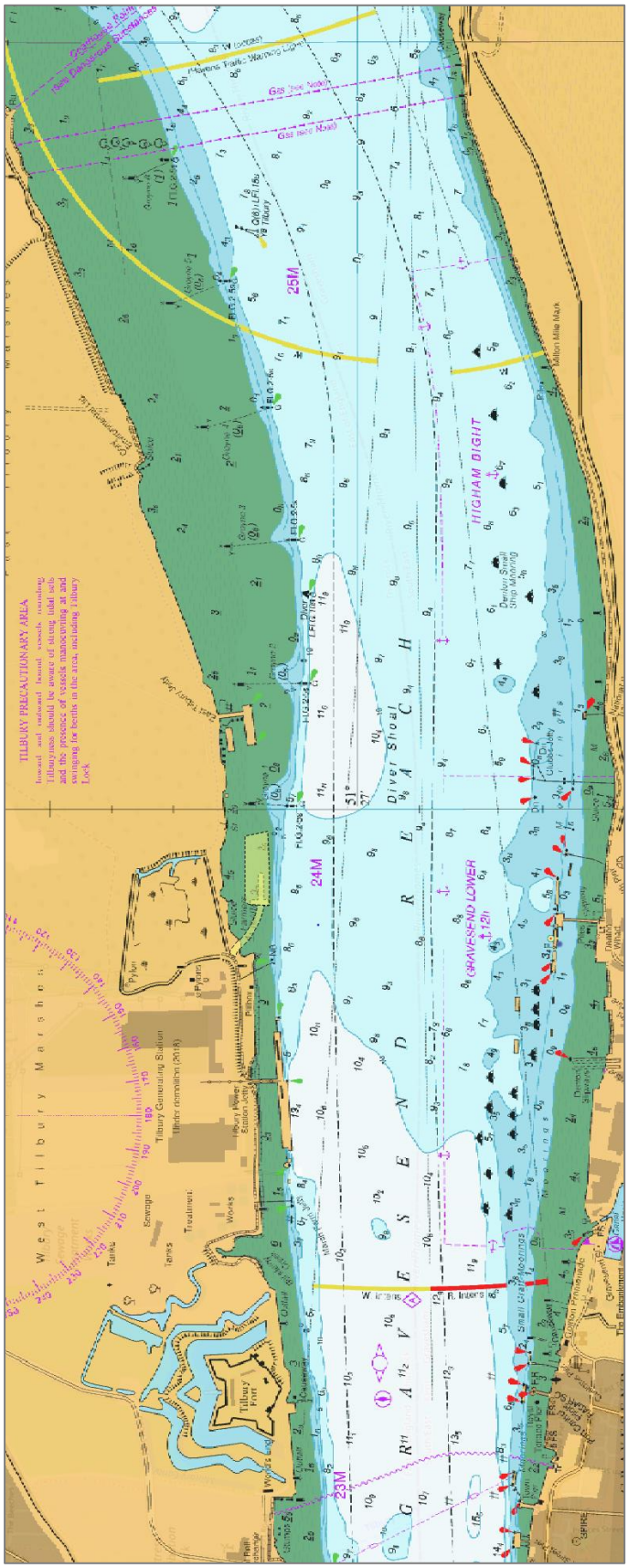


Figure 16: The Causeway (Yellow) and Surrounding Area.

- On the southern side of the Authorised Channel, opposite Tilbury 2 and the Causeway site there are several moorings. PLA service vessels operate from Royal Terrace Pier and Denton Wharf, and the Tilbury ferry departs from Town Pier. A regular aggregates service upriver operates from Clubbs Jetty and Gravesend Sailing Club is located on the south bank. It should be noted that all these navigational features on the southern side lie well clear of the 'Authorised Channel', nevertheless a serious marine casualty occurred on 15 Nov 2012 when the bulker *MV Amber* (10,490 GT) struck the moored barges off Denton Wharf in fog – MAIB Report No 22/2013 dated October 2013 provides further detail. (https://assets.publishing.service.gov.uk/media/547c6f48e5274a429000001d/mvAmber.pdf)

3.3. TIDES AND TIDAL STREAMS

The maximum spring tidal range in Gravesend Reach can be as much as 6.5 metres and surges and cuts in the tidal heights are not uncommon. London VTS mitigates this risk by including relevant information on heights of tide during its routine half-hourly VHF broadcasts. **Table 4** gives a summary of the tidal heights at the Tilbury Tidal Station.

Table 4: Tilbury Tide Station Tide Heights [m]

Level of Chart Datum below Ordnance Survey	Mean Low water Springs (MLWS)	Mean Low Water Neaps (MLWN)	Mean High Water Neaps (MHWN)	Mean High Water Springs (MHWS)	Highest Astronomical Tide (HAT)
3.12	0.6	1.5	5.4	6.6	7.0

Tidal streams in the main part of the Authorised Channel on the ebb stream may reach 3 knots at maximum spring rates: the flood stream is usually a little less; the tide reduces towards the riverbanks but even off the alongside berths it can reach 1 knot.

3.4. WEATHER

Gale force (>35 knots) winds occur on average on two days each month, although as might be expected this could increase to 4 days during the months of November, December, and January. Fog occurs, on average on 11 days each year with two days per month being common during December and January – note the *MV Amber* serious marine casualty referred to above.

3.5. PORT OF LONDON AUTHORITY

The PLA is the Statutory Harbour Authority (SHA) for the River Thames responsible for "*maintaining safe access and managing and supporting the safety of vessels, the general public and all users of the tidal River Thames, together with a duty to improve and conserve the river and its environment*[2]".

[2] Quoted from the PLA's Navigational Safety Policy

The PLA Harbour Master is responsible for the management of navigation safety in vicinity of Tilbury 2 on the River Thames and, at the time of conducting this assessment, the PLA are identified as the appropriate overarching statutory authority responsible for implementing regulation, guidance and administering risk control measures aimed at managing navigation risk and safety within the Thurrock 'DCO Order Limits' and the area of Causeway operation. The PLA publish their regulations, codes of practice and other general guidance on their website (www.pla.co.uk) which includes 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.

The key "embedded" risk control measures utilised to mitigate risk in this NRA are outlined in section **6.5**

3.6. PORT OF TILBURY AND TILBURY 2

Adjacent to the PLA SHA area, the POT have SHA responsibilities for Tilbury 2 within the area marked 'Tilbury Harbour Limits' demarcated in **Figure 1**. The POT also has SHA responsibilities for the impounded Tilbury dock.

Consultation with the Asset Manager Marine at the POT confirmed that the *Terra Marique* will be subject to an independent passage plan risk assessment in order to confirm any operating restrictions applicable should the POT be chosen as the AIL transhipment terminal. Should the POT be utilised it is understood that the below restrictions and requirements will apply to the *Terra Marique* whilst transiting through the POT impounded dock and lock system:

- Draught is unrestricted at all states of tide (minimum draught for operations at all states of the tide being 4.1m).

- Two tugs will be required to assist in transit through the lock – which is a POT requirement for any vessel with a width greater than 16m.
- Tug and tows over 80m have to be assessed on an individual basis – similar to a non-routine passage plan risk assessment required by the PLA and commonly undertaken when details of the vessel, timings and operation are finalised.

4. BASELINE CHARACTERISATION

To establish baseline traffic levels and disposition of vessel traffic activity in the vicinity of the proposed Causeway, NASH Maritime Ltd installed an AIS[3] station at the POT in order to monitor vessel activity in the study area. AIS data was collated from the 22nd September 2020 to the 6th October 2020 and this data has been analysed in order to understand the general / representative disposition of vessel movements in and around the study area.

A further AIS data set, procured from the PLA, from September 2018 has also been analysed in order to benchmark the 2020 data in response to concerns raised by the PLA and POT that vessel numbers are reduced from previous years, due to the impact of the Covid-19 pandemic.

In order to establish a baseline understanding of vessel movement in vicinity of the Causeway and passage of the *Terra Marique* the following analysis was conducted:

- Vessel track analysis by vessel type
- Vessel density analysis
- Gate analysis near the proposed site
- Swept path analysis of vessels berthing / unberthing at Tilbury 2 (and of vessels similar to the *Yeoman Bridge* arriving / departing a berth in the vicinity of the project location).

A full review of PLA incident data was also undertaken in order to inform likelihood / consequence of hazard occurrence.

The following sections provide details and analysis of the disposition of vessels navigating in Gravesend Reach and in close proximity to the proposed Causeway and the Tilbury 2 terminal. This provides the baseline evidence behind the understanding and characterisation of vessel traffic that informs the assessment of risk.

4.1. BENCHMARKING AIS DATA

The AIS data analysed to inform the NRA presented as part of this report covers periods in early autumn in 2018 (pre-COVID and pre-Tilbury 2 opening) and 2020 (during COVID – but not within a lock down period for England and with Tilbury 2 in operation). The AIS data presented allows analysis of vessel traffic disposition by vessel type and transit geometry past the Causeway site. It is considered that September represents a good approximation of commercial vessel traffic. Whilst, detailed seasonal and historical statistics of vessel traffic

[3] AIS data is vessel position data transmitted by vessels engaged in commercial cargo or passenger operations navigating on the River Thames. 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, size, type, etc.) and "dynamic" information (e.g. speed, heading, position, etc.).

transits past the Causeway site are not available it is possible to compare the AIS data collected and analysed for 2018 and 2020 with:

- Department for Transport: Average London port traffic, total tonnage and units, quarterly from 2009 to 2019 – which shows that September provides a reasonable proxy for commercial vessel movements through the year (see **Figure 17**) with Jul-Sept being the highest average tonnage and units of all four seasons.
- Department for Transport: London port traffic, by total tonnage and units, quarterly from 2009 to 2019 – which shows that September provides a reasonable proxy for commercial vessel movements (see **Figure 18**).

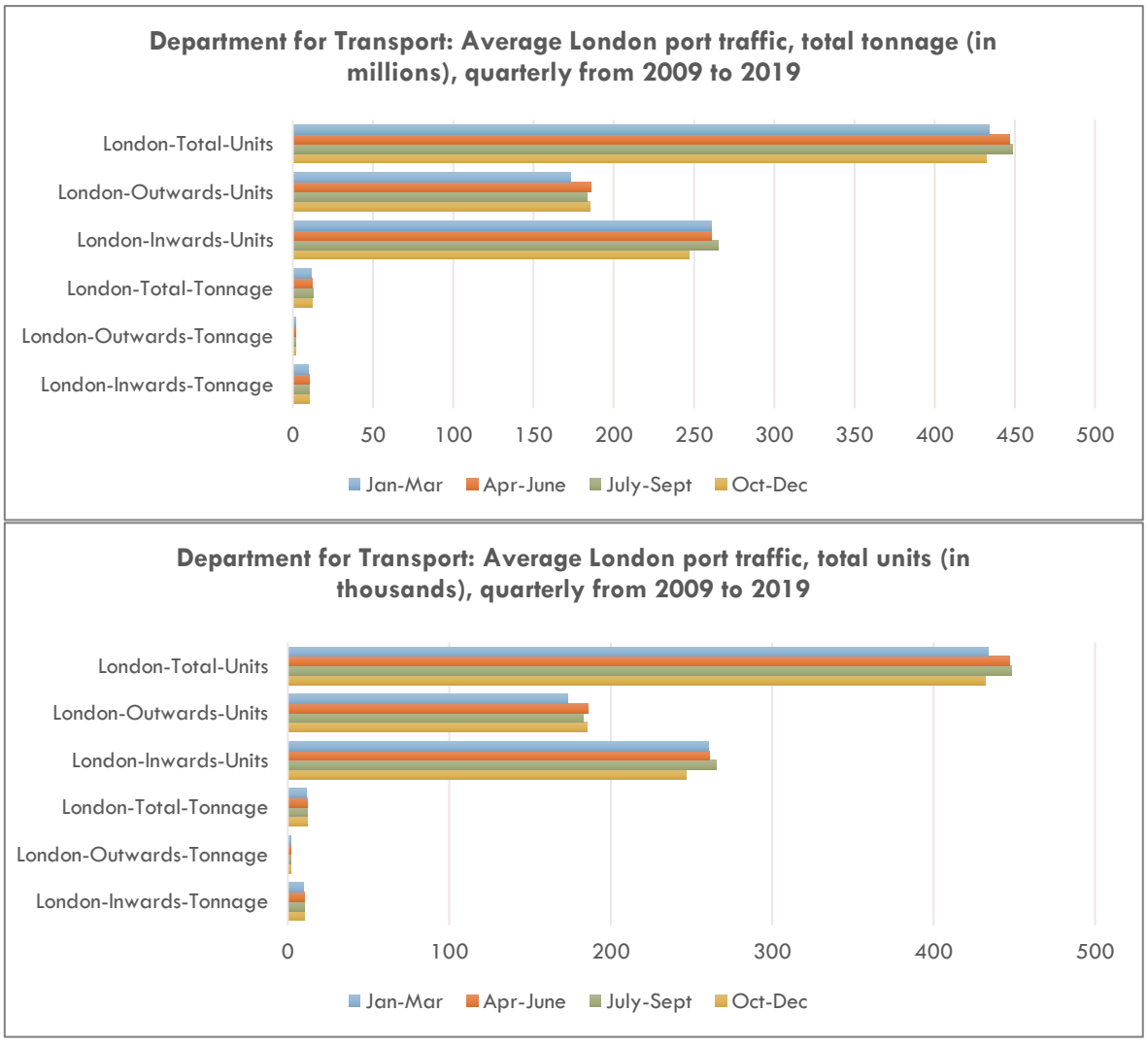


Figure 17: Analysis of London port traffic by total tonnage (top) and units (TEU) (bottom).

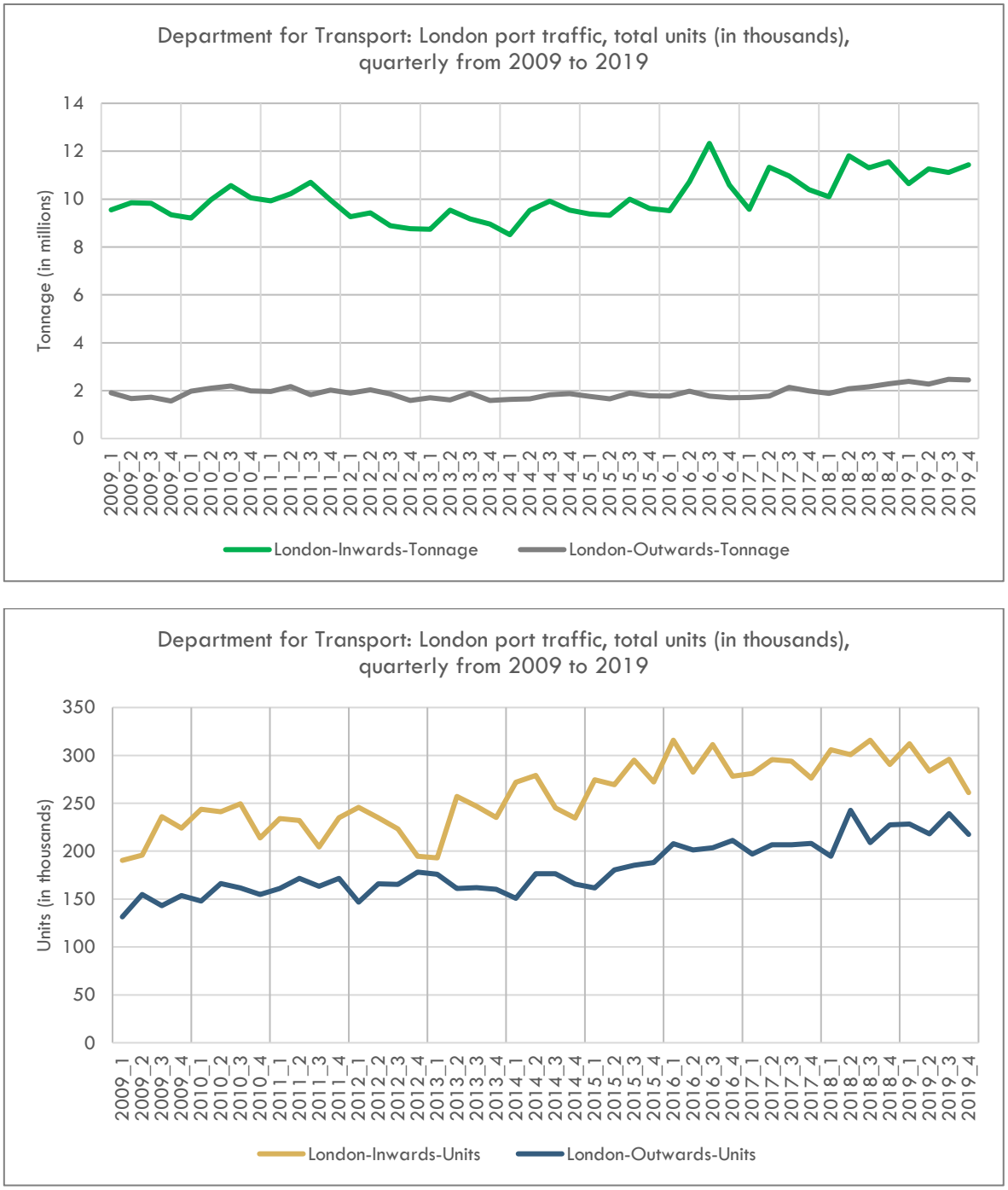


Figure 18: Analysis of London port traffic by total tonnage (top) and units (bottom) between 2009 and 2019

Additionally, statistics from the PLA published as part of their annual statement, indicate that "*chargeable vessel*" numbers are largely static on the River Thames, whilst trade tonnage has increased slightly between 2014 and 2019 (see **Figure 20**).

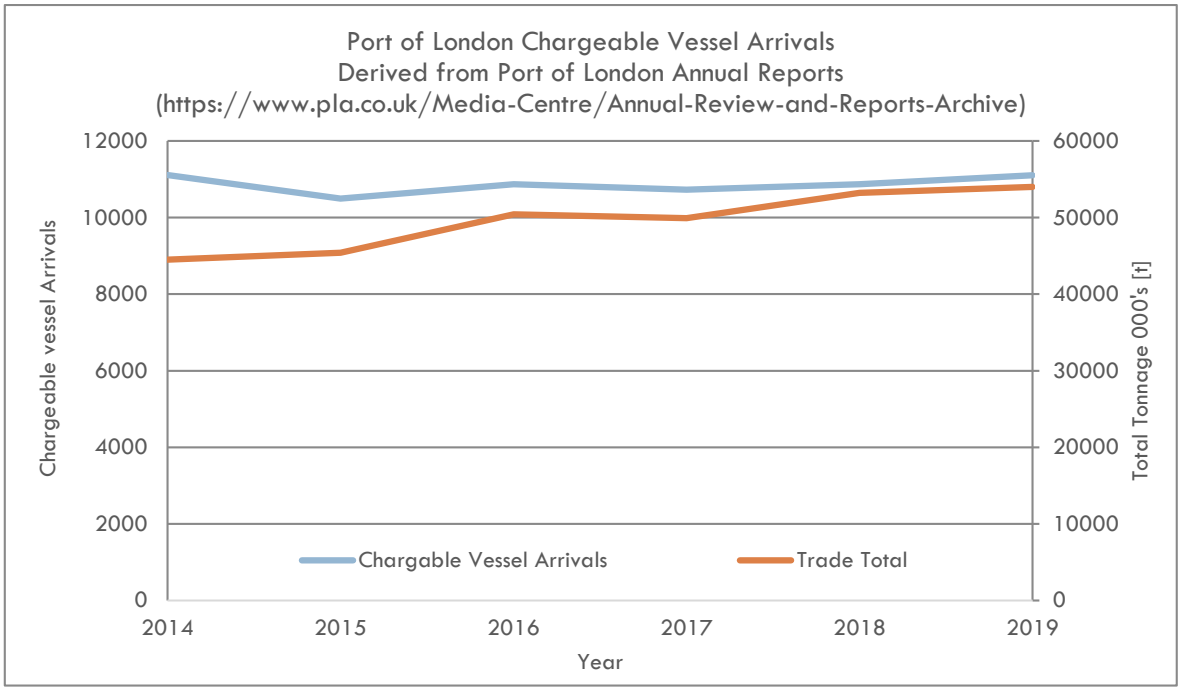


Figure 19: Port of London "Chargeable Vessels Arrivals"

4.2. VESSEL TRACK AND VESSEL DENSITY ANALYSIS

Vessel traffic analysis was undertaken on the AIS datasets based on the follow vessel type classifications:

- All AIS equipped vessels
- Commercial sea going vessels, e.g.:
  - Cargo
  - Tanker
  - Sea going passenger (cruise ships / ferries)
  - Dredgers
  - Naval Vessels
- Intra port trade vessels, e.g.:
  - Inland Freight / Cargo (e.g., Polla Rose, Yasam Rose, Prior Boats, GPS tugs, Livet's tugs)
- Intra Port passenger vessels, e.g.:
  - High Speed Craft Passenger Vessels
  - Class 5 Passenger Vessels
- Tug and Service Vessels, e.g.:
  - Harbour towage (Svitzer, SMS, etc.)
  - Pilot boat
  - Survey boat
  - Workboats
  - RNLI

- Recreational vessels, e.g.:
  - Yachts
  - Motor Cruisers

4.2.1. ALL AIS EQUIPPED VESSELS

Figure 20 shows all vessel tracks for every vessel equipped with AIS that transited through the study area during the 2018 and 2020 data collection periods. The noteworthy difference between the two data sets being the activity around the Tilbury 2 terminal and the activity around East Tilbury Jetty. The Tilbury 2 terminal did not become operational until June 2020 hence there is no activity around the terminal area shown in the 2018 vessel track plot. Similarly, activity around the East Tilbury Jetty site is shown in 2020 because the landing stages are currently used by tugs transporting spoil from the Thames Tideway Tunnel project, this activity was not taking place in 2018.

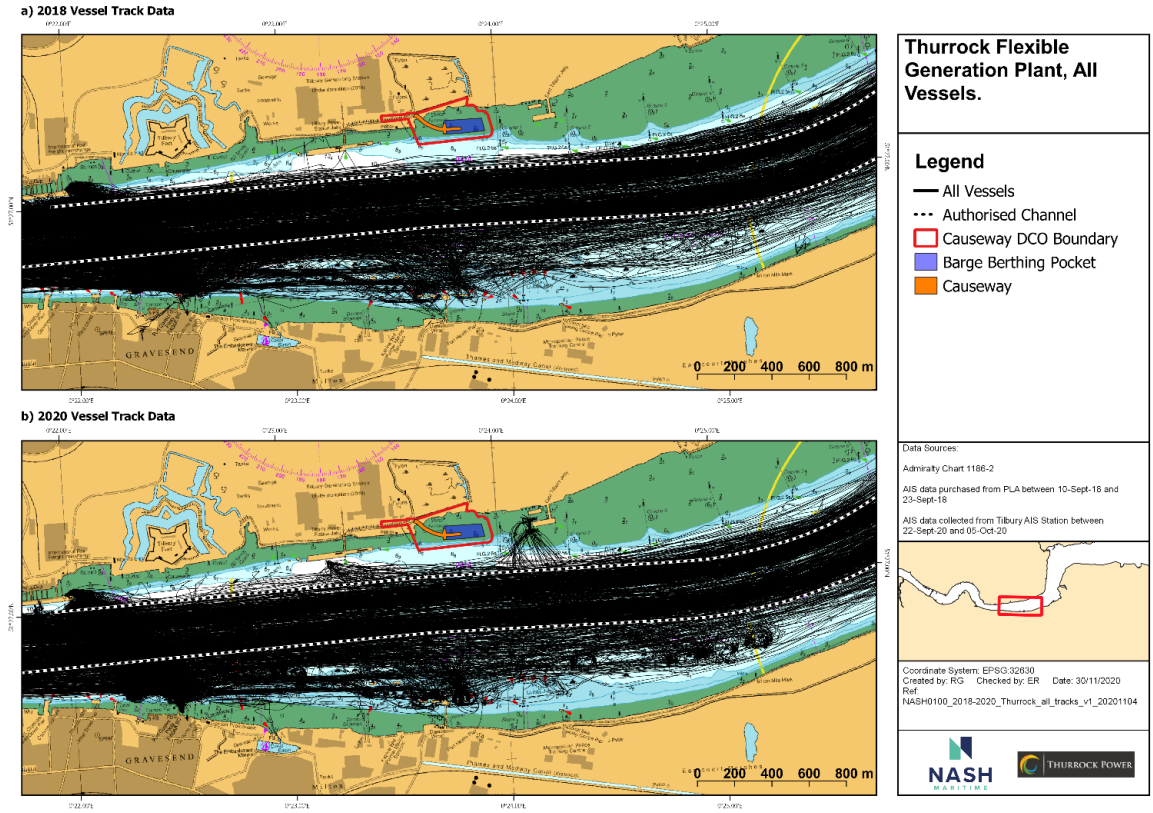


Figure 20: 2018 and 2020 – All AIS Equipped Vessel Tracks in Study Area

4.2.2. COMMERCIAL SEA GOING VESSELS

Figure 21 below shows vessel tracks made by commercial vessels (seagoing cargo, tanker, cruise ships, ferries, dredgers and naval ships). The 2018 data shows that all commercial use was confined to the Authorised Channel with no vessels shown to be navigating outside the Authorised Channel, this is to be expected because Tilbury 2 terminal did not become operational until June 2020. The 2020 plot shows that regular transits to the Tilbury 2

terminal were made throughout the study period, further analysis of the Tilbury 2 operation is presented in section **4.8.**

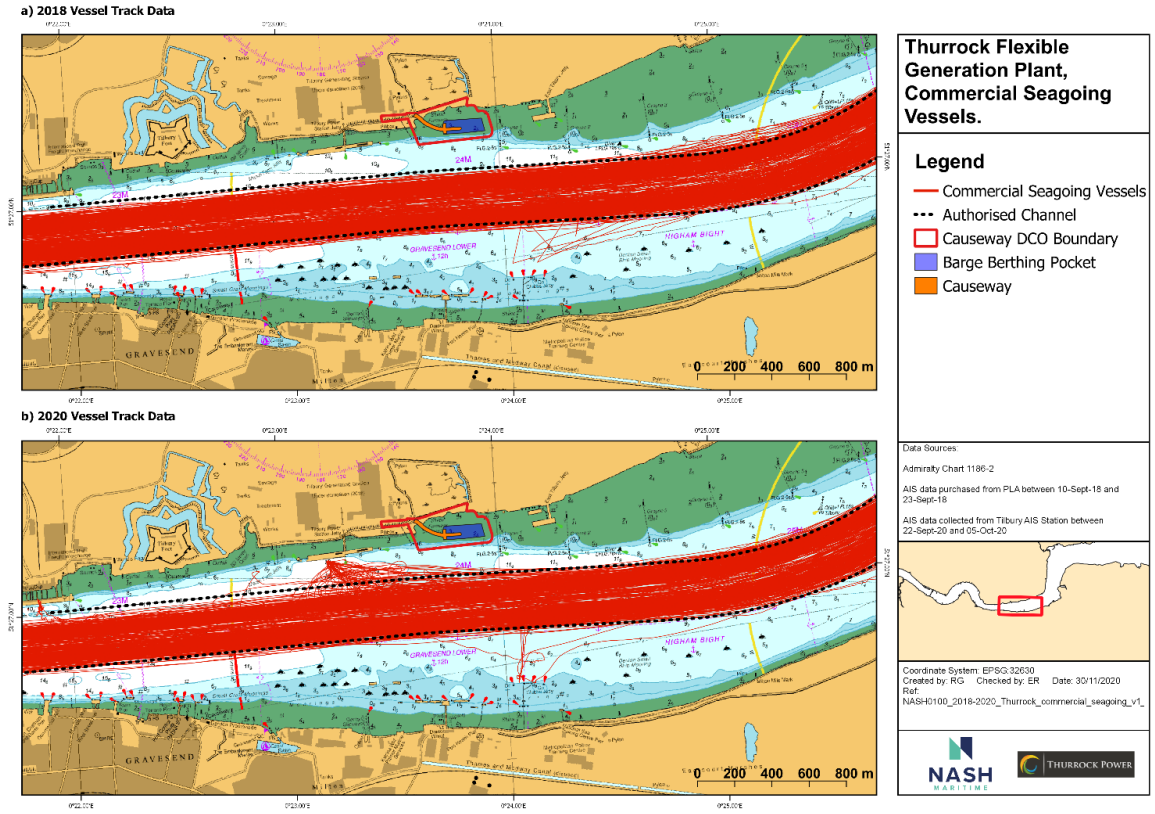


Figure 21: 2018 and 2020 Commercial Vessel Tracks in Study Area

Figure 22 shows the vessel density plots for average daily transits made by commercial vessels during the 2018 and 2020 study periods, respectively. The density of daily transits is indicated by red shaded areas on the plot, the darker the colouring the greater the number of transits. In line with expectations the majority of transits were made by vessels utilising the Authorised Channel.

In order to compare the change in seagoing commercial vessel activity between the 2018 and 2020 data sets a density comparison plot was produced - see **Figure 23.**

Figure 23 shows the daily average change in vessel traffic density for commercial vessels between the 2018 and 2020 study periods. Increases in vessel traffic density are shown in green, the darker the shading the greater the increase. Decreases in vessel traffic density are shown in orange, the darker the shading the greater the decrease. As expected, the plot shows that vessel traffic around the vicinity of Tilbury 2 increases, this reflects the fact that Tilbury 2 was operational in 2020 but not in 2018. It can also be observed that vessel density on the northern side of the Authorised Channel and to the west of the Tilbury 2 terminal decreased in density, it is likely that this decrease is due to the rerouting of commercial vessel traffic from POT to Tilbury 2 between 2018 and 2020.

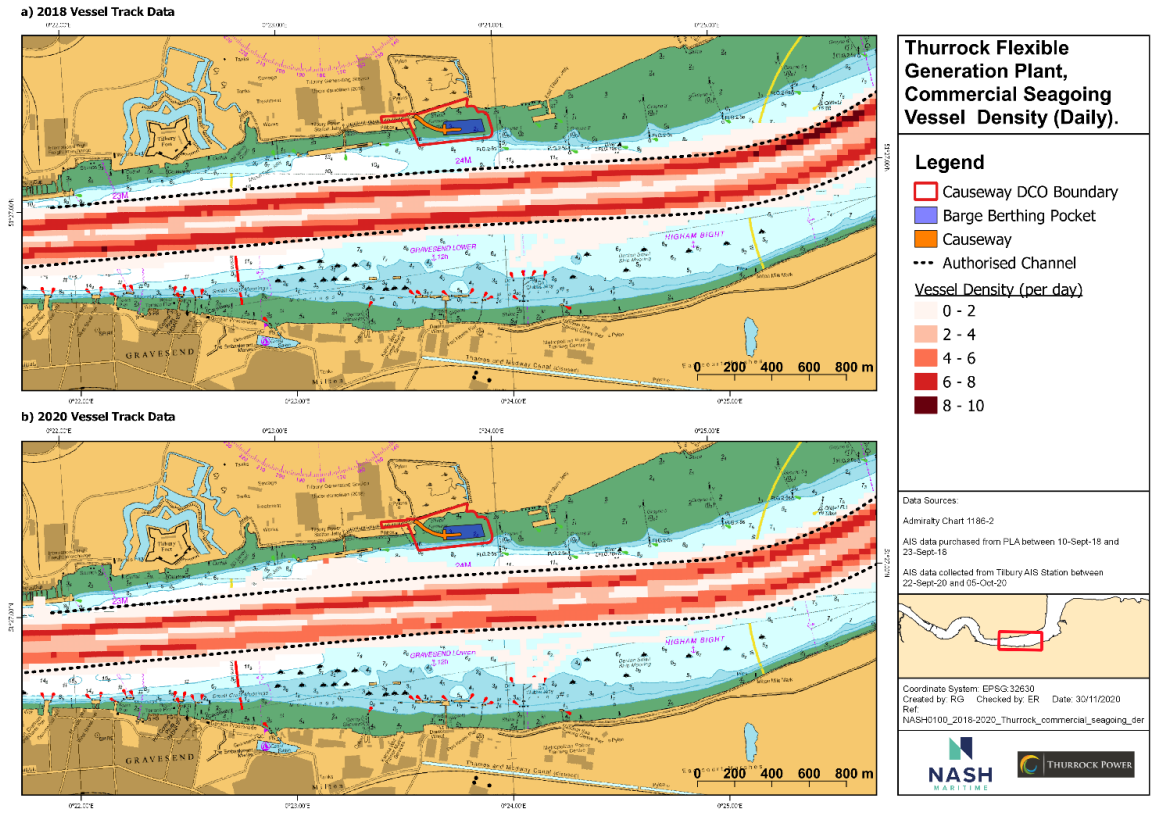


Figure 22: 2018 and 2020 Commercial Vessel Density Plots (Per Day)

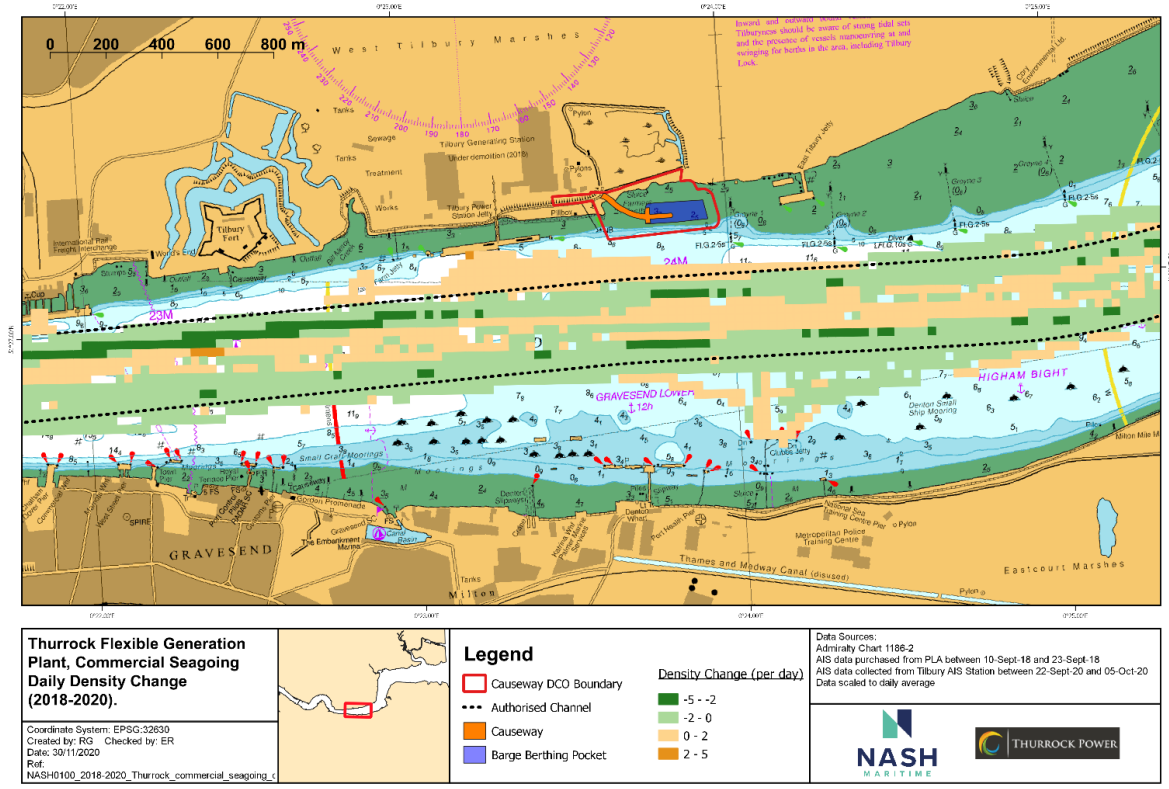


Figure 23: 2018 to 2020 Average Daily Commercial Density Change

4.3. INTRA PORT TRADE VESSELS

There is significant intra port trade (trade on the river Thames that does not proceed to sea) activity in the Gravesend Reach with most activity limited to the southern side of the Authorised Channel around Royal Terrace Pier and Denton Wharf as well as the Authorised Channel. Intra port trade activity around the Causeway and to the north of the Authorised Channel increased in 2020. **Figure 24** shows the vessel tracks for the 2018 data and 2020 data.

This difference between the two data sets can be attributed to the activity of the GPS tugs *India* and *Ionia* on transit to and from the East Tilbury Jetty on multiple occasions as shown in **Figure 25**. It is understood that the jetty is regularly utilised for spoil disposal. Approval for this use of the Jetty was sought for a maximum 5-year period in 2017, it can therefore be expected that the tugs will continue to operate in such a manner for the foreseeable future.

Whilst there is significant tug and tow activity (attributed to the activity of the *GPS Iona /GPS India*) within the vicinity of the proposed Causeway, the tug and tow vessels maintain approximately 110 metres clearance from the proposed Causeway site. This is likely to be due to presence of a groyne 80 m to the east of the Causeway site and 180m west of the East Tilbury Jetty, this groyne creates a physical barrier between the two sites and will effectively ensure separation of the two operations.

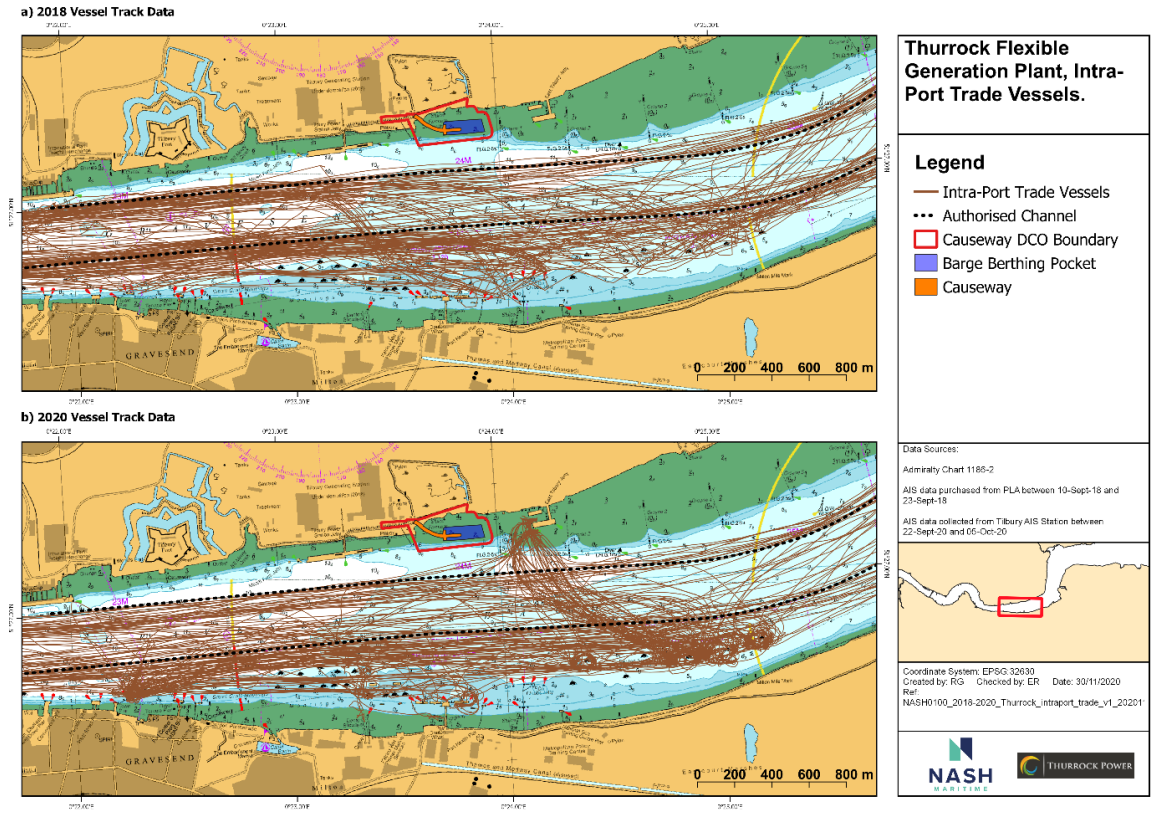


Figure 24: Vessel Tracks of Intra-Port Trade

Figure 25: India and Ionia Arrival / Departure of East Tilbury Jetty

Figure 26 shows the average daily vessel traffic density plots for the 2018 and 2020 data sets, the key difference shown being the increase in vessel traffic density around the East Tilbury Jetty site.

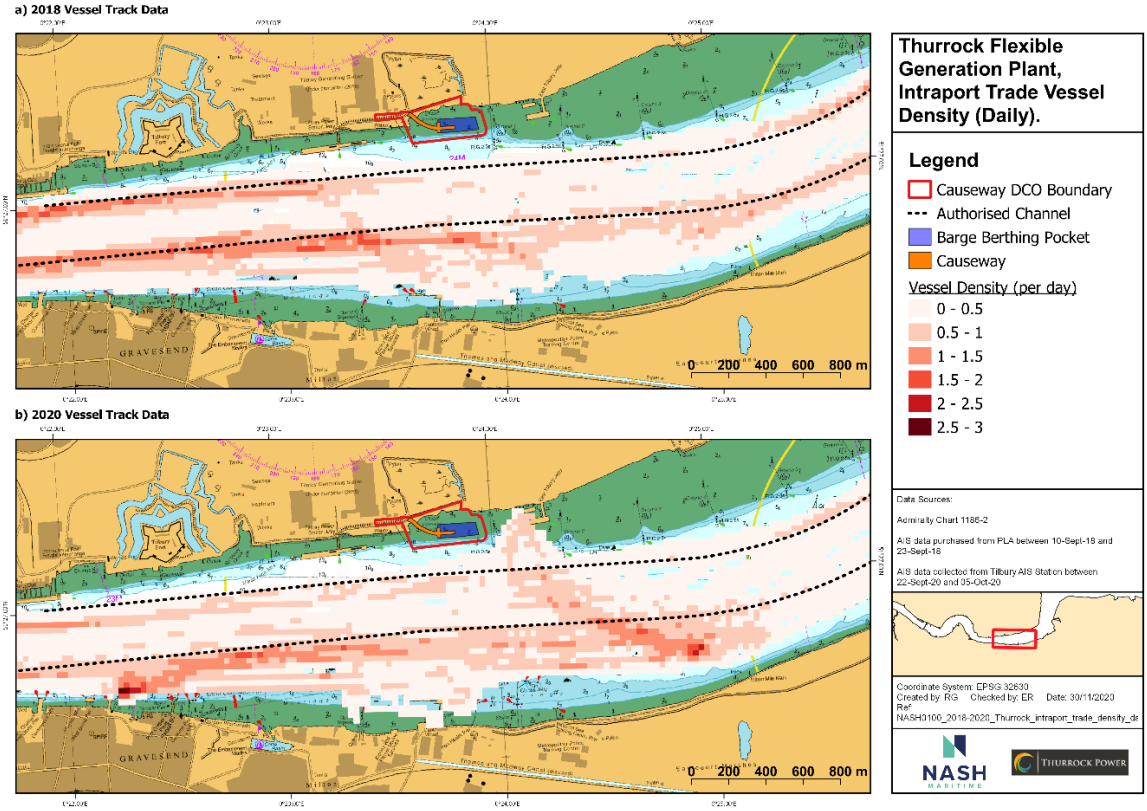


Figure 26: Average Daily Density Analysis of Intra Port Trade 2018 and 2020

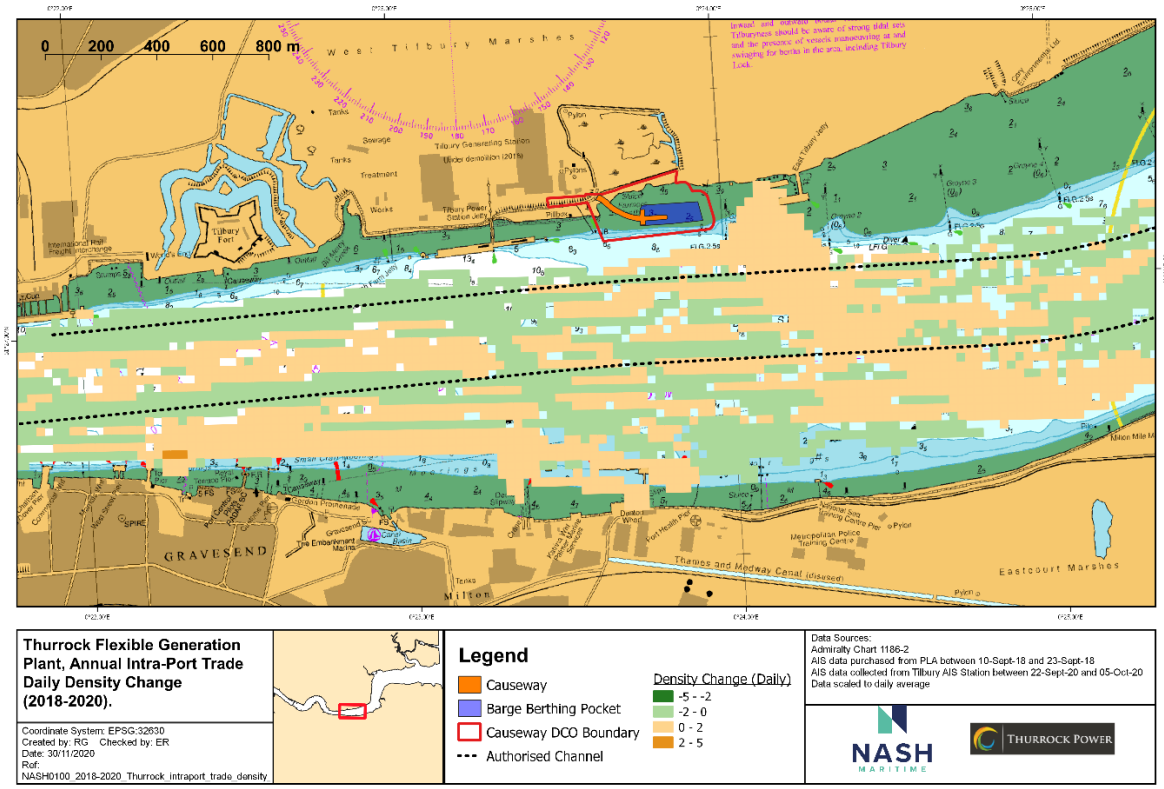


Figure 27: Average Daily Density analysis comparison for intra port trade vessels, 2018 and 2020

Figure 27 shows the average daily intra port density change between 2018 and 2020, the key differences between the two years being an increase in intra port trade activity around the East Tilbury site and an increase in north to south transits across the Authorised Channel, which is presumably due to the transits made by the *GPS Ionia and GPS India* as they make their approach to East Tilbury Jetty and use of a layby mooring to the south of the Authorised Channel. A reduction in intra port trade is evident on the north and south sides of the Authorised Channel to the west of the study area as well as between Gravesend and Tilbury. However, this reduction looks to be balanced out by an increase in intra port trade traffic toward the centre of the Authorised Channel.

4.4. INTRA PORT PASSENGER VESSELS

Intra port passenger traffic consisting of non-sea going passenger vessels (including High Speed Craft Passenger Vessels and Class 5 Passenger Vessels) is consistent between the 2018 and 2020 data sets (see **Figure 28**).

Activity is confined almost exclusively to between Gravesend and Tilbury Riverside where a regular ferry service operates approximately every 30 minutes, Monday to Saturday. The service is operated by Jetstream Tours and the vessel *Thames Swift* is deployed to provide the service (see **Figure 29**).

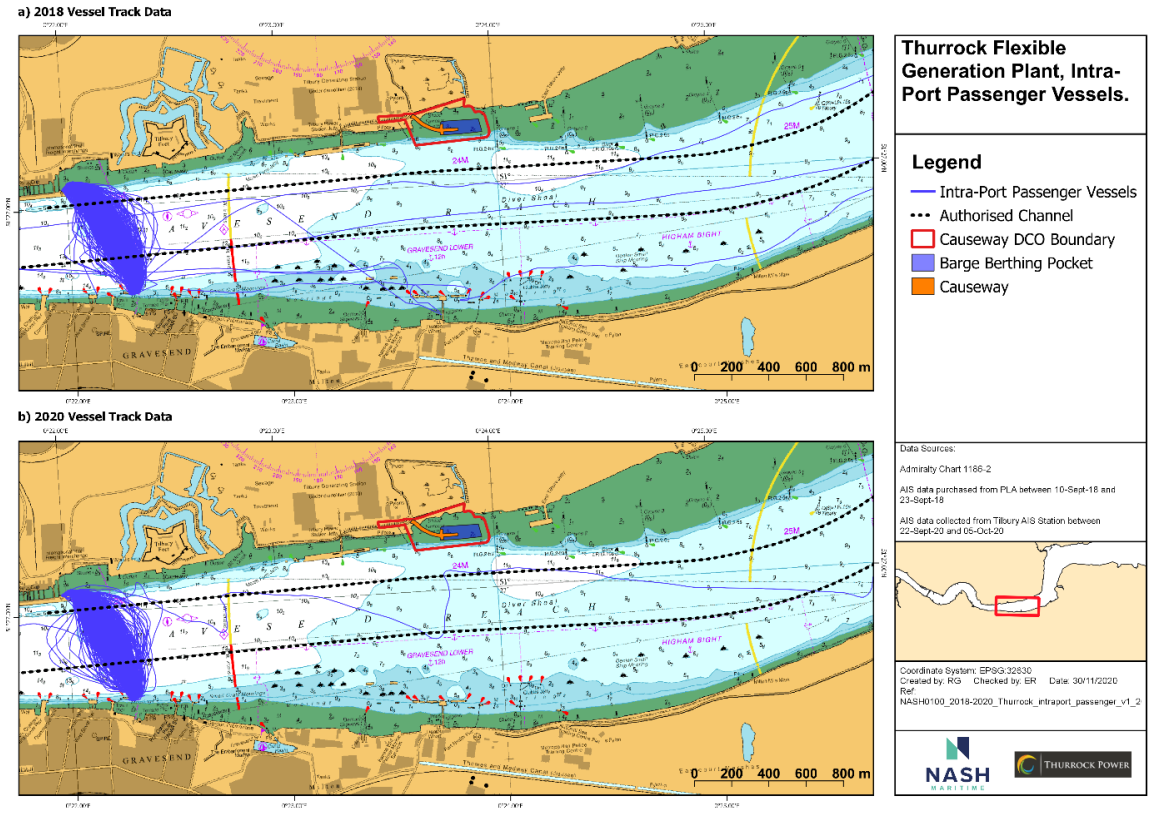


Figure 28: Vessel tracks for intra port passenger vessels.

Figure 29: Thames Swift.

4.5. TUG AND SERVICE VESSELS

Tug and Service vessel activity consisting of harbour towage vessels, pilot boats, survey boats, workboats and RNLI vessels was consistent between the 2018 and 2020 data sets. Activity was confined mostly to the Authorised Channel and to the south of the Authorised Channel in the Gravesend area (see **Figure 30**).

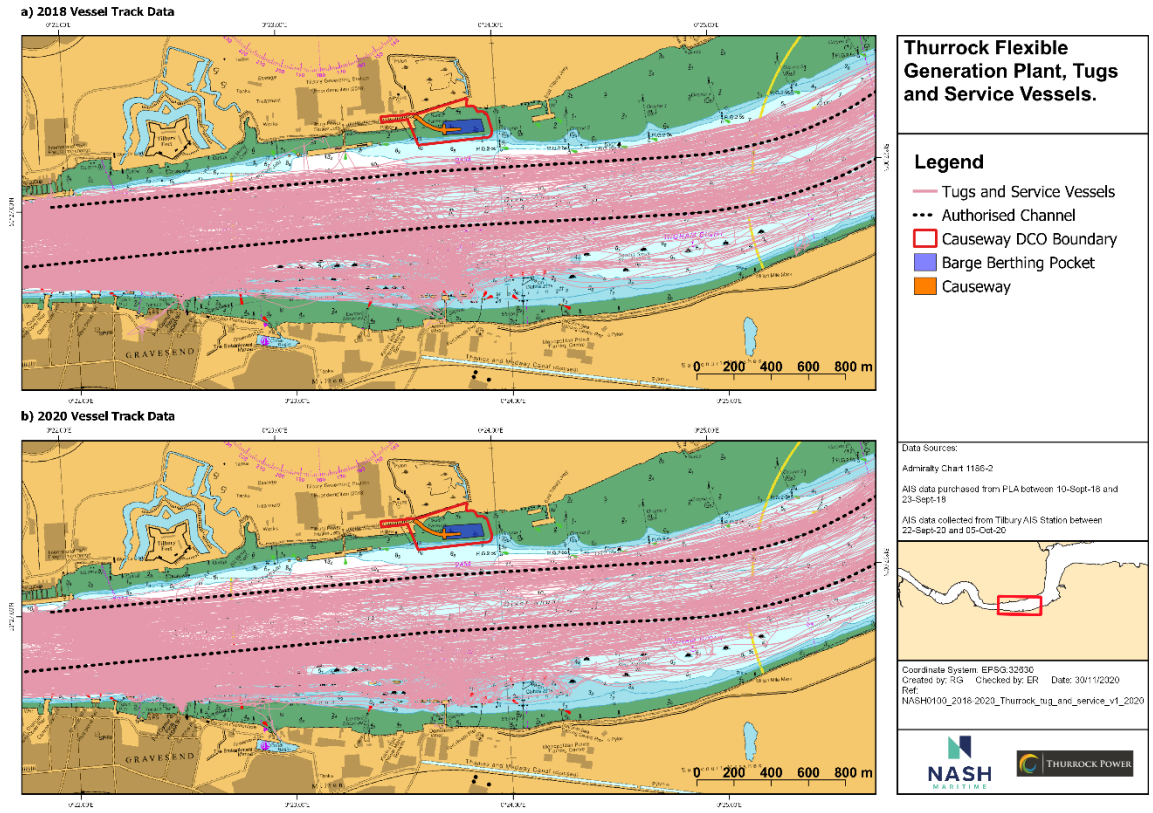


Figure 30: Vessel Tracks for Tug and Service Vessels.

4.6. RECREATIONAL VESSELS

Recreational vessel activity is difficult to quantify, as only a limited number of vessels (usually larger craft) carry AIS equipment. **Figure 31** shows the respective vessel tracks recorded in the 2018 and 2020 data sets. There is a clear reduction in recreational craft vessel activity in 2020, this could well be attributed to the Covid-19 pandemic.

There are a number of sailing clubs and marinas in Gravesend Reach including Thurrock Yacht Club, Gravesend Sailing Club, Gravesend Embankment Marina, Gravesend Town Pier and various Mooring Buoys. It is therefore likely that there is recreational activity occurring in Gravesend reach that will not be picked up by AIS data analysis

A 15m channel to the south and north of the Authorised Channel is kept clear for the use of recreational craft. In Gravesend reach the "*River Thames Recreational Users Guide – Broadness to Sea Reach*" (see extract below in **Figure 32**) specifies that inbound and outward bound vessels should cross the Authorised Channel and navigate south of the lateral mark "Mucking No 5". Recreational craft are however free to navigate on the southern or northern side of the Authorised Channel when they pass the Causeway site.

The Recreational User Guide states that, "*Inward and Outward-bound vessels rounding Tilburyness should be aware of strong tidal sets and the presence of vessels manoeuvring at and swinging for berths in the area including Tilbury*

Lock." Recreational craft are also advised not to transit north of the marks at the southern end of each of the 6 groynes marking the Divers Shoal.

Recreational craft should therefore not come within the vicinity of the Causeway site as they should pass to the south of the groynes, the groynes extend beyond the Causeway so any recreational craft coming into the immediate vicinity of the Causeway will either have to cross the groynes or navigate to the south and then transit to the north, this occurrence is considered to be unlikely.

Whilst there is significant recreational craft activity within the Gravesend Reach the increase from project movements within the area, when compared to current levels of commercial traffic that recreational craft already have to negotiate, is minimal. As highlighted above it is also unlikely that recreational craft will come into the immediate vicinity of the Causeway itself and should pass to the south of the Causeway and designated waiting area identified in section **2.4.**

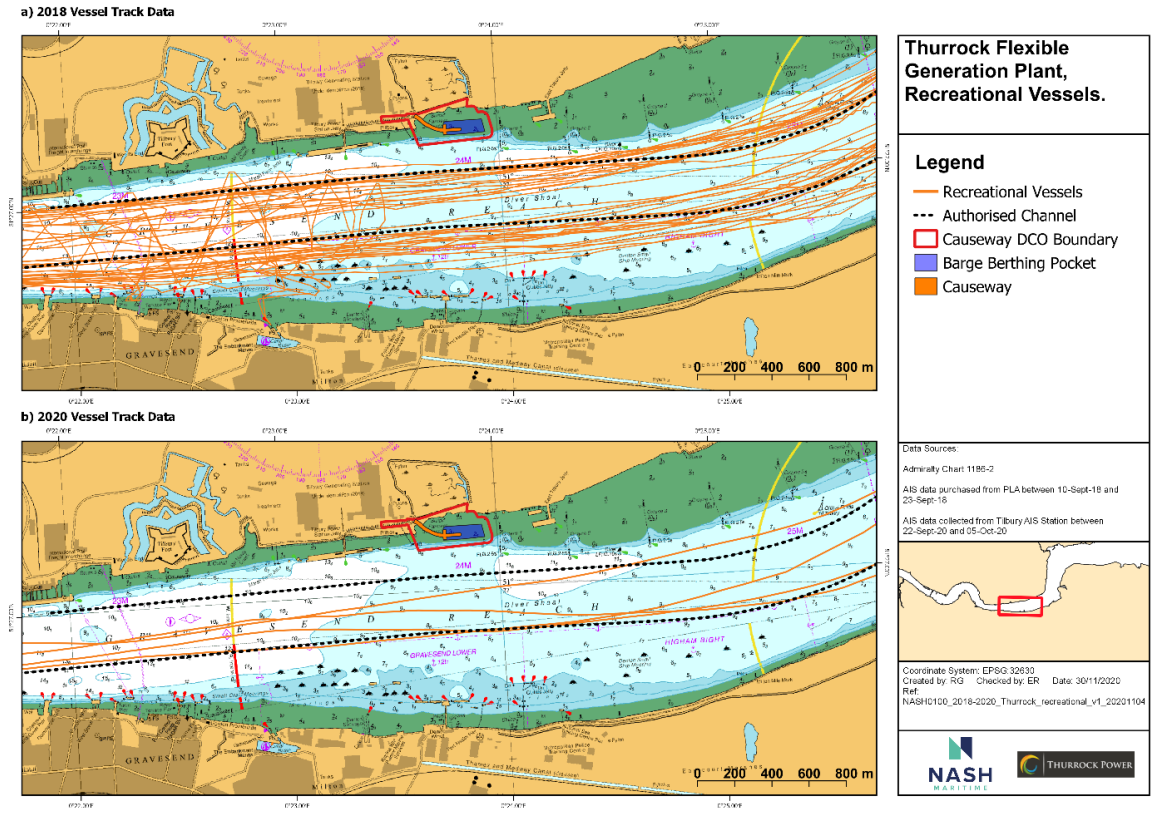


Figure 31: Vessel Tracks for Recreational Vessels

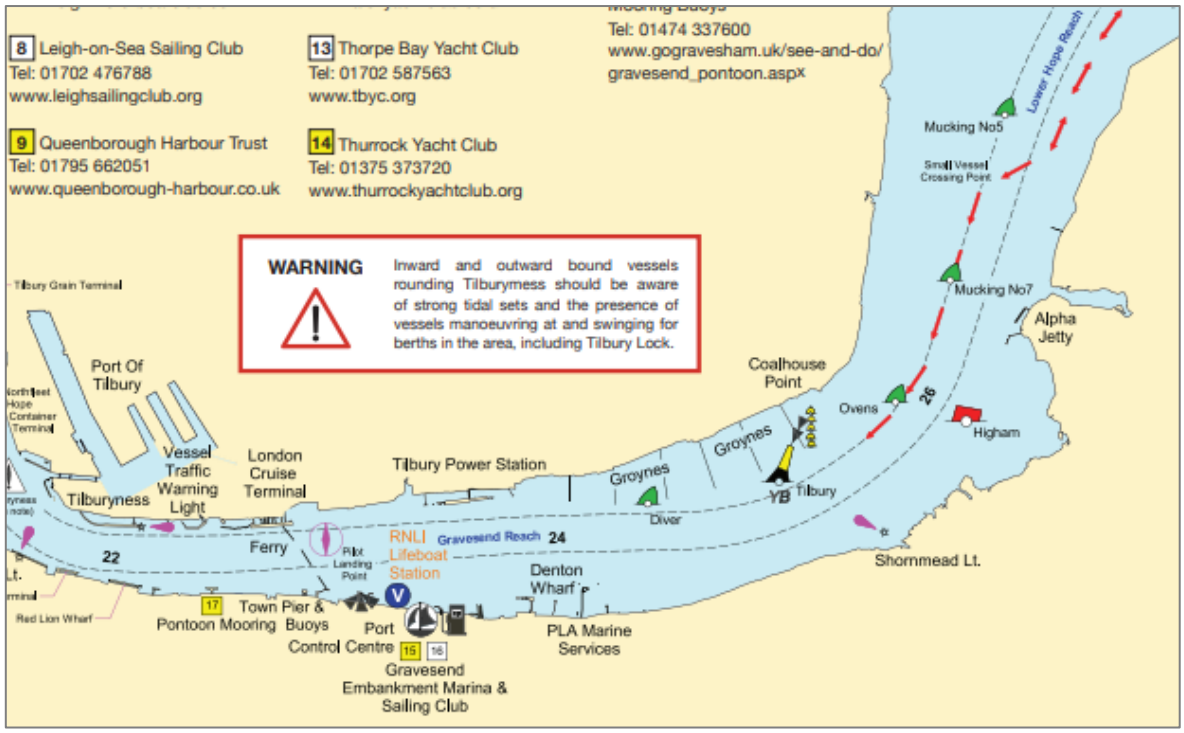


Figure 32: Extract from Thames Recreational Users Guide

4.7. GATE ANALYSIS

Vessel traffic differs year on year as shown by the benchmarking exercise undertaken in section **4.1.** However, 2020 is likely to be an exceptional year due to the impact of the Covid-19 pandemic, it is therefore prudent to undertake further analysis to understand whether the number of transits recorded during the 2020 study period are representative of the true number of vessel transits that can be expected whilst the Causeway site is in operation. In order to understand the potential impact of Covid-19 on vessel movement in and around the immediate vicinity of the site the 2020 data was examined against the 2018 data using gate analysis.

In order to compare the two data sets, gate analysis for vessels navigating past the Causeway site was carried out. The total number of transits recorded during the respective study periods (during the representative month of September, see **4.1**) were analysed. Analysis was undertaken to examine the following:

- Average number of transits per day for 2018 and 2020 based on vessel type
- Average number of transits per day by vessel length for 2018 and 2020
- Average number of transits per day by vessel draught for 2018 and 2020
- Average hourly transits by hour of the day for 2018
- Average hourly transits by hour of the day for 2020
- Total number of transits by date for the study period 2018
- Total number of transits by date for the study period 2020
- Average number of transits by tidal progress 2018 and 2020
- Average number of daily transits by vessel category throughout tidal cycle 2018

- Average number of daily transits by vessel category throughout tidal cycle 2020

The projected total number of transits by all vessel types in 2018 was 24,794 and in 2020 the total number of transits projected by all vessel types was 22,276. This represents approximately 10% year on year reduction in the number of transits, which is most likely attributed to the effects of the Covid-19 pandemic.

4.7.1. VESSEL TYPE

Figure 33 shows the average number of transits per day for 2018 and 2020 based on vessel type. There is a reduction in transits made by sea going commercial vessels, intra port trade vessels and recreational craft in 2020. Average daily transits made by tug and service vessels increased in 2020 and intra port passenger services remained stable between 2018 and 2020.

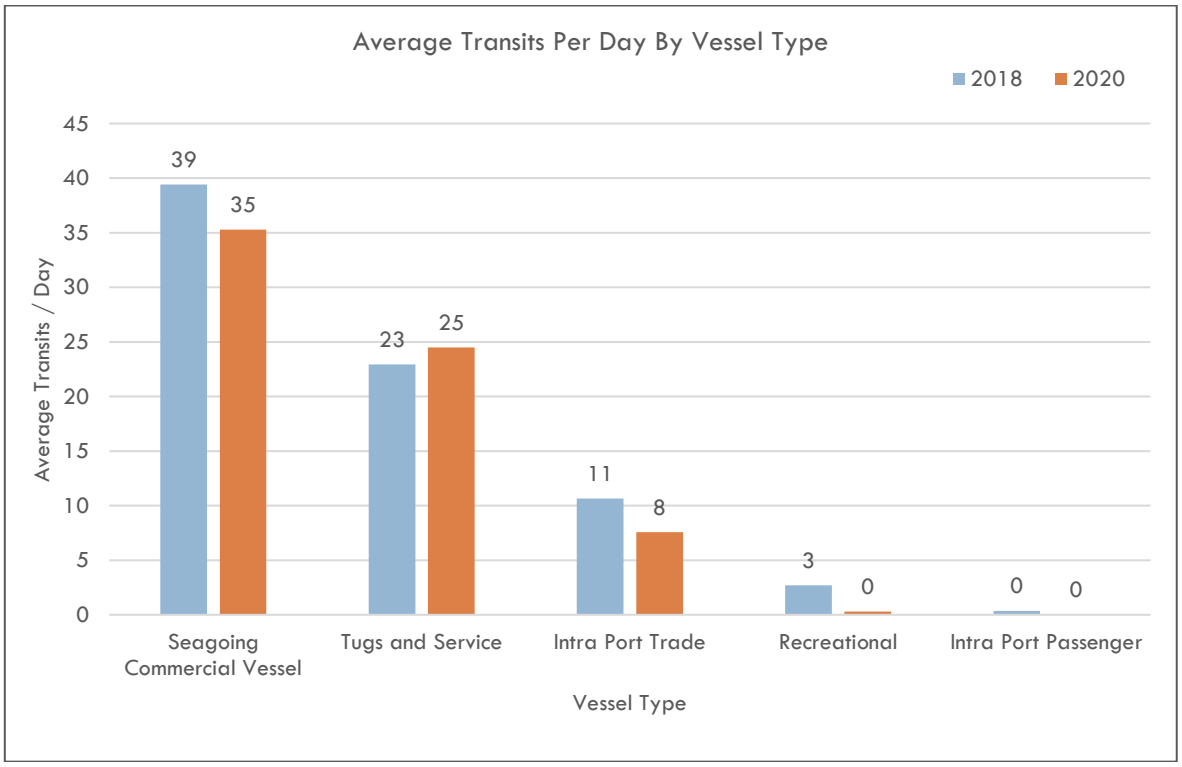


Figure 33: Average transits per day by vessel type for 2018 and 2020

4.7.2. VESSEL LENGTH

Figure 34 shows the average number of transits per day made by vessels of differing lengths throughout the 2018 and 2020 study data. Analysis of the data shows that a greater number of transits were made by longer vessels in 2020 when compared to 2018, perhaps reflecting a more long-term trend of gradually increasing commercial sea going vessels sizes entering the Port of London. The 2018 data set showed 1,065 transits were made passed the Causeway site during the study period compared to 948 transits in the 2020 study period.

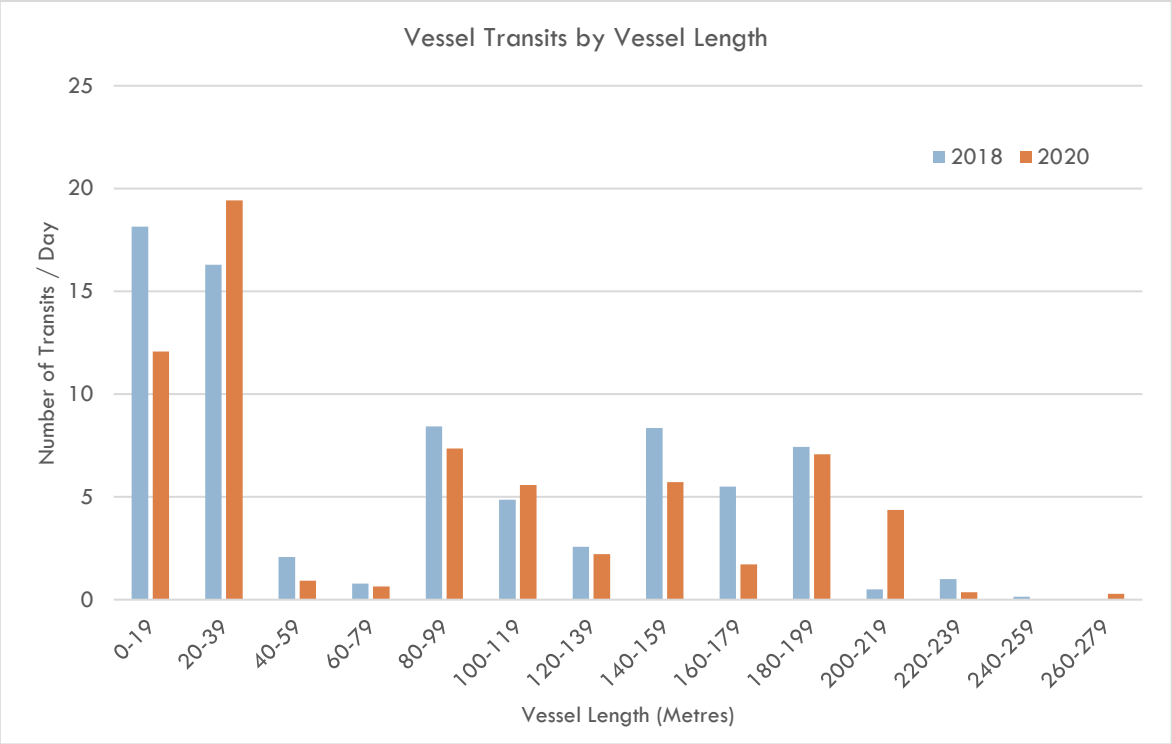


Figure 34: Number of vessel transits by vessel length during 2018 and 2020 Study Periods (per day)

4.7.3. VESSEL DRAUGHT

Figure 35 shows the average number of transits per day made by vessels of differing draughts throughout 2018 and 2020. Analysis of the data shows that a greater number of transits were made by vessels of a deeper draught in 2020 when compared to 2018 again reflecting a more long-term trend that sees a gradual increase in the size of commercial sea going vessels entering the Port of London. Analysis of the vessel draught also showed that there was a decrease in 2020 of transits made by shallow draught vessels, this is likely due to the impact of Covid-19 and the subsequent decrease in intra port trade and recreational craft activity.

4.7.4. TIME OF DAY

Figure 36 and **Figure 37** show the average number of transits per-hour of the day for 2018 and 2020.

In 2018 recreational craft are seen transiting throughout the daylight hours with a decrease in transits after dark, this is widely consisted with expectations. Commercial seagoing activity peaks early in the morning and late at night with less traffic during daylight hours when other vessel activity increases. This likely reflects a pattern of established timetabled activity. Intra port trade activity peaks during daylight hours with less activity after dark with intra port passenger activity occurring in the morning, in the early afternoon and in the evening, likely coinciding with scheduled service timetables.

Analysis of the 2020 data set follows a similar pattern but a reduction in recreational craft activity as a whole is evident. It also appears that there are less regular intra port passenger services operating, this could be due to the fact that a reduced service was being operated in September as a result of the Covid-19 pandemic. Commercial seagoing activity again occurred early in the morning and late at night.

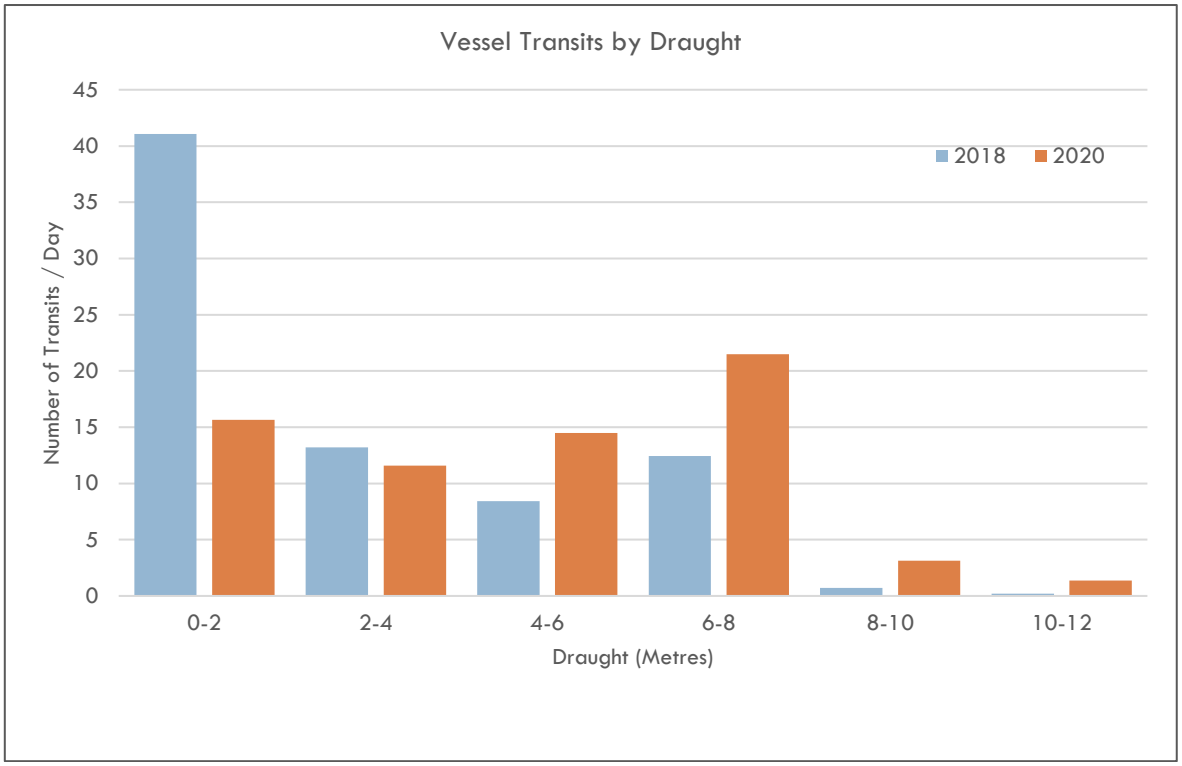


Figure 35: Percentage of vessel transits by vessel draught for 2018 and 2020 (per day)

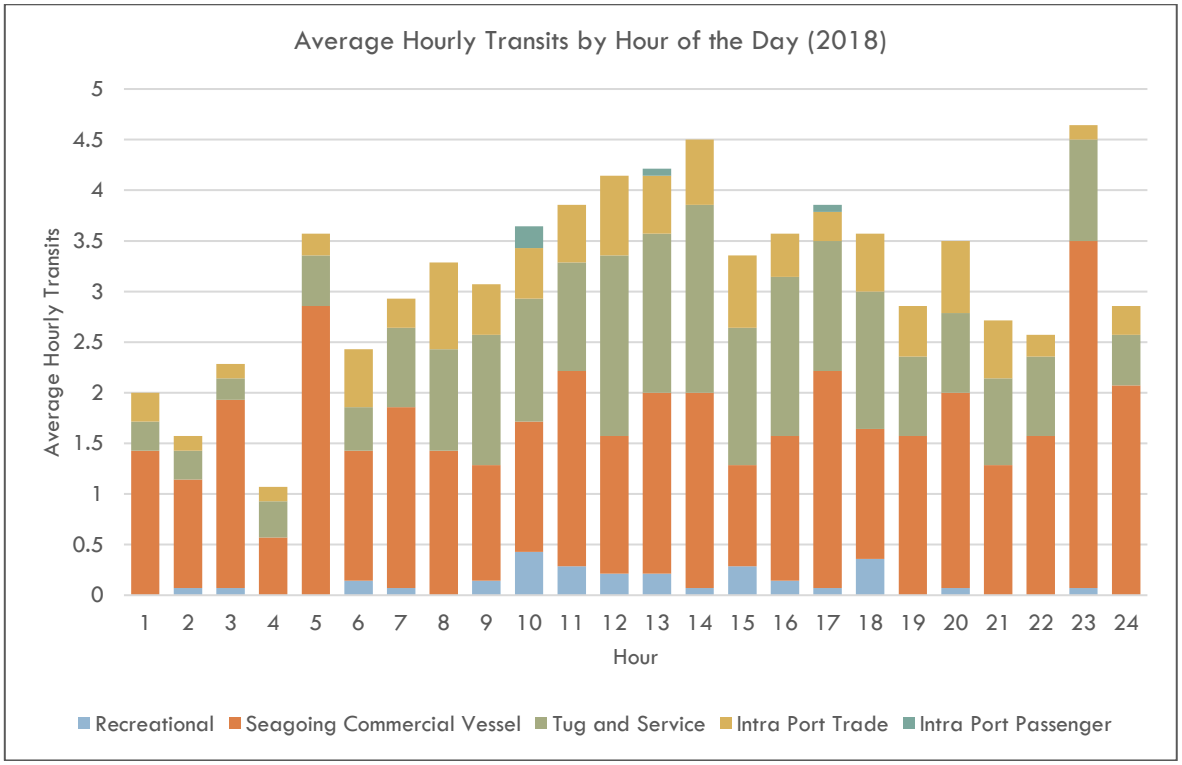


Figure 36:Average hourly transits by hour of the day (2018)

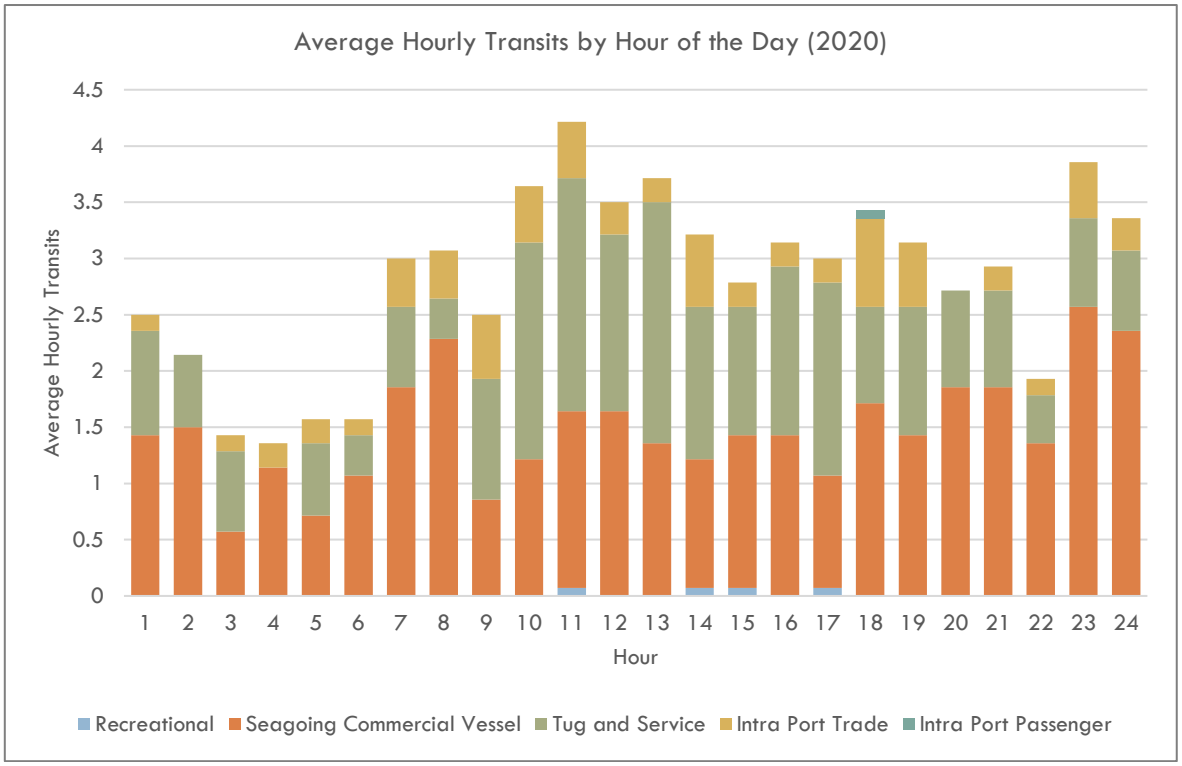


Figure 37: Average hourly transits by hour of the day (2020)

4.7.5. DAY OF WEEK

Figure 38 shows the number of transits made on each day of the study period in 2018. A greater number of transits took place on a Monday, Wednesday and Thursday with Tuesday and Friday being quieter. Weekends saw the least amount of vessel transits; this is likely due to most commercial activities occur during the working days of the week.

Figure 39 shows the number of transits made on each day of the 2020 study period. Weekend traffic remains reduced most likely due to a reduction in commercial activity. There is a decrease in weekend activity during the first weekend of the study period, this can probably be attributed to reduced recreational craft activity. However, interestingly transits on the second weekend in the 2020 study period are more even, indicating that weekend traffic is not entirely contingent on recreational craft movements.

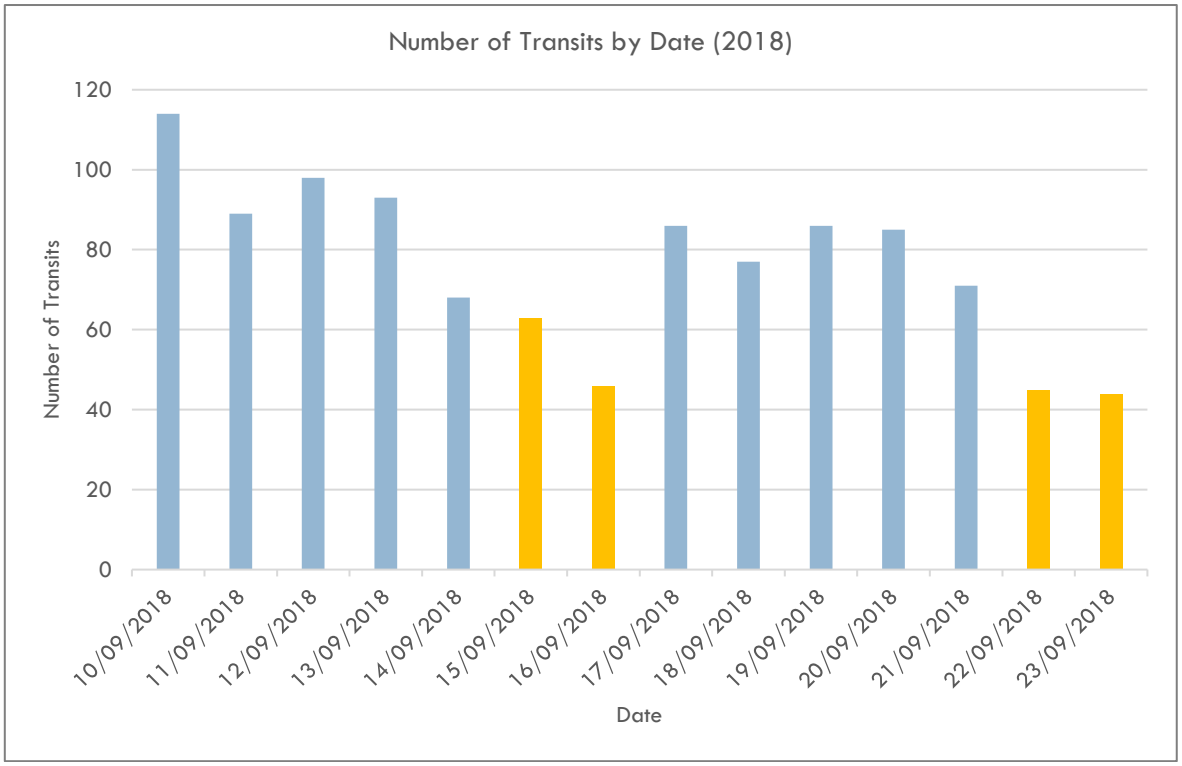


Figure 38: Total number of transits by date in 2018. Weekends are shown in orange.

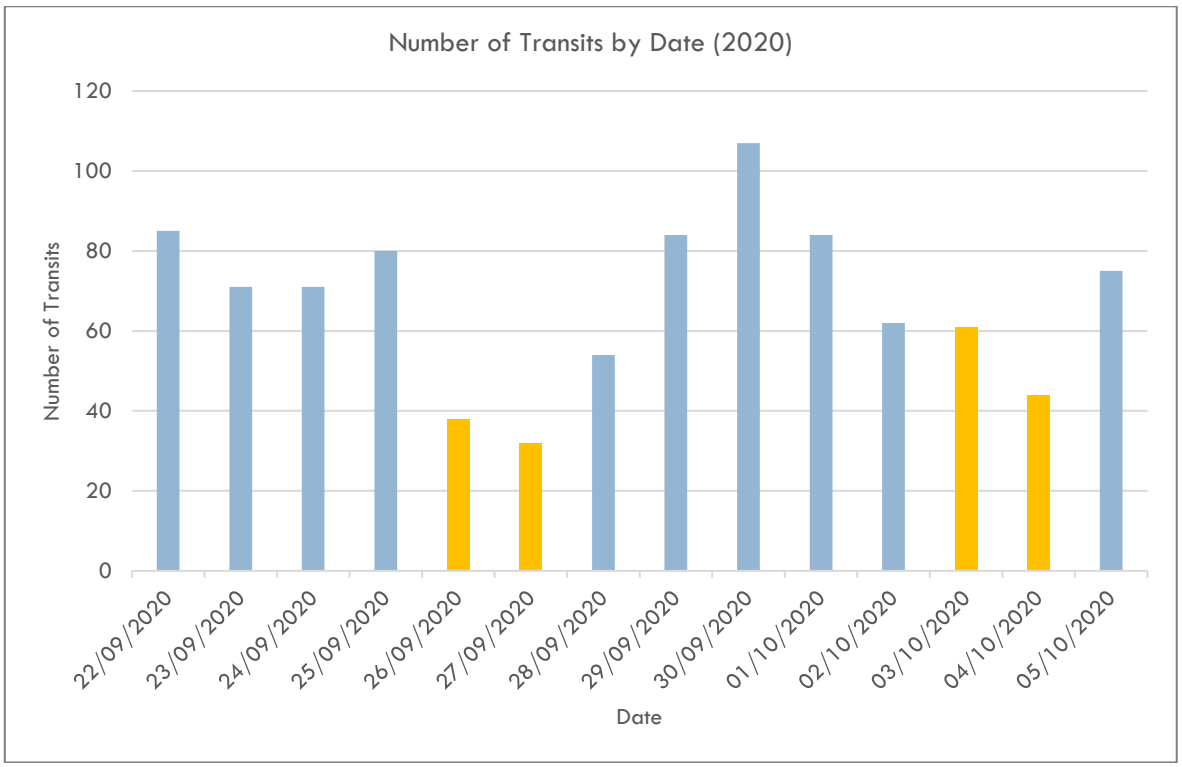


Figure 39: Total number of transits by date in 2020. Weekends are shown in orange.

4.7.6. TIDAL HEIGHT

The *Terra Marique* will make her approach to the Causeway just before high water with the aim of arriving at the Causeway site at high water and ballasting down on the ebb tide. Concerns were raised during consultation that this would involve the *Terra Marique* crossing the Authorised Channel approximately 1 hour before high water, when vessel transits are most frequent as operators look to take advantage of the increased depth available. Analysis shows the distribution of vessel transits through the tidal cycle is reasonably level (see **Figure 40**).

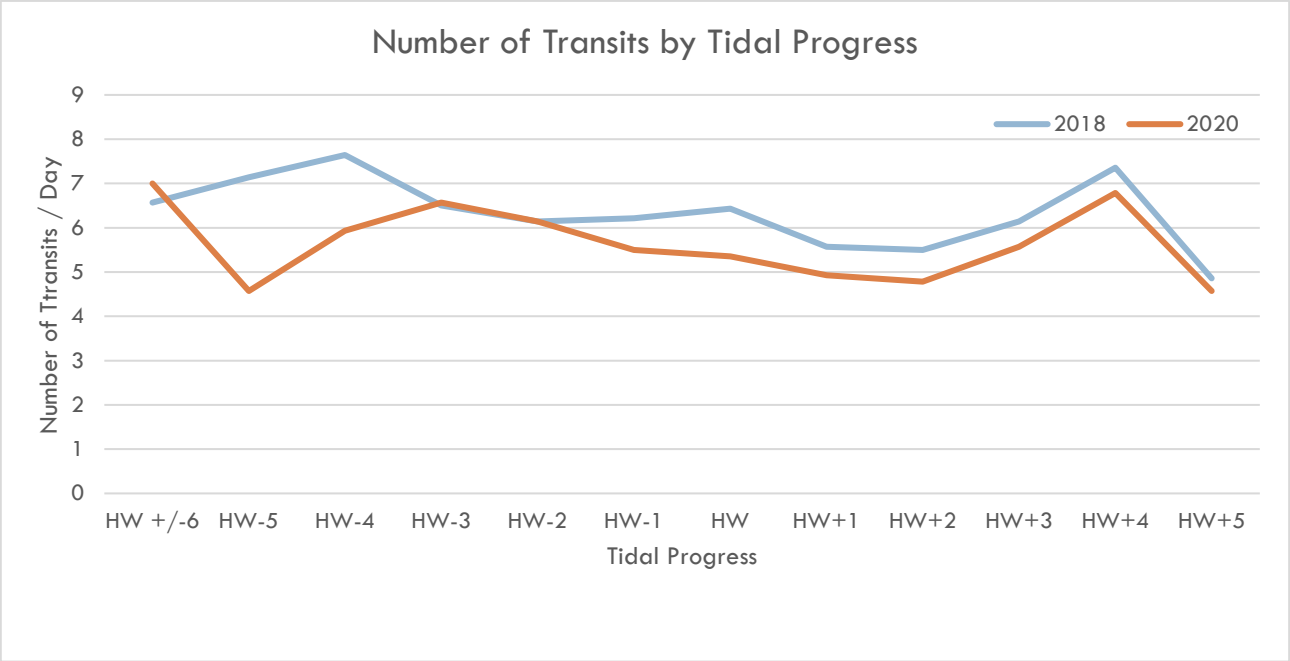


Figure 40: Average number of daily vessel transits throughout the tidal cycle for 2018 and 2020

Figure 41 and **Figure 42** show the number of average daily transits made by vessel types at differing states of tide. In the 2018 data fewer transits were made by all vessel types between 1 hour before high water and high water, with the exception of tug and service vessels. In 2020, apart from sea going commercial vessels, high water was when the least number of vessel transits were made by all vessel types. High water can therefore be considered one of the states of tide where fewer transits are made, this will coincide with when the *Terra Marique* will be making her approach to the Causeway.

It is likely that high water maybe amongst the least busy times for transits off the Causeway because any tidally restricted vessels will be timing their arrival and departure at berth at around High Water, not their transit past the Causeway. The Authorised Channel adjacent to the Causeway therefore will not represent the limiting depth for vessels on through transit.

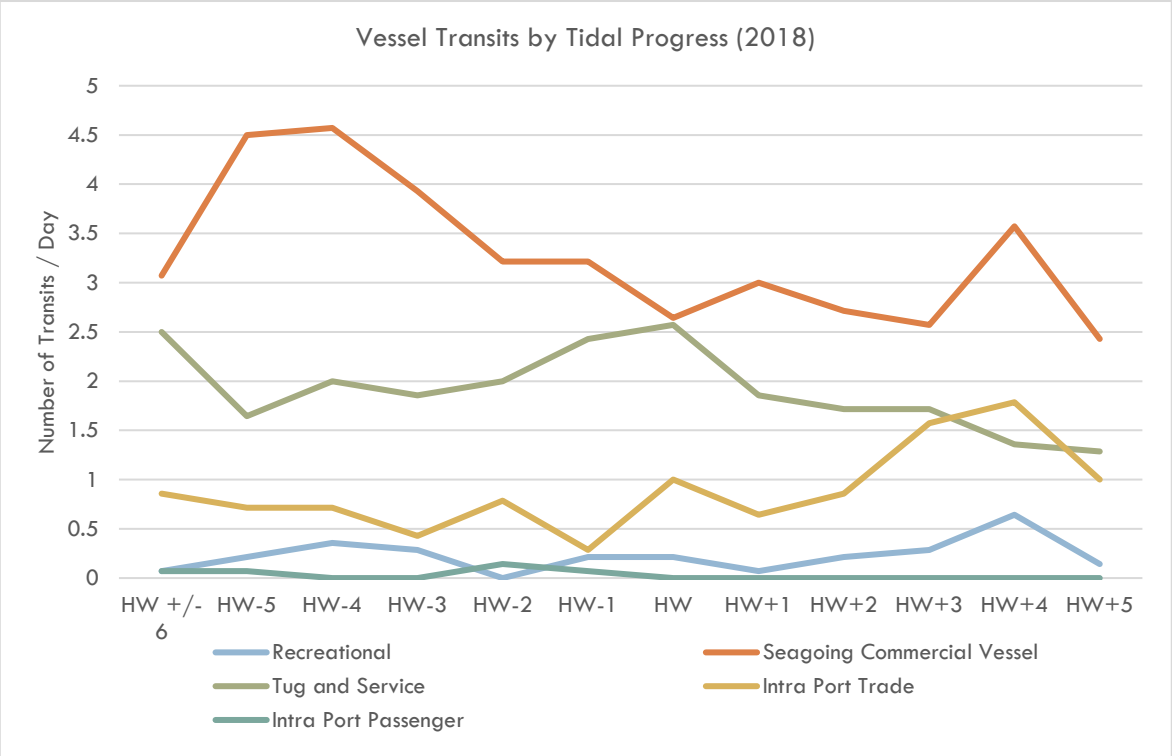


Figure 41: Average number of daily transits by vessel category throughout the tidal cycle for 2018

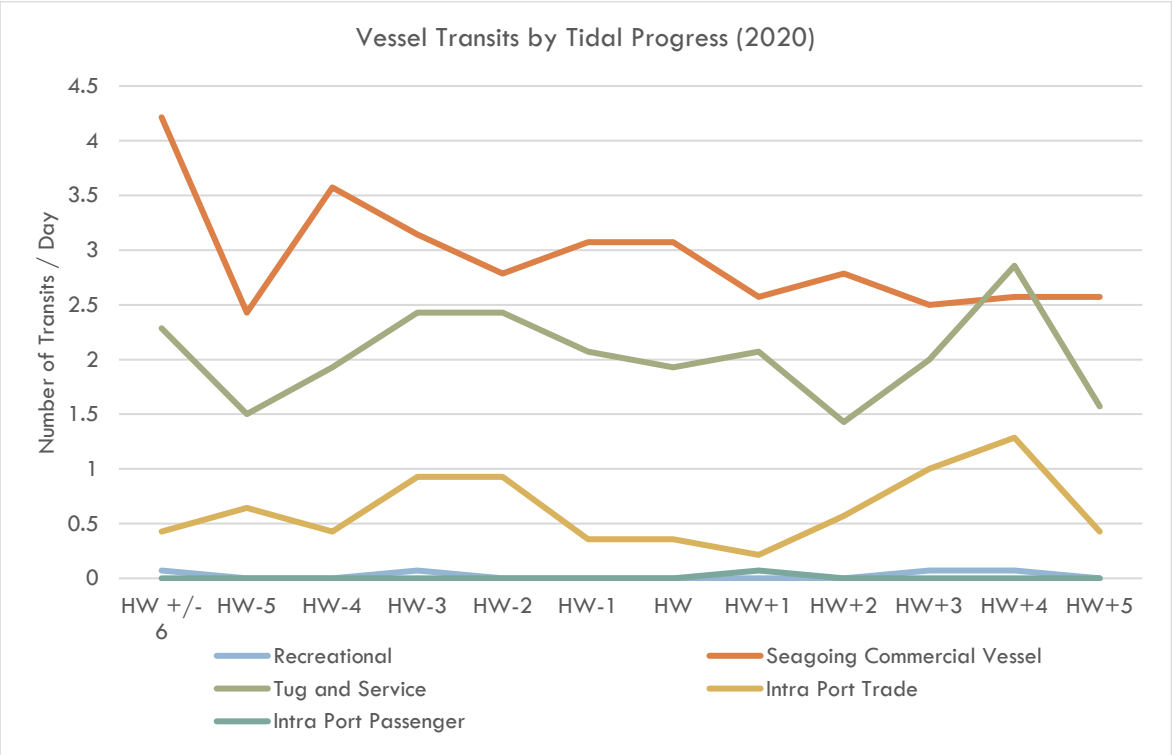


Figure 42: Average number of daily transits by vessel category throughout the tidal cycle for 2020

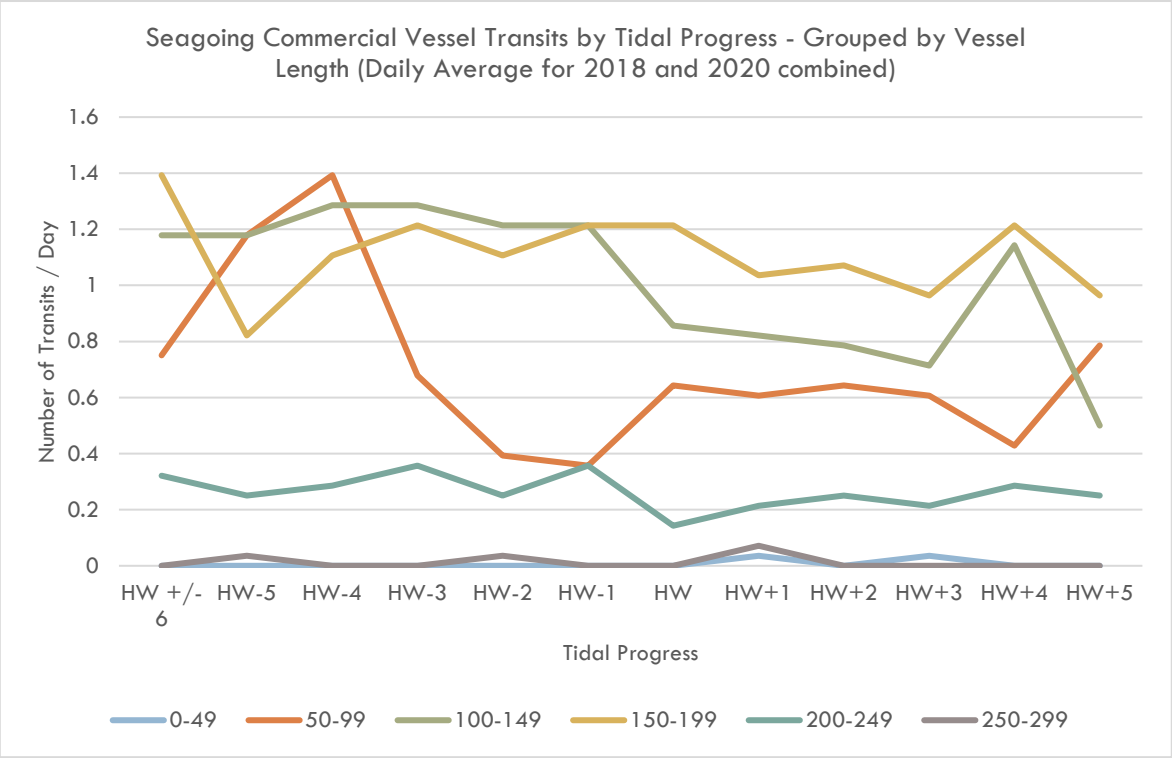


Figure 43: Comparison of tidal state for sea going commercial vessel by length (m) (per day)

In summary, a comparison between the 2018 and 2020 data sets using gate analysis of transits by vessel type shows:

- Vessel traffic activity in the vicinity of the Causeway is higher in 2020. This increase is due to an increased number of vessel transits to and from Tilbury 2 and East Tilbury Jetty.
- The total number of transits reduced by 10% between 2018 and 2020.
- The percentage of transits made by larger vessels increased in 2020.
- Vessel activity per hour of the day remains largely consistent between 2018 and 2020, albeit with a reduced number of transits in 2020.
- Vessel activity in the immediate vicinity of the Causeway reduces during the hours around high water when the *Terra Marique* will make her approach to the Causeway.

Given the reduced number of transits made in 2020 it is likely that when the Causeway comes into operation the number of vessel transits may well be closer to that of 2018 rather than 2020. This has been accounted for when scoring levels of risk associated with hazards relating to the Causeway operation.

4.8. SWEPT PATH ANALYSIS

4.8.1. CURRENT USE OF TILBURY 2

The September 2020 AIS data collected to inform the baseline characterisation of vessel traffic was analysed to determine the current frequency of use of the Tilbury 2 terminal. The 2018 data is not a useful comparison in this instance because Tilbury 2 did not become operational until June 2020

For most of the 2020 study period there were two vessel arrivals at Tilbury 2 a day at regular times. The ro-ro cargo vessels *Norsky* and *Norstream* arrived and departed the Tilbury 2 terminal once a day on most days during the study period with the *Norsky* arriving at approximately 0500 and departing at around 1000 and the *Norstream* arriving at approximately 1700 and departing at 2200. The arrival and departure times differed slightly throughout the study period and on occasion there was only one arrival and departure but never more than 2 arrivals a day. On one occasion the *Norstream* utilised the upstream "Dolphin" berth but on all other occasions both vessels used the middle berth.

Figure 44 shows the vessel tracks for the *Norsky* and *Norstream* as they arrive and depart the Tilbury 2 ro-ro terminal, both vessels keeping well clear of the proposed Causeway site at all times with the closest vessel track being 183 metres from the Causeway itself.

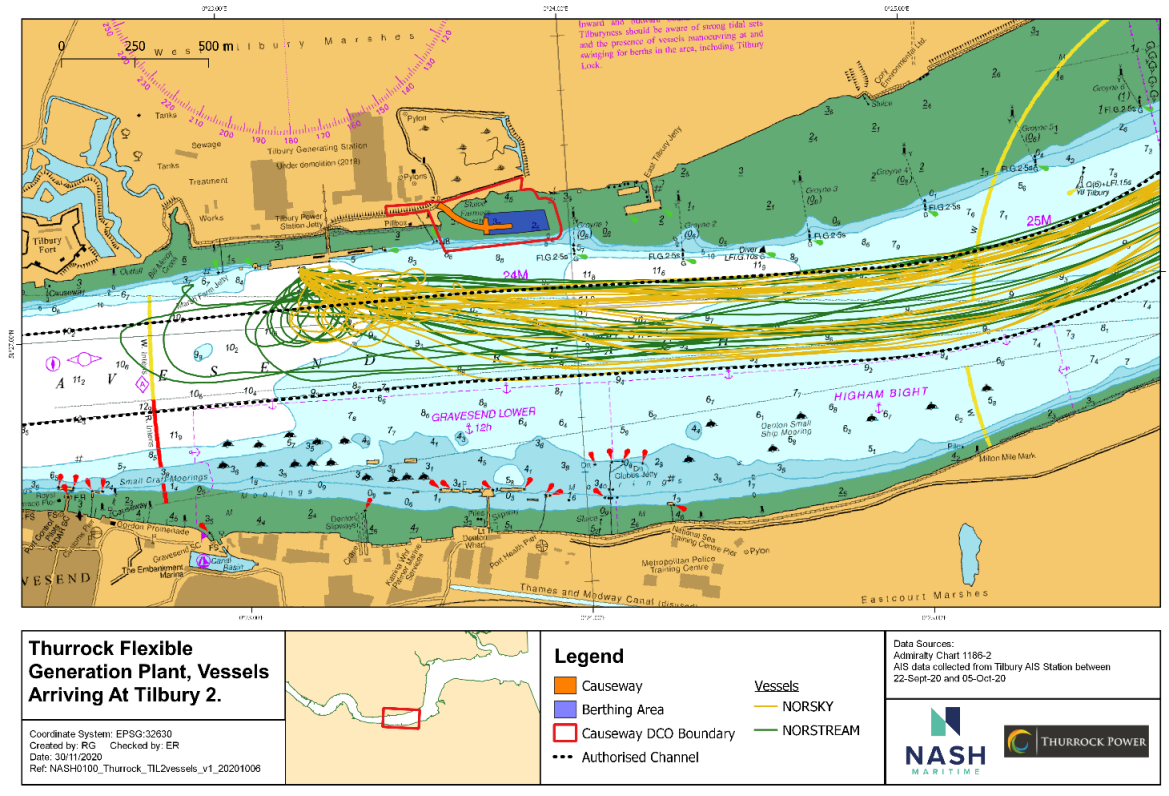


Figure 44: Vessel Tracks "Norsky and Norstream"

It was observed that the *Norsky* and *Norstream* made slightly different approaches to the Tilbury 2 terminal throughout the study period with the Master of the *Norsky* tending to exit the Authorised Channel earlier and

manoeuvring downstream to the east of the berth before going stern on to the mooring. In contrast the Master of the *Norstream* tended to manoeuvre adjacent to or upstream of the berth and ferry glide toward the mooring.

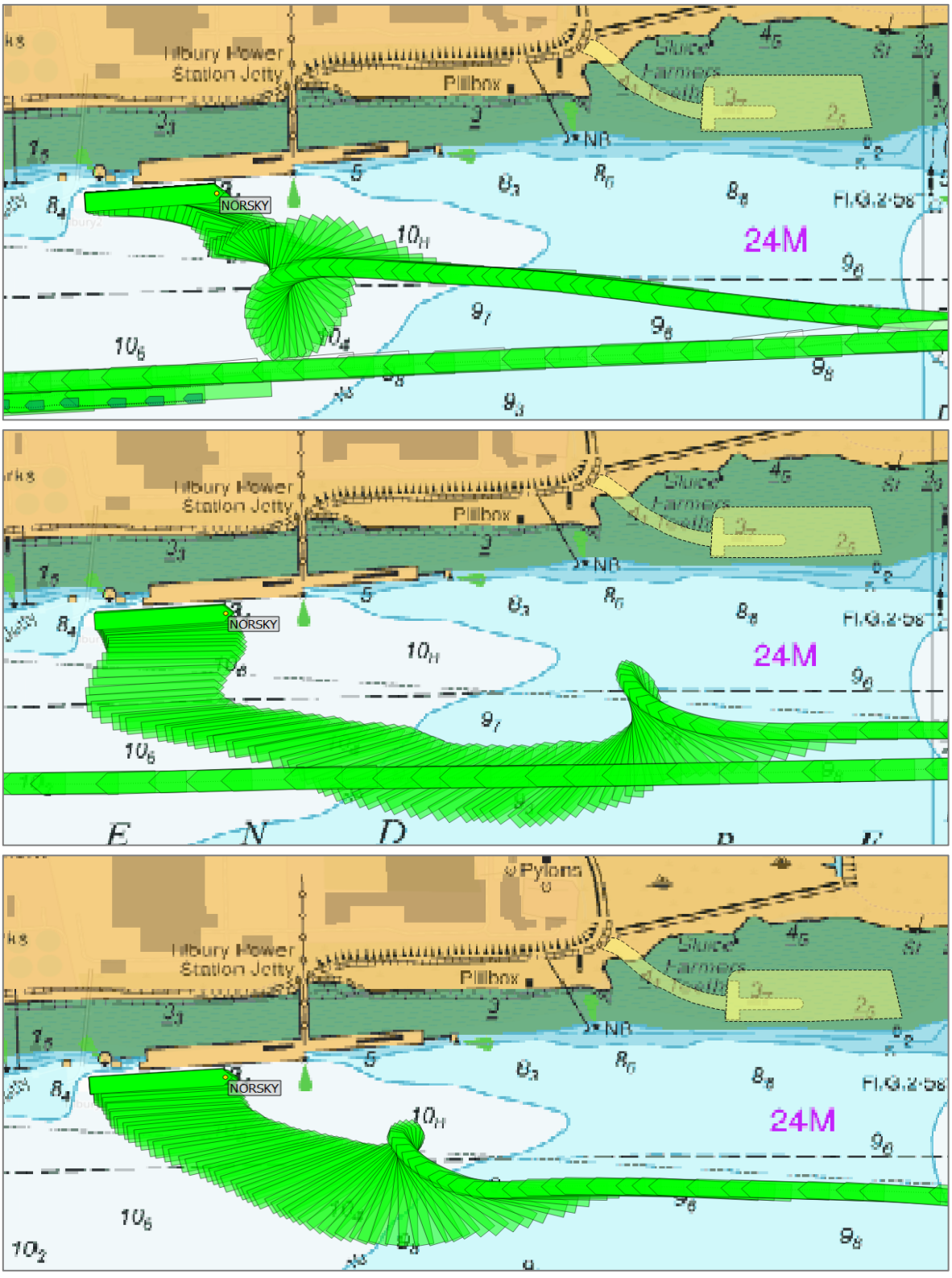


Figure 45: Arrival of the Norsky

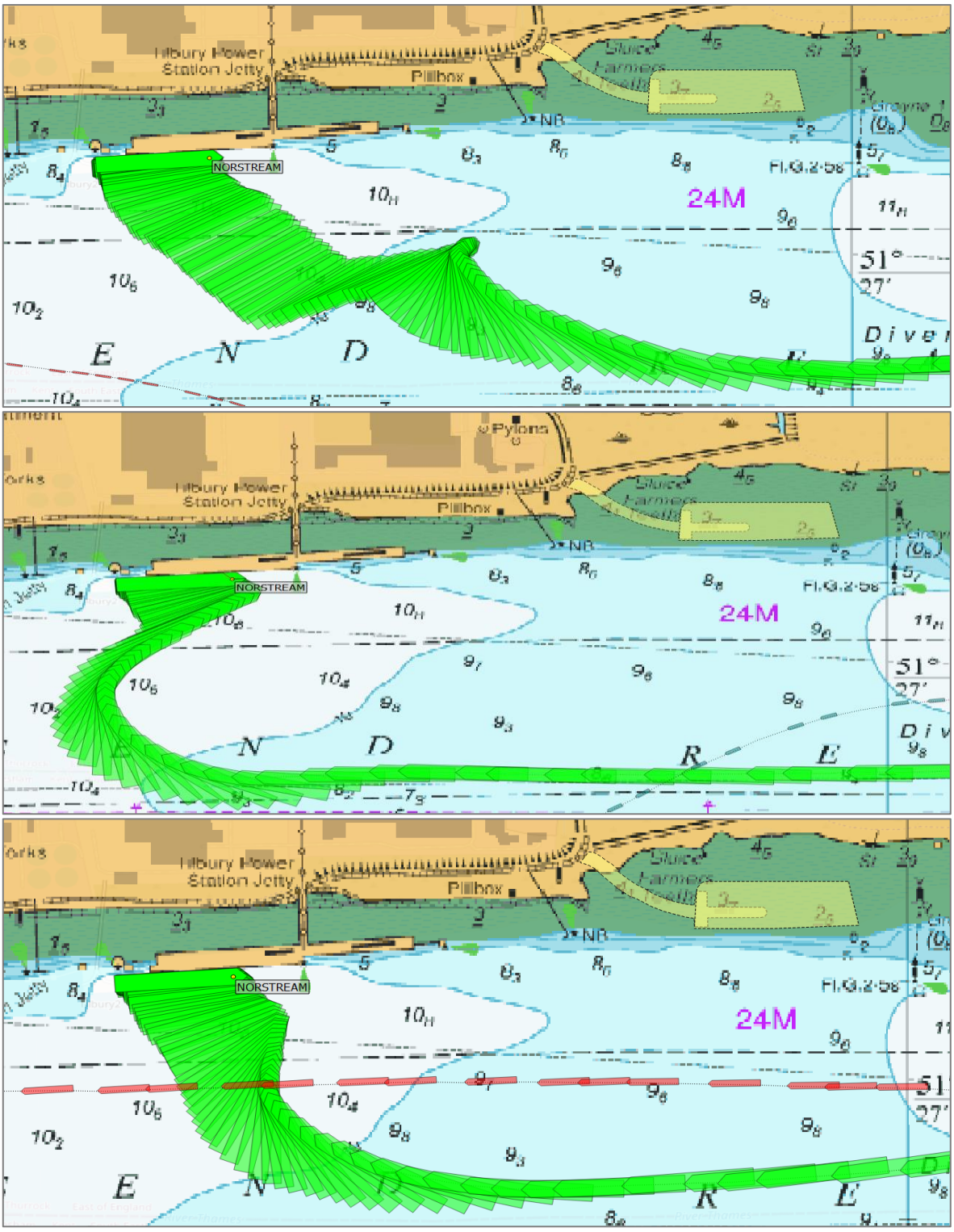


Figure 46: Arrival of the Norstream

Figure 45 shows the typical approach to the berth made by the *Norsky* during the study period. The contrasting approach made by the *Norstream* can be seen in **Figure 46**. **Figure 47** shows a typical departure from the berth, in this instance the *Norstream* is seen departing, this departure is consistent with other departures of the berth.

All arrivals and departures see both vessels manoeuvring well clear of the proposed Causeway. During the study period both the *Norsky* and *Norstream* transited to the downstream ro-ro cargo berth rather than utilising the upstream "Dolphin" berth. Consultation with the Marine Asset Manager at the POT confirmed that the masters of vessels arriving at Tilbury 2 are at present free to decide which berth to utilise.

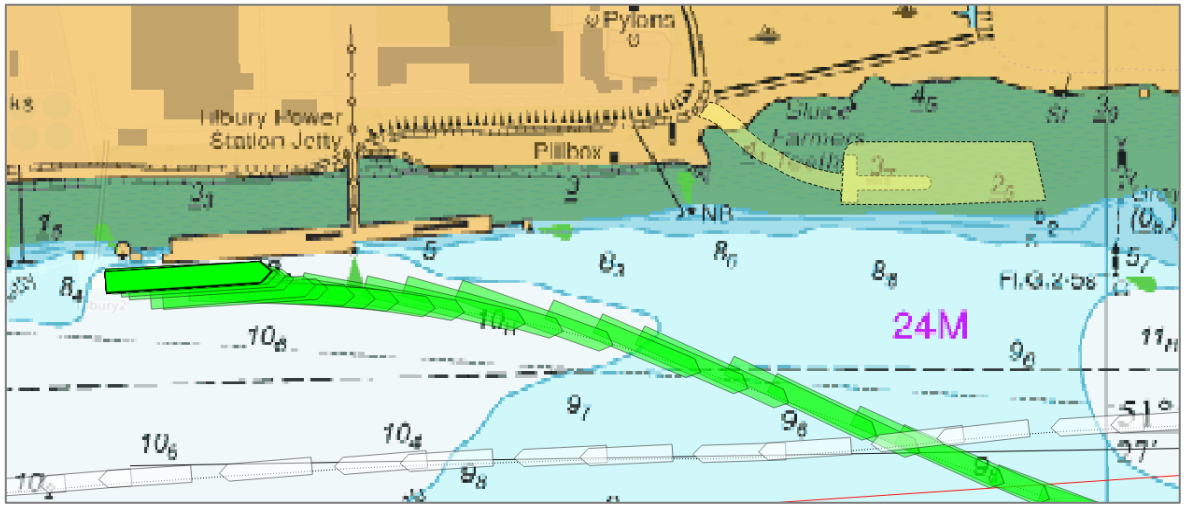


Figure 47: A Typical Departure from Tilbury 2

4.8.2. FUTURE USE OF TILBURY 2

The consultation meeting with the POT Asset Marine Manager confirmed that a third berth will begin to be utilised at Tilbury 2 in the coming months. This berth will be a CMAT (Construction Material and Aggregates Terminal) berth, facilitating the arrival of Bulk Carriers such as the *Yeoman Bridge*, see **Figure 48.** It is understood that the berth will facilitate approximately three arrivals a month initially. Further consultation revealed that the CMAT berth could also be utilised by smaller vessels such as tug and tows moving aggregate between terminals on the Thames, the frequency and likelihood of such movements is not yet understood.

In order to understand the potential impact on the Causeway operation of a vessel using the Tilbury 2 CMAT berth analysis of the swept paths of a similar sized vessel in the area approaching a similar berth was undertaken. The best comparably sized vessel in the study area, where AIS data was available, was the *Bahra,* an oil tanker 249 meters long and 45 metres wide, the *Yeoman Bridge* in contrast is 249.9 metres long and 42 metres wide. **Figure 49** shows the *Bahra*'s arrival at London Gateway – which is a similar type of berth to the proposed CMAT berth - located further down river.

When transiting on to her berth at London Gateway, the *Bahra* swung off the berth with the aid of tugs at her bow and stern. Once in position off the berth the vessel was bodily pushed onto the berth with the aid of the tugs in attendance. It is considered that a similar manoeuvre would likely be undertaken for a vessel such as the *Yeoman Bridge* were it to berth at the Tilbury 2 CMAT berth. Assuming that a similar manoeuvre was undertaken when large vessels make the approach to the Tilbury 2 CMAT berth, there would sufficient sea room for the vessel to maintain a safe distance from the proposed Causeway site.

Figure 48: Yeoman Bridge

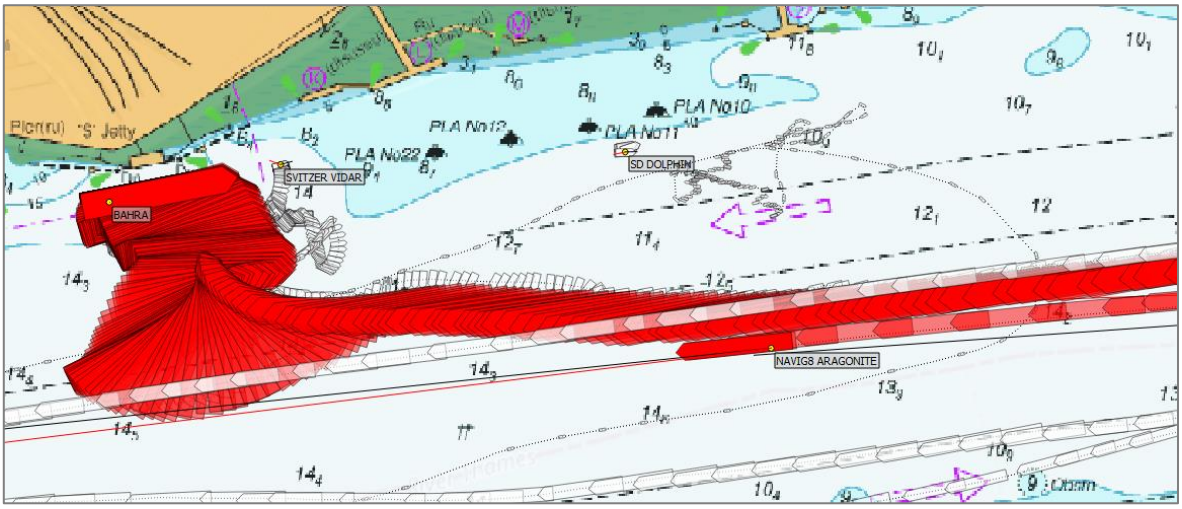


Figure 49: Bahra Arrival London Gateway (red vessel outline)

It is anticipated that the CMAT berth will service vessels with a draught of up to 14m with the berth being dredged to depths of between 14.48 and 14.98m. At present only the berthing area has been dredged with the approaches to the berth awaiting a dredge application based on the DCO boundary (note the red broken line represents the extent of Tilbury 2 DCO boundary (see **Figure 1**)). The DCO Boundary extends out toward the Authorised Channel, this was to allow for further dredging, if required, to create sufficient depth to the approaches to the CMAT berth for large deep draught vessels.

At present, it is understood that further dredging of the DCO boundary area is not planned and that instead CMAT arrivals will be scheduled to coincide with high tide. Although the swept path analysis conducted as part of this report shows that a vessel approaching the CMAT berth will not come into close contact with the Causeway itself, it is not advisable that the CMAT berth is approached by a large bulk carrier vessel at the same time that the *Terra Marique* is making her approach to the Causeway. As both operations would be required to make their

final approach at high tide, arrangements will need to be put in place to ensure adequate deconfliction to mitigate the risk of a collision.

4.9. FUTURE VESSEL TRAFFIC

4.9.1. THE PLA'S THAMES VISION

In 2016, the PLA launched the Thames Vision which set several goals for future vessel traffic on the River Thames for 2035. Within this vision the following relevant goals for vessel traffic were identified and compared against the 2019 vision progress report:

- Double the underlying intra-port freight to over four million tonnes as shown in **Figure 50** - between 2015 and 2017, this increased by 41%.
- Double the number of people travelling by river – reaching 20 million commuter and tourist trips per year - between 2015 and 2018 this reduced by 4%, however new piers and new vessels are being brought into service.
- Greater participation in sport and recreation on and alongside the water.

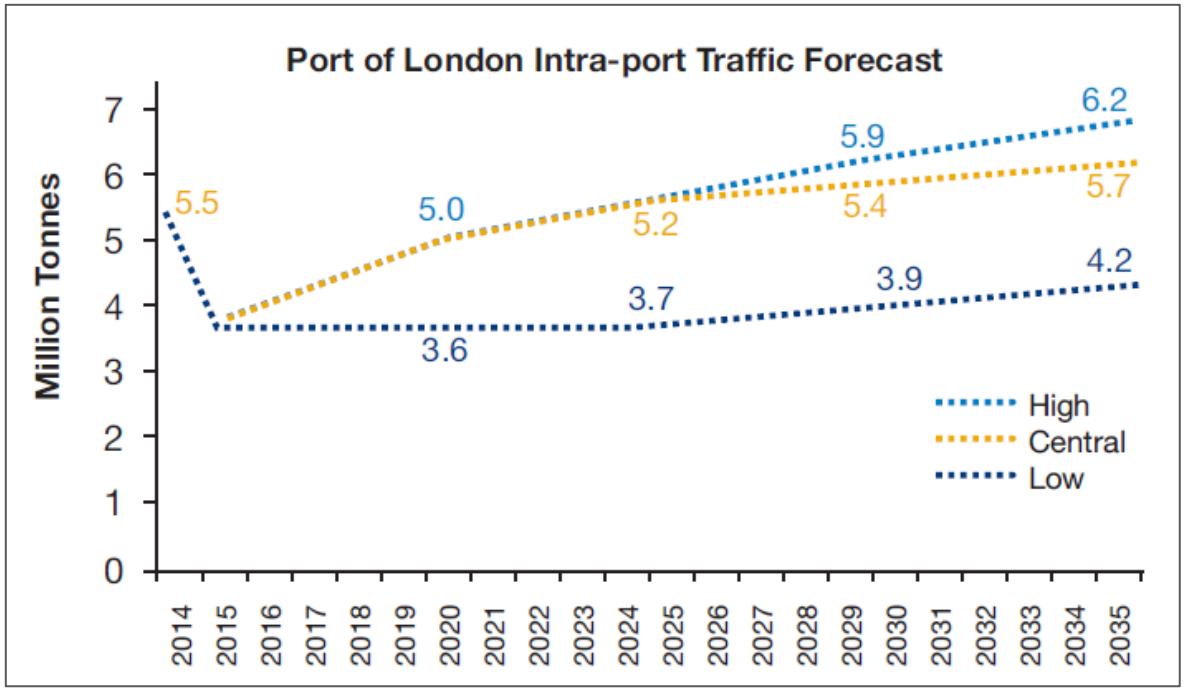


Figure 50: Forecast trends in intra-port trade (source: Stamford Research Group, 2015).

It is likely that vessel traffic on the River Thames will increase in the future, but how many additional vessels there will be and what additional measures will be implemented to maintain tolerable risk levels are unknown at present.

The Thames Vision sets out long term goals that will not be realised during the lifespan of the delivery of AILs for construction of the Thurrock Plant. However, it is the intention that the Causeway will remain in situ to facilitate

further maintenance operations and should vessel traffic increase in line with the PLA's vision it would be prudent to conduct further risk assessment reviews when considering future operation of the Causeway.

In terms of trends in vessel numbers transiting the Thames then this is difficult to detail specifically for the Causeway location. However, the PLA and Department for Transport (DfT) do provide statistics on ship arrivals for "Chargeable Ship Arrivals" in the case of the PLA derived from their annual report, and "Ship Arrivals" derived from several sources in the case of the DfT.

The actual numbers of ship arrivals in the PLA and DfT datasets are different due to the sources of data. However, the data does show that vessel numbers have largely been static in recent years whilst there is trend for cargo growth this does not always manifest itself into additional vessel traffic. In terms of referencing this data to the localised area of the Thames in the vicinity of the Causeway then it is unlikely that this area will see a significant increase in passing vessel traffic – with the exception of additional vessels associated with the Tilbury 2 CMAT berth.

Analysis of vessel traffic movements associated with the two AIS datasets shows that vessel numbers fall in the 2020 dataset from 2018 by around 10% which is thought to be primarily associated with the Covid-19 pandemic. Therefore, in future years an increase in vessel traffic is likely as the Covid-19 downturn is reversed. It is therefore likely that vessel traffic past the site will be similar to the numbers analysed and presented in the 2018 data.

Figure 52 and **Figure 53** summaries the statistics provided by the DfT for "Ship Arrivals" and the information provided by the PLA for "Chargeable Ship Arrivals".

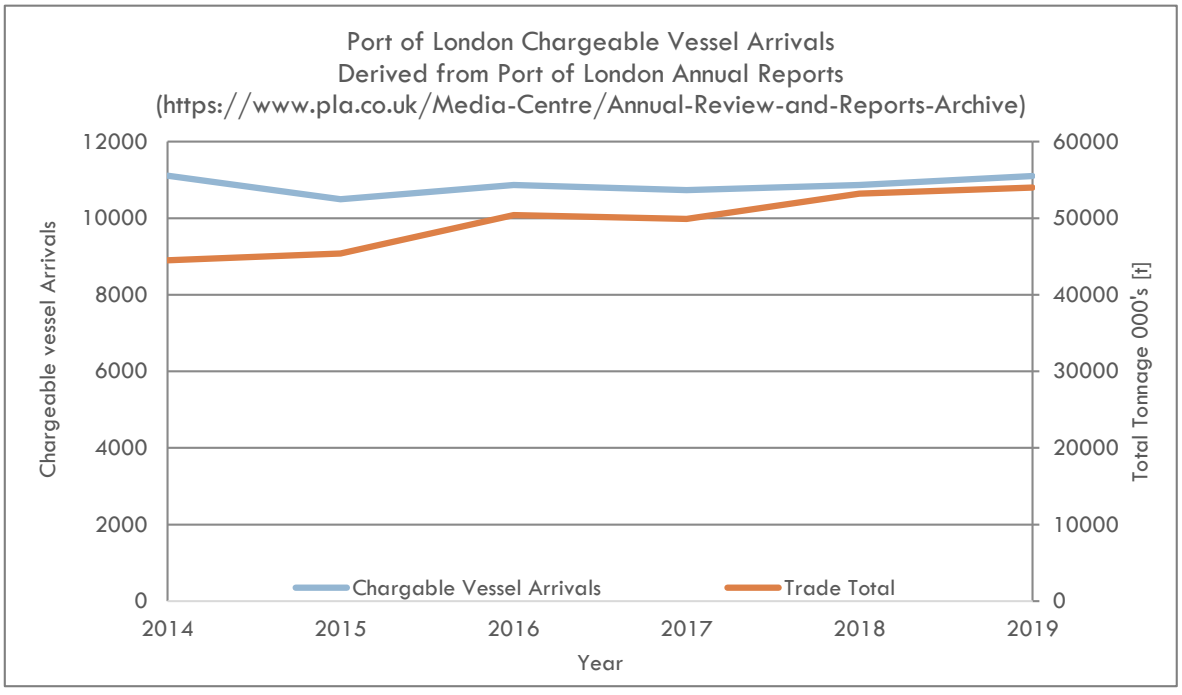


Figure 51: Port of London Chargeable Vessel Arrivals

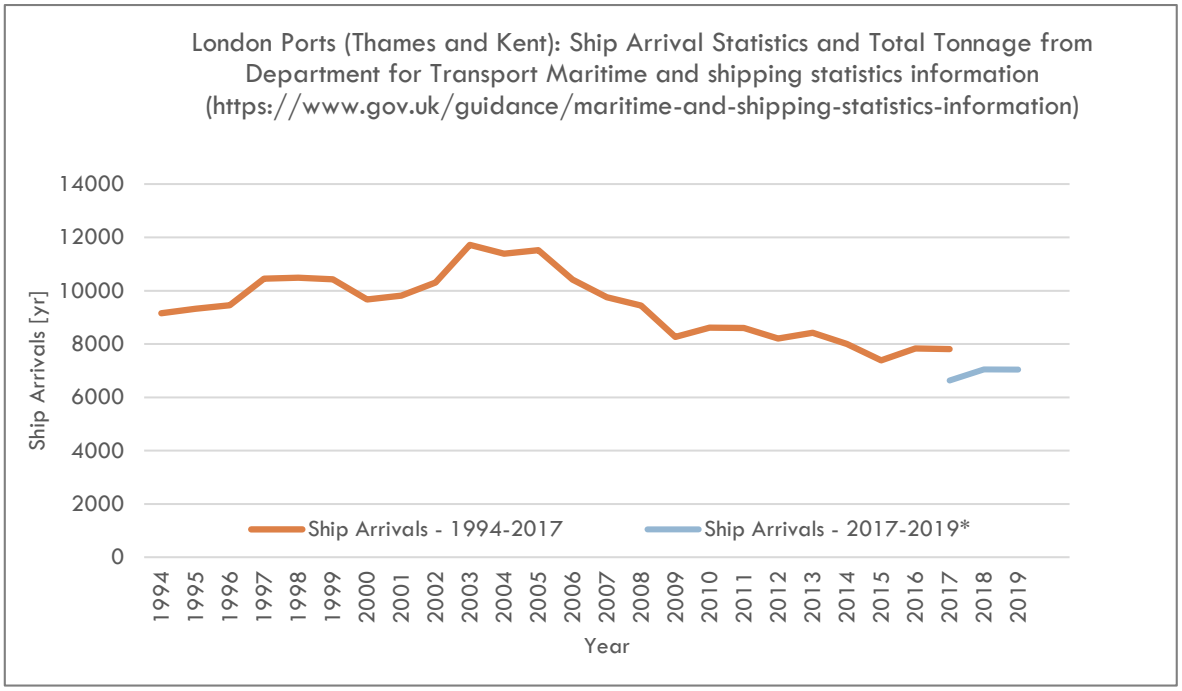


Figure 52: Department for Transport London Ports Ship Arrivals[4]

4.9.2. LONDON RESORT

The London Resort is a theme park development proposed to be constructed in Swanscombe, the proposed development is currently subject to a DCO application and the developer currently plans to submit a planning application toward the end of the 2020 financial year. If approved the proposal includes plans for a regularly running passenger service from central London and Tilbury to bring guests to the theme park, substantial plans for goods to arrive via marine transport in order to facilitate the operation of the resort and for the movement of construction materials during the construction period.

It is anticipated that the construction will commence in 2021 should permission be granted through the DCO process. It is then planned that the resort will become operational in 2024.

At present there is not adequate information available to allow for any meaningful analysis as to how the London Resort construction and operation could impact on the Causeway operation. However, whilst the scale of plans and the developers desire to utilise the POT to assist in the moving of construction materials is significant, the London Resort site is not located near to the Causeway so it is unlikely that intra port trade in the immediate

[4] * 2009 to 2017 figures are derived from data supplied by Lloyds List Intelligence, combined with data on passenger vessel arrivals collected by DfT from ferry companies, as well as counts of cargo vessel voyages collected from ports and shipping agents as part of port freight statistics. From 2018 onwards, the data sources used to estimate vessel arrivals have changed. The primary source of data is now the Maritime and Coastguard Agency CERS system, though data from ferry companies, ports and shipping agents collected by DfT is also still used. A direct comparison is not possible

vicinity of the Causeway will increase as a result of the development. This was confirmed during consultation with the PLA and POT.

4.9.3. LOWER THAMES CROSSING

The Lower Thames Crossing is subject to a DCO and is a proposal for a new road scheme put forward by Highways England. The new road will be 14.3 miles long and will connect the A2 and M2 in Kent with the A13 in Thurrock and M25 in Havering. The scheme includes a proposal for a 2.6-mile-long tunnel under the river Thames to the East of the Tilbury 2 terminal. At present there is no timeline for construction, but it is anticipated that a DCO decision will be made in 2022 and that the tunnel will open in 2027 /2028.

Initial documents include provisions for a new jetty to allow for the transport of waste material via marine freight. As yet these plans are not well developed so it is not possible to produce any meaningful analysis. It is however likely that intra port freight will increase in future years as a result of the development if consent is forthcoming, although this is unlikely to be close proximity to the Causeway. This was confirmed in consultation with the PLA.

4.10. INCIDENTS WITHIN STUDY AREA

The PLA Incident database was analysed to identify trends of incidents within the vicinity of the Causeway site. 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 53 shows the number of incidents per year and demonstrates a change in reporting method in 2013. For the period 2013 to 2018, 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, see **Figure 54.**

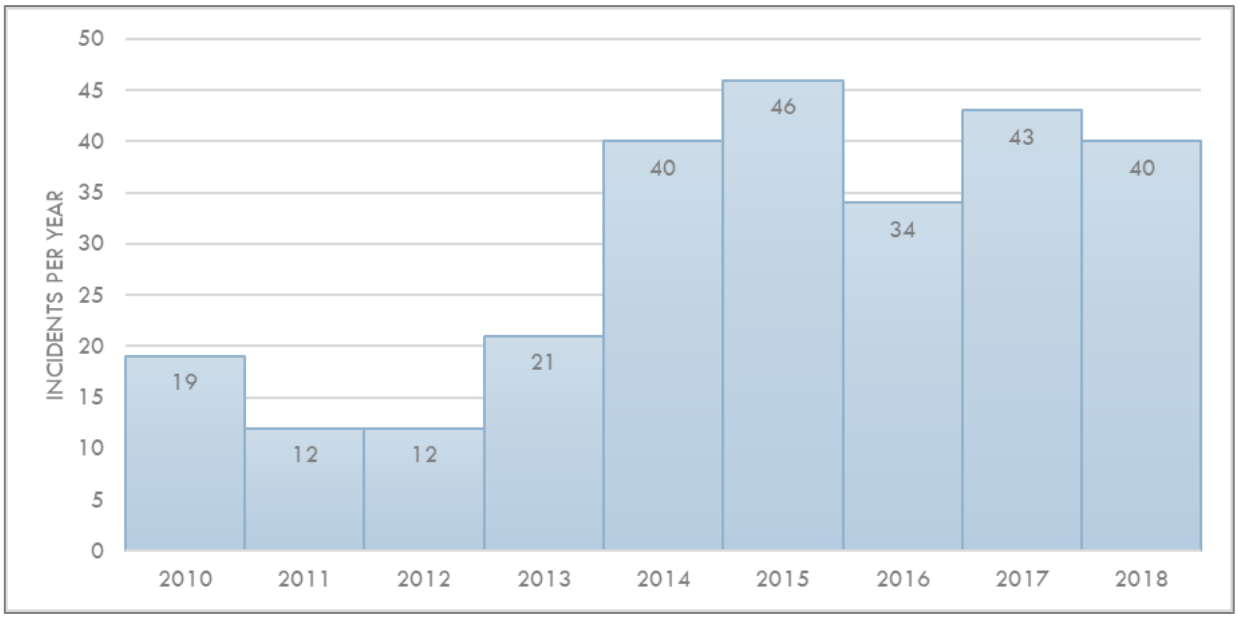


Figure 53: Incidents Per Year in Study Area

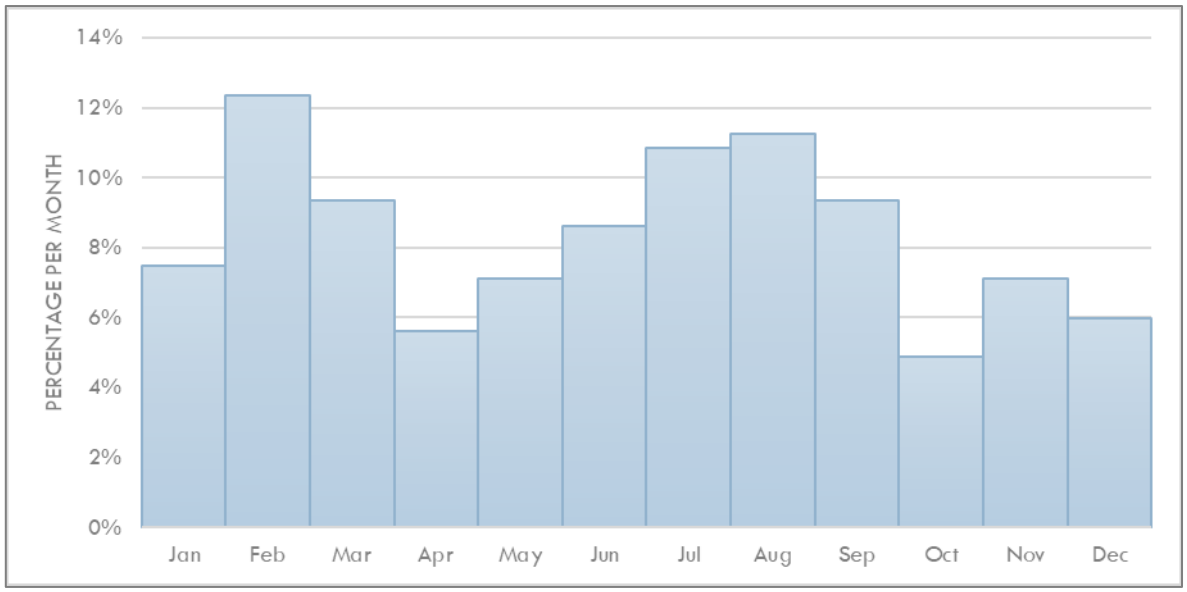


Figure 54: Proportion of Incidents by Month.

Figure 55 breaks down the incidents between 2013 and 2018 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%).

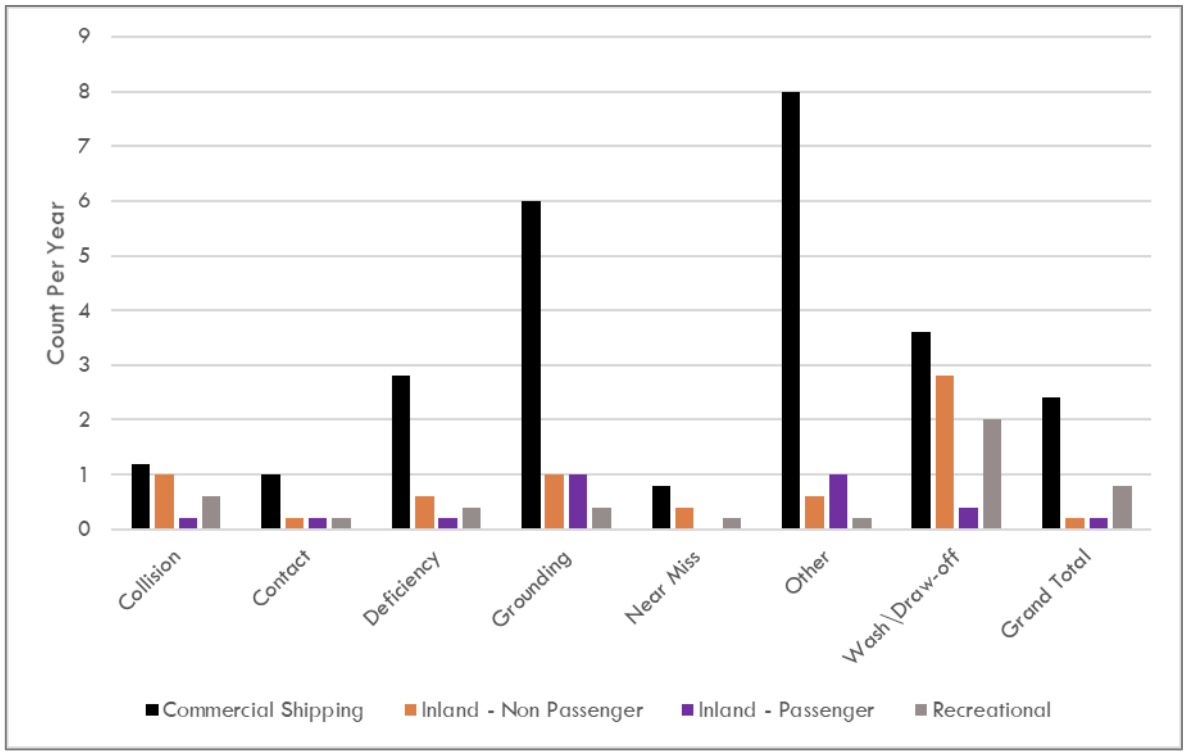


Figure 55: Incidents between 2014 and 2018 by Vessel Type.

4.11. SUMMARY

In summary, baseline characterisation and a detailed review of the AIS data collated revealed:

- Data recorded in September should be considered representative of the year as a whole.
- Traffic in the area remains, for the most part, confined to the Authorised Channel.
- Exceptions are the regular ro-ro arrivals at Tilbury 2 and the tug and tow operation at East Tilbury Jetty.
- Vessel traffic movement in the area is no greater around high water and the hour prior to high water compared to other hours of the tidal cycle.
- There was a reduction in vessel transits between 2020 and 2018 of around 10% associated with the Covid-19 pandemic. Although vessel traffic activity in the vicinity of the Causeway was higher in 2020 due to Tilbury 2 and East Tilbury activity.
- Swept path analysis of the vessels arriving and departing Tilbury 2 revealed different approaches by the respective Masters, but both the vessels transited well clear of the Causeway on inward and outward approaches.
- Future use of the Tilbury 2 CMAT berth by large vessels such as the *Yeoman Bridge* is likely to have an impact on the Causeway operation because both operations will need to occur at High tide. Therefore, adequate deconfliction measures will need to be put in place.
- Tug and tows operating out of East Tilbury Jetty are unlikely to conflict with the operation of the Causeway and the approach of the *Terra Marique* due to the presence of a physical barrier in the form of a groyne marking the edge of Divers Shoal.
- Recreational craft activity in the area whilst not high is prevalent, however the Causeway operation is unlikely to present significant impact to recreational craft.

5. STAKEHOLDER CONSULTATION

The aim of consultation was to elicit local stakeholder and regulator knowledge and feed it into the Preliminary NRA to ensure any navigational concerns related to the project are identified and addressed. The list of consultees was agreed with the PLA, as SHA for the Causeway area at commencement of the Preliminary NRA. Consultation was carried out with the PLA and POT as follows:

- PLA
  - Consultation 1: 14:00 – 15:00 / 8-Oct-2020
    - Miles Featherstone, Deputy Harbour Master (PLA)
    - Ed Rogers, Sam Anderson-Brown, Raffi Grace (NASH Maritime Ltd)
  - Consultation 2: 12:00-15:00 / 9-Nov-2020
    - Cathryn Spain, Senior Harbour Master (PLA)
    - Ed Rogers, Sam Anderson-Brown, (NASH Maritime Ltd)
  - Consultation 3: 11:30 – 12:30 / 20-Nov-2020
    - Cathryn Spain, Senior Harbour Master (PLA)
    - Ed Rogers, Sam Anderson-Brown, (NASH Maritime Ltd)
- POT
  - Consultation 1: 14:00 – 15:00 / 5-Oct-2020
    - Nick Evans, Asset Manager Marine (Forth Ports)
    - Ed Rogers, Sam Anderson-Brown, Raffi Grace (NASH maritime Ltd).
  - Consultation 2: 11:30 -12:15 /5-Nov-2020
    - Nick Evans, Asset Manager Marine (Forth Ports)
    - Ed Rogers, Sam Anderson-Brown (NASH maritime Ltd).
  - Consultation 3: 14:00 – 16:00 /20-Nov-2020
    - Nick Evans, Asset Manager Marine (Forth Ports)
    - Ed Rogers, Sam Anderson-Brown, (NASH maritime Ltd).

Summaries of the minutes from the consultation meetings can be found in **Annex G to J** and were circulated to all participants for comment and agreement.

In addition, a number of telephone calls were also undertaken to clarify comments and keep consultees appraised on assessment progress.

The following section provides a summary of the key themes and issues raised by the POT and PLA during initial consultation meetings.

5.1. SUMMARY OF CONSULTATION WITH POT

Key discussion points:

- *Terra Marique* will need to fit around current schedules when entering and exiting POT and will require independent risk assessment.
- Nick Evans noted:
    - the presence of regular recreational traffic to the north of the Authorised Channel and suggested further investigation.
    - he had no concerns with the hazards identified.
    - Suggested that 2 weeks-worth of AIS data may not be a sufficient sample because of COVID-19 – this was addressed by including none AIS data in the assessment and benchmarking to yearly / quarterly trends.
    - CMAT berth expects "a few" arrivals a month.
    - *Yeoman Bridge* identified as key design vessel for CMAT berth.
    - that the Causeway location does not create immediate concerns.

5.2. SUMMARY OF CONSULTATION WITH PLA

Key discussion points – Miles Feather Stone:

- Confirmed the scope of the assessment proposed by NASH Maritime was suitable.
- Confirmed CMAT berth will become operational soon – MF confirms *Yeoman Bridge* as an appropriate design vessel.
- Confirmed that 2 weeks of recent AIS data is suitable.
- Confirmed need for recreational vessels to be considered in the assessment and that they are advised to keep clear of the groynes adjacent to the Causeway site.
- Confirmed that Hazards Identified are valid but suggest an additional hazard for consideration – Collision of *Terra Marique* with vessels approaching or manoeuvring at Tilbury 2 terminal.
- If surface piercing structures are installed, then these should be marked with Aids to Navigation (AtoN).
- Suggested that a speed easement should be added as a risk control measure.

5.3. FURTHER CONSULTATION

Following the issue of the draft NRA on 14-Oct-2020, two further consultations were carried out with the PLA and POT to present further work carried out by NASH Maritime Ltd. This work addressed concerns regarding a need for additional detail around the passage plan element of the operation, developed the hazards identified as part of the risk assessment matrix and discussed appropriate risk control measures.

Minutes from these consultation meetings can be found in **Annex H and J.**

6. HAZARD IDENTIFICATION AND RISK ASSESSMENT

6.1. INTRODUCTION

The following section outlines the identification and assessment of navigation hazards utilising the PLA's standard risk assessment methodology for river developments. The following definitions apply:

- **Hazard** - an unwanted event resulting in adverse consequences
- **Likelihood** - a determination of how likely a hazard is to occur
- **Severity** – the magnitude of the consequences should a hazard occur
- **Risk** - a non-dimensional measure of hazard severity and likelihood.
- **Embedded risk control measures** – a risk control measure that is already in place
- **Additional risk control measures** – a risk control measure that is put in place specifically for the project scheme under consideration.
- **Inherent Assessment of Navigation Risk** – an assessment of hazard risk with the project / scheme / development in place including existing risk control or mitigation measures
- **Residual Assessment of Navigation Risk** – an assessment of hazard risk with the project / scheme / development in place including existing risk control or mitigation measures, and additional project / scheme / development risk control or mitigation measures

6.2. PLA RISK ASSESSMENT METHODOLOGY

The PLA risk assessment methodology requires that navigation hazards be identified and assessed in relation to hazard likelihood and hazard consequence to generate a hazard risk score:

$$Navigation\ Risk = likelihood\ of\ hazard\ occurence\ \times consequnce\ of\ hazard\ occurence$$

The assessment of navigation risk is made for two risk scenarios – "*inherent*" and "*residual*" assessment.

The inherent and residual assessment enables the determination of hazard risk reduction brought about by either an additional individual project risk control or in most cases a suite of project related risk control measures.

In order to determine hazard likelihood assessments, the PLA use a likelihood classification table to allocate likelihood scores to hazards – see **Table 5**.

Hazard consequence classifications are as shown in **Table 6** and relate in board terms to hazard impact to:

- People
- Environment
- Property
- Reputation
- Port Impact

Table 5: Hazard Likelihood Classifications

Hazard Likelihood Classifications
Rare: Very unusual - not common or frequent
Unlikely: Not probable or likely to happen
Possible: Not certain – might or might not happen
Likely: Will probably happen or is expected
Almost Certain: More than likely / in all likelihood

Table 6: PLA Hazard Consequence Classifications

Consequence Classifications	People	Environment	Property	Reputation	Port Impact
Minor:	-Minor or No injuries.	-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 approx. £5,000
Moderate:	-Moderate injuries.	-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 adjustments to working / operational methods may be required.	-Local news coverage and control measures required to manage publicity.	-Moderate cost implications for Port. Guidance approx. between £5,000 & £50,000
Serious:	-Major / life changing injuries.	-Limited impact on environment and port operation with short term or long-term effects.	-Vessel / Equipment / structure un-operational and in need of repairs.	-Regional news coverage with potential for reputational damage.	-Serious cost implications for Port. Guidance approx. between £50,000 & £250,000
Very Serious:	-Single Fatality.	-Significant impact on environment and Port operation with short term or long-term effects	-Vessel / Equipment / Structure un-operational and in need of extensive repairs / dry docking.	-National news coverage with significant potential for reputational damage	-Very Serious cost implications for Port. Guidance approx. between £250,000 & £500,000
Severe:	-Multiple fatalities.	-Serious long-term impact on environment and / or permanent damage.	-Vessel / equipment / structure unsalvageable. -Serious long-term impact on port operational effectiveness.	-International news coverage with severe potential for reputational damage.	-Severe cost implications for Port. Guidance approx. over £500,000

A risk matrix is then used to combine the likelihood and consequence scores for each hazard to generate an inherent assessment of risk.

Based on the evaluation of the impact of the development each hazard is scored using the matrix as defined in **Table 7**.

Table 7: PLA's Risk Score 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	Minor	Moderate	Serious	Very Serious	Severe

6.3. ACCEPTABILITY

The PLA methodology does not state the acceptability of risk scores - however, it is assumed that risk scored at "Moderate" and "Minor" would be deemed acceptable, which puts the acceptability threshold at risk scores lower than 9.0 / 25 (see **Table 8** for PLA risk score classifications). Where inherent hazard risk scores are greater than 9/25 (Serious, Very Serious or Severe), risk controls are identified and allocated to hazards. Hazard risk scores are then recalculated using the same method as above and a residual assessment of risk determined.

Table 8: PLA Hazard risk score classifications.

Total Risk Score	
Minor	1-3.9
Moderate	4-8.9
Serious	9-14.9
Very Serious	15-19.9
Severe	20-25

6.4. HAZARD IDENTIFICATION

Navigation hazards were identified based on vessel types navigating within the study area, defined as the project vessels on passage, or berthing at the Causeway (see **Table 9**) which were then combined with a defined list of navigation hazard types. This resulted in a total of 18 identified hazards, outlined in **Table 10**. The hazard list was shared and agreed with stakeholders.

Table 9: Hazard area / operation.

Hazard Area / Operation	Description
Causeway	Operation of the *Terra Marique* and attendant tugs in vicinity of the Causeway (to include Tilbury 2, groyne downstream and immediately east of the causeway, East Tilbury Jetty and the adjacent area to the north of the Authorised Channel.
Passage	Passage from the AIL transhipment site to the Causeway

Table 10: Summary of Identified Hazards

Hazard ID	Hazards
Haz Id #:1	Contact of *Terra Marique* (including project vessels) with Causeway, Tilbury 2, or other structures.
Haz Id #:2	Contact with Causeway by passing vessels (All types).
Haz Id #:3	Collision of *Terra Marique* (including project vessels) with vessels arriving and departing Tilbury 2 Ro-Ro Berth.
Haz Id #:4	Collision of *Terra Marique* (including project vessels) with vessels arriving and departing CMAT berth.
Haz Id #:5	Collision of *Terra Marique* (including project vessels) with passing commercial vessels (All types).
Haz Id #:6	Collision of *Terra Marique* (including project vessels) with passing recreational vessels.
Haz Id #:7	Collision of *Terra Marique* (including project vessels) with passing tug and tow.
Haz Id #:8	Collision caused as a result of avoiding *Terra Marique* (including project vessels) transiting during Causeway operation.
Haz Id #:9	Grounding of *Terra Marique* (including project vessels) as a result of Causeway operation.
Haz Id #:10	Grounding of non-project vessels as a result of Causeway operations (All types).
Haz Id #:11	Breakout of *Terra Marique* during berthing / alongside.
Haz Id #:12	Contact of *Terra Marique* (including project vessels) with infrastructure whilst on passage outside Causeway operation area.
Haz Id #:13	Collision of *Terra Marique* (including project vessels) with passing commercial vessels outside the defined Causeway operation area.

Hazard ID	Hazards
Haz Id #:14	Collision of *Terra Marique* (including project vessels) with passing recreational vessels outside the defined Causeway operation area.
Haz Id #:15	Collision of *Terra Marique* (including project vessels) with passing Tug and Tow outside the defined Causeway operation area.
Haz Id #:16	Collision caused as a result of avoiding *Terra Marique* (including project vessels) during passage (All vessels)
Haz Id #:17	Grounding of *Terra Marique* (including project vessels) whilst on passage to Causeway outside the defined Causeway operation area.
Haz Id #:18	Grounding of non-project vessels as a result of *Terra Marique* Passage (All types).

6.5. EMBEDDED RISK CONTROL MEASURES

Key embedded risk control measures that will significantly reduce the navigation risk posed by the operation of the Causeway were discussed with key stakeholders and are summarised in **Table 11.** A full summary of the other embedded risk control measures is provided in **Section 3.5.**

Table 11: Key Embedded Risk Control Measures

E1	**Charting**	PLA charts will be updated to show the location of the Causeway, any depth alterations as a result of the construction of the Causeway and dredged berthing pocket and any aids to navigation.
E2	**Aids to navigation**	Appropriate Aids to Navigation will need to be installed based on the final Causeway design and could include, by way of an example, day marks on the Causeway 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 Thames has specific bearing on the Causeway operation. This is detailed in Section 108 of the Port of London Act, 1968 108. in terms of "due care and attention", as well as PLA Byelaw 57 which specifically addresses wash and draw-off. This control does not mandate the requirement for permanent impacts on passing vessels.
E4	***Terra Marique* Specific Vessel Passage Port Plan and RAMS**	A detailed port passage plan (in accordance with PLA General Directions) for the *Terra Marique* is to be approved by the PLA (and any other SHA area it passes through) and developed in conjunction with the PLA Harbourmaster & pilots. The port passage plan should include identification of specific procedures including holding procedures, safe tidal operating windows for the berthing operation, emergency response procedures and should identify navigational constraints. MetOcean limitations will need to be agreed as part of the safe operating procedures. For example, limits for the passage and Causeway berthing operation should be reviewed: - if sustained winds exceed 15 knots the operation should be postponed - if visibility is less than 0.5 nm visibility the tow should not commence and if during the operation visibility is reduced to less than 0.25 nm then appropriate layby mooring should be sought until such a time that visibility clears. - if wave heights consistently exceed 0.5m the operation should be postponed.

E5	Pilotage	The *Terra Marique* is subject to compulsory pilotage in PLA waters in accordance with PLA Pilotage directions (compulsory pilotage is required for *Terra Marique* as a vessel of 80m LOA (when operating as a motorised barge) and compulsory pilotage is required for tug and tow (i.e., *Terra Marique* acting as a non-motorised barge) as the combined length of the tug and tow is over 90m). As the Causeway berth and operation is new, familiarisation may be necessary by PLA pilots and/or PEC holders (which may include simulation). Tripping numbers for PEC authorisation will be as defined by the PLA.

6.6. HAZARD ANALYSIS

The following sections provides a narrative overview on the identified navigation hazards. It should also be noted that the generic embedded risk controls measures identified in **Section 3.5** and also the key embedded risk control measures (see **Section 6.5**) are in place and manage everyday navigation risk on the river Thames.

6.6.1. CONTACT OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH CAUSEWAY, TILBURY 2, OR OTHER STRUCTURES.

The *Terra Marique* will exit the Authorised Channel east of the Tilbury 2 terminal and transit on to the Causeway at High tide. In addition to Tilbury 2 there are a series of 6 groynes in the immediate vicinity as well as the East Tilbury Jetty. Tidal flow velocities can exceed 3.5 knots with the ebb (outgoing tide) although typical ebb speeds are in the region of 2 knots. However, tidal velocities around high water and towards the edge of the river will be significantly less. The likelihood of the *Terra Marique* making contact with infrastructure as a result of potentially strong tidal flows in such conditions is mitigated by the provision of supplementary tug vessels. MetOcean limits will also be applied for the operation.

6.6.2. CONTACT WITH CAUSEWAY BY PASSING VESSELS (ALL TYPES).

Gravesend Reach is used by a wide variety of vessel types including, ferries, general cargo vessels, tankers, ro-ro vessels, and less regular users such as cruise ships and naval vessels. Most vessels transit via the PLA Authorised Channel. However, a possible route for recreational craft is north of the main Authorised Channel passing between the main channel the Causeway and Tilbury 2. In addition, Ro-Ro cargo vessels and bulk carriers will transit to Tilbury 2 and in doing so will exit the Authorised Channel. It is considered very unlikely that a vessel bound for Tilbury 2 would make contact with the Causeway.

In order for such an event to occur the vessel would need to have deviated significantly from its planned course – possibly caused only by mechanical failure. The Causeway is only accessible during hightide and it is likely that any commercial vessel on course to make contact with the Causeway would ground before making contact. It is more likely that recreational vessels could make contact with the Causeway including any navigation marks put in place to notify mariners of the obstruction. However, this is mitigated by the fact that the PLA's recreational craft guidance expressly states that vessels should not navigate north of the lateral makers on the groynes adjacent to the Causeway site. Therefore, it would be unusual for a recreational vessel of any size other that a small craft such as a kayaker or dinghy to navigate in close proximity to the causeway.

6.6.3. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH VESSELS ARRIVING AND DEPARTING TILBURY 2 RO-RO BERTH.

As the *Terra Marique* navigates between the PLA Authorised Channel and Causeway there is a risk that collisions could occur between vessels arriving and departing the Tilbury 2 Ro-Ro berths and the *Terra Marique*. Due to available depths in the area vessels approaching Tilbury 2 need to transit in deep water, this means they will remain approximately 150 m away from the Causeway itself. In addition, at present there are only four movements on and off Tilbury 2 a day and these are scheduled arrivals and departures by time of day, and not dependant on the state of tide. It is possible for the Causeway marine operation to work around these time – therefore the risk of collision is not considered to be significant and can be largely managed with existing risk control measures.

6.6.4. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH VESSELS ARRIVING AND DEPARTING CMAT BERTH.

The CMAT berth at Tilbury 2 will be operational for large deep draught vessels during high tide – when the Causeway (and Terra Marique) will also be operational. The need for deconfliction of the two operations in this instance will be necessary to avoid the risk of a collision as the two vessels make their respective approaches. Given that it is likely that the CMAT berth will be utilised approximately two to three times a month and there will be between 30 to 60 AIL shipments over a 6-month period made by the *Terra Marique*, there should be no need for both vessels to arrive at the respective sites on the same high tide. On occasions when a CMAT arrival by a large vessel is scheduled Causeway marine operations should not occur.

6.6.5. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH PASSING COMMERCIAL VESSELS (ALL TYPES).

Gravesend Reach is used by a wide variety of vessel types and as the *Terra Marique* navigates between the Authorised Channel and Causeway there is a risk that collisions could occur between passing vessels. This risk should be mitigated by the issuing of a comprehensive Notice to Mariners giving details of the Causeway operation and the provision of waiting and layby areas to ensure that the *Terra Marique* will remain clear of the Authorised Channel whilst waiting to make her approach to the Causeway. Analysis of vessel traffic movements adjacent to the Causeway indicate that at around high water there are around 6 transit per hour – it would be incumbent on the tow master of the *Terra Marique* to cross the channel when it is clear to do so.

6.6.6. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH PASSING RECREATIONAL VESSELS.

Downstream of the Causeway site at Mucking No 5 the preferred small craft route crosses from the south side of the PLA Authorised Channel to the north side. Although, the small craft route does not require recreational vessels to pass the Causeway on the northern side of the PLA Authorised Channel it is likely that some skippers will decide to continue navigating on the northern side of the Authorised Channel past the Causeway site. They are therefore, the most likely passing vessel to come into close proximity to the *Terra Marique* as she makes her approach to the causeway. It is also likely that the *Terra Marique* may need to hold station between the PLA Authorised Channel and the Causeway until high tide, this could position her close to or obstructing the recreational route.

The propose waiting area however is located inside the groynes and therefore should not impact recreational vessels on transit. The *Terra Marique* will also have a PLA pilot of PEC holder on board and who will be familiar with recreational craft activity in the area.

6.6.7. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH PASSING TUG AND TOW.

Tug and tows frequently use the East Tilbury Jetty and are more likely to come into close proximity with the *Terra Marique* than most other passing vessels because of this. The *GPS Ionia* and *GPS India* arrived at East Tilbury between one and two hours before HW during the study period and approached the Jetty well to the west of the Causeway. It is likely that the *Terra Marique* may need to hold station between the PLA Authorised Channel and the Causeway whilst awaiting high water, this would position her close to East Tilbury Jetty and would mean that she may be standing off the Causeway as the tugs approach East Tilbury Jetty. However, the presence of a groyne to the east of the Causeway and to the west of the East Tilbury Jetty creates a physical barrier between the Jetty and Causeway limiting the chances of a collision between the *Terre Marique* and passing tug and tows. The inclusion of a waiting area within the operating plans also means that if the *Terra Marique* does need to hold station whilst she waits for high water, she will be clear of East Tilbury Jetty.

6.6.8. COLLISION CAUSED AS A RESULT OF AVOIDING *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) TRANSITING DURING CAUSEWAY OPERATION.

The *Terra Marique* will navigate between the Authorised Channel and the Causeway and in doing so will cross the same section of river utilised by vessels using the Tilbury 2 ro-ro and CMAT berths as well as recreational craft and tug and tows using the East Tilbury Jetty. To avoid the risk of collision as a result of avoiding the *Terra Marique* careful consideration will need to be given to deconfliction of the operations and measures should be taken to warn recreational craft of the *Terra Marique's* intention to transit to the Causeway site, such as regular Notices to Mariners.

6.6.9. GROUNDING OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) AS A RESULT OF CAUSEWAY OPERATION.

There will be very limited under keel clearance when navigating on to the Causeway. Departure / arrival times will have to be calculated very carefully in order to coincide with high water. It is possible that wash from passing vessels could also push the *Terra Marique* off course during final approaches to berth, this change of course could result in grounding. The provision of mooring piles to indicate the edge of the Causeway and correct berthing area will mitigate the risk of grounding.

6.6.10. GROUNDING OF NON-PROJECT VESSELS AS A RESULT OF CAUSEWAY OPERATIONS (ALL TYPES).

The risk of grounding of passing third party vessels as a result of the Causeways is very minimal, as is third party grounding which could only occur if a vessel were navigating north of the lateral marks placed on the groynes. This is only possible at high tide and can only be done by shallow draught vessels. Recreational craft are advised

to avoid navigating in this area by the PLA and larger commercial vessels are likely to ground before making contact with the Causeway.

6.6.11. BREAKOUT OF *TERRA MARIQUE* DURING BERTHING / ALONGSIDE.

It is possible that the *Terra Marique* could break free whilst moored alongside the Causeway. This could be a particular problem with strong tidal flows, rise and fall of tides, periods of adverse weather or from wash / draw off from passing vessels. However, it is envisaged that there will be suitably designed and installed mooring infrastructure to accommodate the *Terra Marique* whilst waiting for the tide to rise and fall. For example, the *Terra Marique* utilises a spud anchor system which she can deploy once in position which will also mitigate the risk of breakout, a temporary speed reduction whilst the *Terra Marique* transitions to being aground and ballasts down will also mitigate the risk of breakout.

6.6.12. CONTACT OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH INFRASTRUCTURE WHILST ON PASSAGE OUTSIDE CAUSEWAY OPERATION AREA.

The *Terra Marique* will need to utilise the PLA Authorised Channel when navigating to and from the AIL transhipment terminal and the Causeway. The *Terra Marique* will be assisted in and out of the AIL transhipment site by appropriate supplementary towage as required by the chosen AIL transhipment Statutory Harbour Authority. There are a number of jetties and moorings situated outside the Authorised Channel that should also be avoided. In order to make contact with these structures the *Terra Marique* would need to deviate significantly from the Authorised Channel and any such occurrence would most likely be as a result of a breakdown. However, the *Terra Marique* will be accompanied by two tugs, and will have her engines ready, whilst transiting to the Causeway site to mitigate any risk of making contact with river infrastructure.

6.6.13. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH PASSING COMMERCIAL VESSELS OUTSIDE THE DEFINED CAUSEWAY OPERATION AREA.

Gravesend Reach is used by a wide variety of vessel types, as the *Terra Marique* navigates the Authorised Channel there is a risk that collisions could occur between passing vessels. However, this risk is no greater than could be expected for any other vessel navigating utilising the Authorised Channel and other similar tug and tows occur on a regular basis – through application of existing risk control measures this hazard is well managed already by the PLA and other SHA on the Thames.

6.6.14. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH PASSING RECREATIONAL VESSELS OUTSIDE THE DEFINED CAUSEWAY OPERATION AREA.

For the most part it is understood that recreational craft will utilise the small craft channel which extends 15 metres to the north and south of the Authorised Channel. There is a possibility that a collision between the *Terra Marique* and recreational craft could occur as the *Terra Marique* enters and leaves the Authorised Channel. A regularly updated notice to mariners should mitigate this risk along with the exiting embedded risk controls.

6.6.15. COLLISION OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WITH PASSING TUG AND TOW OUTSIDE THE DEFINED CAUSEWAY OPERATION AREA.

Intra port freight traffic and tug and tow traffic is common in the Gravesend Reach. As the *Terra Marique* navigates the Authorised Channel there is a risk that collisions could occur between passing vessels.

6.6.16. COLLISION CAUSED AS A RESULT OF AVOIDING *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) DURING PASSAGE (ALL VESSELS)

The *Terra Marique* modest speed may create a hold up in passing traffic and this could lead to congestion and a greater chance of collision between vessels seeking to avoid the *Terra Marique*. Supplementary towage will help to mitigate this hazard as well as the utilisation of waiting and layby areas outside the Authorised Channel.

6.6.17. GROUNDING OF *TERRA MARIQUE* (INCLUDING PROJECT VESSELS) WHILST ON PASSAGE TO CAUSEWAY OUTSIDE THE DEFINED CAUSEWAY OPERATION AREA.

The *Terra Marique* will need to utilise the PLA Authorised Channel when navigating to and from the AIL transhipment terminal and the Causeway. The *Terra Marique* will be assisted in and out of the transhipment terminal by appropriate supplementary towage as per the direction of the chosen AIL transhipment terminal. There are a number of shoals situated outside the main Authorised Channel that should be avoided. In order to ground the *Terra Marique* would need to deviate significantly from the Authorised Channel and any such occurrence would most likely be as a result of a breakdown. The *Terra Marique* will be accompanied by two tugs whilst transiting to the Causeway site to mitigate any risk of her leaving the Authorised Channel and grounding.

6.6.18. GROUNDING OF NON-PROJECT VESSELS AS A RESULT OF *TERRA MARIQUE* PASSAGE (ALL TYPES).

The *Terra Marique*'s modest speed may create a hold up in passing traffic and this could lead to congestion and a greater chance of vessels inadvertently leaving the Authorised Channel in order to avoid the *Terra Marique*. This could result in grounding, particularly for deep drafted vessels. Supplementary towage will help to mitigate this hazard as well as the utilisation of waiting and layby areas outside the Authorised Channel.

7. NAVIGATION RISK ASSESSMENT RESULTS

The results of the NRA are contained in full in the "*Risk Assessment Logs*" which are at **Annex K.** The "*Risk Assessment Logs*" are based on the PLA template and consider hazard risk in terms of:

- Hazard ID
- Inherent Hazard Risk Rank (based on inherent severity score)
- Residual Hazard Risk Rank ((based on residual severity score)
- Hazard Area (project study area)
- Hazard Comments on Disposition - overview of vessel disposition
- Hazard Causes
- Hazard Consequences (broken down into "*Most Likely Consequences*" and "*Reasonable Worst Credible Consequences*")
- Inherent Risk Assessment (no project risk controls in place):
    - Hazard Likelihood Score
    - Hazard Consequence Score
    - Hazard Severity Score
- Control Measures – project risk control or mitigation measures:
- Residual Risk (project risk controls in place)
    - Hazard Likelihood Score
    - Hazard Consequence Score
    - Hazard Severity Score

7.1. INHERENT RISK ASSESSMENT RESULTS

The results of the inherent assessment of risk for the Causeway operation are contained in **Table 12** which relates to an assessment of risk for the Causeway without additional control measures - but includes embedded risk control measures.

Based on the PLA risk score classifications then for the inherent assessment of risk for the Causeway operation there was one hazard which scored as intolerable / unacceptable, this was hazard 4 - Collision of *Terra Marique* (including project vessels) with vessels arriving and departing CMAT berth. This hazard has the highest score because a large vessel approaching the Tilbury 2 CMAT berth would need to approach the berth at high water. This would conflict with the *Terra Marique's* approach to the Causeway, meaning that both vessels would be navigating outside the Authorised Channel within the immediate vicinity of the Causeway site.

All other Hazards scored as "moderate" risks, with the exception of Hazard 18 which scores as minor. Five, hazards were scored at the higher end of the "moderate" risk category, these being:

- Hazard 3- Collision of Terra Marique (including project vessels) with vessels arriving and departing Tilbury 2 Ro-Ro Berth.
- Hazard 5- Collision of Terra Marique (including project vessels) with passing commercial vessels (All types).
- Hazard 6- Collision of Terra Marique (including project vessels) with passing recreational vessels.
- Hazard 7- Collision of Terra Marique (including project vessels) with passing tug and tow.
- Hazard 8- Collision caused as a result of avoiding Terra Marique (including project vessels) transiting during Causeway operation.

Hazards scoring in the "Serious" risk category and above require additional risk control measures to mitigate the risk score to acceptable levels, but it is also strongly advised that all hazards are reduced to as low as reasonably practical (ALARP). Therefore, where appropriate, additional control measures have been utilised to bring all hazards down to as low as reasonably practical.

Table 12: Inherent Assessment of Risk

Hazard ID	Operation	Inherent Risk Rank	Residual Risk Rank	Hazard	Inherent Risk		
					Likelihood	Severity	Score
1	Causeway	8	1	Contact of Terra Marique (including project vessels) with causeway, Tilbury 2 or other structures.	3	2	6
2	Causeway	8	1	Contact with causeway by passing vessels (All types).	3	2	6
3	Causeway	2	1	Collision of Terra Marique (including project vessels) with vessels arriving and departing Tilbury 2 Ro-Ro Berth.	2	4	8
4	Causeway	1	1	Collision of Terra Marique (including project vessels) with vessels arriving and departing CMAT berth.	3	4	12
5	Causeway	2	1	Collision of Terra Marique (including project vessels) with passing commercial vessels (All types).	2	4	8
6	Causeway	2	1	Collision of Terra Marique (including project vessels) with passing recreational vessels.	2	4	8
7	Causeway	2	1	Collision of Terra Marique (including project vessels) with passing tug and tow.	2	4	8
8	Causeway	2	1	Collision caused as a result of avoiding Terra Marique (including project vessels) transiting during causeway operation.	2	4	8
9	Causeway	15	1	Grounding of Terra Marique (including project vessels) as a result of causeway operation.	2	2	4
10	Causeway	15	16	Grounding of non-project vessels as a result of causeway operations (All types).	2	2	4
11	Causeway	8	11	Breakout of Terra Marique during berthing / alongside.	2	3	6
12	Passage	8	11	Contact of Terra Marique (including project vessels) with infrastructure whilst on passage outside causeway operation area.	2	3	6
13	Passage	8	11	Collision of Terra Marique (including project vessels) with passing commercial vessels outside the defined causeway operation area.	2	3	6
14	Passage	2	1	Collision of Terra Marique (including project vessels) with passing recreational vessels outside the defined causeway operation area.	2	4	8
15	Passage	8	11	Collision of Terra Marique (including project vessels) with passing Tug and Tow outside the defined causeway operation area.	2	3	6
16	Passage	8	16	Collision caused as a result of avoiding Terra Marique (including project vessels) during passage (All vessels)	2	3	6
17	Passage	15	16	Grounding of Terra Marique (including project vessels) whilst on passage to causeway outside the defined causeway operation area.	2	2	4
18	Passage	18	11	Grounding of non-project vessels as a result of Terra Marique Passage (All types).	1	3	3

8. RISK CONTROL OPTIONS

8.1. ADDITIONAL RISK CONTROL MEASURES

Following consultation with the PLA and POT, a review of the existing embedded risk control measures, and through the expertise of the project team, six additional risk control measures, as detailed in **Table 13**, were identified. These are over and above the control measures mandated by the SHA and could be used to reduce hazard risk scores.

The risk controls identified in **Table 13**, were allocated to hazards where they would mitigate risk, to determine the residual risk assessment. In addition to the additional risk control measures summarised in **Table 13**, two additional risk controls were identified by the project team but after consultation with the PLA these were not utilised to reduce the inherent risk score further. The two risk control measure not utilised are summarised in **Table 14.** Details of the hazards these risk controls were applied to are identified in **Table 15**.

It should be noted that the residual assessment of risk therefore considers the cumulative reduction in risk brought about by all risk control measures applied to the hazard, and individual risk control effectiveness cannot be determined from the assessment methodology without re-scoring hazards with individual controls applied cumulatively.

Table 13: Recommended Additional Risk Control Measures

A1	**Notice to Mariners**	PLA and POT Notices to Mariners (NtM) will be issued specifying the details of the Causeway operation including outline passage plan, wating/layby areas, operational procedures, transit times and operational dates, and details of any temporary speed easement. see Risk Control ID#A3.
A2	**Mooring Piles**	Mooring piles to be installed to aid positioning of the *Terra Marique* whilst berthing and mitigate the likelihood of contact or grounding on the Causeway or riverbed. **Note:** the relative benefits of this risk control measure should be considered against the potential impacts i.e., a possible increase in risk contact for passing vessels with the piles themselves. A review should therefore be conducted prior to construction.
A3	**Temporary Speed Reduction**	Once in position over the Causeway berth the *Terra Marique* will ballast down on to the prepared berthing area in order to maintain a stable platform throughout the unloading operation. During this time, a temporary speed easement for passing vessels will be issued by the PLA, to reduce wash from passing vessels impacting the *Terra Marique* as it "takes the ground". The provision of a temporary speed easement will be limited to the transition period whilst the *Terra Marique* takes the ground, which will be nominally between +0.5m Under Keel Clearance and -0.5m Under Keel Clearance. It is envisaged that the request for a speed easement will be made by the pilot (or PEC) on board the *Terra Marique*, who will notify PLA VTS when the *Terra Marique* approaches the transition period. Once safely aground (e.g., UKC at -0.5) the pilot will notify PLA VTS and the speed easement will be ended. It is estimated that it will take the *Terra Marique* approximately 20-30 minutes to ballast down depending on tidal conditions. It is envisaged that the Temporary Speed Reduction would apply for a similar duration for re-floating.

A4	**Marine Operations Plan with Tilbury 2 CMAT berth.**	A Marine Operations Plan with POT will be developed to deconflict the Causeway operation from Tilbury 2 CMAT berth operations. This will apply when large vessels (e.g., Panamax bulk carriers such as *Yeoman Bridge*) are bound to or from the Tilbury 2 CMAT berth and during these times the Causeway marine operation will not proceed. The PLA should be party to and approve any arrangements made as SHA for the Causeway area.
A5	**Waiting and Layby Areas**	In order to ensure that the Authorised Channel remains clear in the event that the *Terra Marique* has to hold position (e.g., whilst awaiting the high tide or for any other operational / emergency reason), a "*Waiting Area*" and a "*Layby Area*" have been specified outside the Authorised Channel.
A6	**Supplementary Towage**	The *Terra Marique* is classified as a motorised barge and can navigate independently in up to category D waters. The AIL transhipment site and the Causeway will be category D waters. However, due to tidal currents and density of vessel traffic in the Thames, throughout her passage to and from the transhipment site and onto / off the Causeway (including the berthing operation) the *Terra Marique* will be assisted by up to two tugs. One tug will act as the primary tow tug for passage and will tow the *Terra Marique* using a conventional stern tow configuration and a second tug will escort the tow and provide assistance to manoeuvre the *Terra Marique* on and off the berth e.g., when berthing at the Causeway site. Details of the supplementary towage provisions will need to be agreed with the PLA and other SHA as part of the approved passage plan.

Table 14: Risk Control Measures Identified but not Utilised in Final Assessment.

N1	**Safety / Guard Boat**	Provision of a Safety / Guard boat to warn recreational traffic transiting to the north of the Authorised Channel when the *Terra Marique* is transiting between the Authorised Channel and Causeway as well as utilising the holding area. To provide safety cover and back up to Causeway operation.
N2	**Expert Local Knowledge**	Barge Master / Tow Master (towing and pushing endorsement and PEC B) with local knowledge and knowledge of the *Terra Marique* to be employed on the tow.

8.2. RESIDUAL RISK ASSESSMENT RESULTS

The residual risk assessment rescores the inherent risk scores (see section **7.1)** by including the additional risk control measures (presented in **Table 13).** The summary residual risk assessment results are presented in **Table 16**.

Two risk control measures identified, where not used to reduce the risk scores in the residual risk assessment matrix. These were N1 – Safety / Guard Boat and N2 – Expert Local Knowledge, summarised in **Table 14.** In both cases and after extensive consultation with the PLA, it was felt that these risk control measures were not necessary.

A safety / guard boat was thought to be surplus to requirement by the PLA because it is deemed that recreational craft activity in the immediate vicinity of the Causeway site is not of a sufficient level to make the use of a safety / guard boat a necessary requirement.

Expert Knowledge was not utilised during the final assessment because the *Terra Marique* will be subject to compulsory pilotage when being towed and when under her own power. It was therefore felt that this risk control measure did not add substantially to the embedded risk control requirements for pilotage.

The results of the residual assessment of risk show that all hazards are reduced to a risk score below 9.

Hazard 4 (Collision of *Terra Marique* (including project vessels) with vessels arriving and departing CMAT berth.) scored as a "serious" risk with an overall score of 12 when scored during the inherent risk assessment, see **7.1.** The application of four additional risk control measures (summarised in **Table 13**), has allowed the risk score to be reduced to 4, meaning that hazard 4 now scores as a "minor" risk.

As previously identified this hazard scored as "serious" because both the *Terra* Marique and a large vessel bound for the CMAT berth would need to transit in the immediate vicinity of the Causeway site at high water. Risk control measure A4 specifies that transits to the causeway will not be scheduled when a large vessel arrival is due at the Tilbury 2 CMAT berth. This removes the key concern relating to this hazard and combined with a dedicated Notice to Mariners, utilisation of supplementary towage, and dedicated waiting / layby areas, results in a reduction in the likelihood of a collision between the two vessels occurring, thus allowing the likelihood of a collision occurring to be reduced from "possible" to "rare".

Similarly, additional risk control measures have been adopted in order to reduce the risk scores for all other hazards. The five Hazards that scored as "moderate" in the inherent risk score are mitigated using a combination of the additional risk control measures. The key risk control measure in the case of these five hazards being risk control A6, supplementary towage.

The inclusion of two tugs to assist the *Terra Marique* in her passage of the Thames and during her transit to and from the Causeway berth will ensure a greater degree of vessel manoeuvrability, speed and control reducing the changes of a collision. This combined with the other additional risk control measure outlined in **Table 15** allows for the likelihood of a collision occurring to be revised down from "unlikely" to "rare" and therefore reduces the overall risk score.

Table 15: Risk Controls Applied to hazards

Haz. ID	Hazard	Additional Control Measures applied
1	Contact of *Terra Marique* (including project vessels) with Causeway, Tilbury 2, or other structures.	A2 Mooring Piles A6 Supplementary Towage
2	Contact with Causeway by passing vessels (All types).	A1 Notice to Mariners
3	Collision of *Terra Marique* (including project vessels) with vessels arriving and departing Tilbury 2 Ro-Ro Berth.	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
4	Collision of *Terra Marique* (including project vessels) with vessels arriving and departing CMAT berth.	A1 Notice to Mariners A4 Marine Operations Plan with Tilbury A5 Waiting and Layby Areas A6 Supplementary Towage
5	Collision of *Terra Marique* (including project vessels) with passing commercial vessels (All types).	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage

Haz. ID	Hazard	Additional Control Measures applied
6	Collision of *Terra Marique* (including project vessels) with passing recreational vessels.	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
7	Collision of *Terra Marique* (including project vessels) with passing tug and tow.	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
8	Collision caused as a result of avoiding *Terra Marique* (including project vessels) transiting during Causeway operation.	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
9	Grounding of *Terra Marique* (including project vessels) as a result of Causeway operation.	A2 Mooring Piles A6 Supplementary Towage
10	Grounding of non-project vessels as a result of Causeway operations (All types).	A1 Notice to Mariners A2 Mooring Piles
11	Breakout of *Terra Marique* during berthing / alongside.	A2 Mooring Piles A3 Temporary Speed Reduction A6 Supplementary Towage
12	Contact of *Terra Marique* (including project vessels) with infrastructure whilst on passage outside Causeway operation area.	A5 Waiting and Layby Areas A6 Supplementary Towage
13	Collision of *Terra Marique* (including project vessels) with passing commercial vessels outside the defined Causeway operation area.	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
14	Collision of *Terra Marique* (including project vessels) with passing recreational vessels outside the defined Causeway operation area.	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
15	Collision of *Terra Marique* (including project vessels) with passing Tug and Tow outside the defined Causeway operation area.	A1 Notice to Mariners A5 Waiting and Layby Area A6 Supplementary Towage
16	Collision caused as a result of avoiding *Terra Marique* (including project vessels) during passage (All vessels)	A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage
17	Grounding of *Terra Marique* (including project vessels) whilst on passage to Causeway outside the defined Causeway operation area.	A6 Supplementary Towage
18	Grounding of non-project vessels as a result of *Terra Marique* Passage (All types).	A1 Notice to Mariners

Table 16: Summary Residual Risk Assessment Results

Hazard ID	Inherent Risk Rank	Residual Risk Rank	Hazard	Inherent Risk			Residual Risk		
				Likelihood	Severity	Score	Likelihood	Severity	Score
1	8	1	Contact of *Terra Marique* (including project vessels) with Causeway, Tilbury 2, or other structures.	3	2	6	2	2	4
2	8	1	Contact with Causeway by passing vessels (All types).	3	2	6	2	2	4
3	2	1	Collision of *Terra Marique* (including project vessels) with vessels arriving and departing Tilbury 2 Ro-Ro Berth.	2	4	8	1	4	4
4	1	1	Collision of *Terra Marique* (including project vessels) with vessels arriving and departing CMAT berth.	3	4	12	1	4	4
5	2	1	Collision of *Terra Marique* (including project vessels) with passing commercial vessels (All types).	2	4	8	1	4	4
6	2	1	Collision of *Terra Marique* (including project vessels) with passing recreational vessels.	2	4	8	1	4	4
7	2	1	Collision of *Terra Marique* (including project vessels) with passing tug and tow.	2	4	8	1	4	4
8	2	1	Collision caused as a result of avoiding *Terra Marique* (including project vessels) transiting during Causeway operation.	2	4	8	1	4	4
9	15	1	Grounding of *Terra Marique* (including project vessels) as a result of Causeway operation.	2	2	4	2	2	4
10	15	16	Grounding of non-project vessels as a result of Causeway operations (All types).	2	2	4	1	2	2
11	8	11	Breakout of *Terra Marique* during berthing / alongside.	2	3	6	1	3	3
12	8	11	Contact of *Terra Marique* (including project vessels) with infrastructure whilst on passage outside Causeway operation area.	2	3	6	1	3	3
13	8	11	Collision of *Terra Marique* (including project vessels) with passing commercial vessels outside the defined Causeway operation area.	2	3	6	1	3	3
14	2	1	Collision of *Terra Marique* (including project vessels) with passing recreational vessels outside the defined Causeway operation area.	2	4	8	1	4	4
15	8	11	Collision of *Terra Marique* (including project vessels) with passing Tug and Tow outside the defined Causeway operation area.	2	3	6	1	3	3
16	8	16	Collision caused as a result of avoiding *Terra Marique* (including project vessels) during passage (All vessels)	2	3	6	1	2	2

17	15	16	Grounding of *Terra Marique* (including project vessels) whilst on passage to Causeway outside the defined Causeway operation area.	2	2	4	1	2	2
18	18	11	Grounding of non-project vessels as a result of *Terra Marique* Passage (All types).	1	3	3	1	3	3

9. STUDY FINDINGS

A Preliminary Navigation Risk Assessment was conducted, to ascertain navigation risk posed by the passage of AILs on the river Thames by a specialist Heavy Lift Barge (*Terra Marique*) and berthing operation at the Causeway. The Preliminary NRA has reached the following conclusions:

1. That Gravesend Reach and adjacent Reaches are busy parts of the river Thames with numerous vessel types and activities taking place.
2. There are a number of embedded risk control measures in place to manage navigation risk which are implemented and managed by the PLA. POT has similar measures to manage risk within its SHA areas.
3. That the Preliminary Navigation Risk Assessment was conducted using PLA navigation risk assessment guidance and associated methodology.
4. The assessment methodology included:
    a. A review of the AIL marine operation, including development of an outline port passage plan for the *Terra Marique* on the river Thames, undertaken in consultation with, Thurrock Flexible Power Generation Plant, the owners of the *Terra Marique (Peter Wynn)*, the towage providers for the Terra Marique (MTS), a local Thames towage exert (Chris Livett of Livetts Launches) and the NASH project team.
    b. Quantitative vessel traffic analysis including:
        i. Vessel track, density, and gate analysis
        ii. PLA incident analysis
    c. Qualitative input including:
        i. Consultation with PLA and POT harbour masters
        ii. Expertise of project personnel
5. Based on the analysed vessel traffic and incident data, consultation, and the expertise of the project team a total 18 individual hazards were identified for the project. For each hazard, the likelihood and consequence of occurrence was determined, using the risk assessment methodology, based on an "inherent" assessment of risk with embedded risk controls applied, and a "residual" assessment for risk which included additional risk controls measures over and above those already in place and mandated by the PLA as SHA.
6. The highest scoring, and only hazard to score within the "Serious" risk category in the inherent assessment of risk, was identified as a collision of the *Terra Marique* with vessels arriving and departing the Tilbury 2 CMAT berth. With the introduction of the additional risk control measures this hazard was mitigated to acceptable levels – specifically the introduction of a Marine Operations Plan with the POT to ensure that when large vessels were bound to / from the Tilbury 2 CMAT berth, Causeway operations were suspended. This was deemed to significantly reduce the likelihood of hazard occurrence in the residual assessment of risk and reduce it to acceptable levels.

7. In total eight project additional risk control measures were identified and evaluated. Of the eight identified additional risk control measures, six were agreed with the PLA and POT (as SHAs), as mandated, for mitigating inherent risk scores across the 18 hazards identified. These included:
    a. Risk Control A1: Notice to Mariners
    b. Risk Control A2: Mooring Piles
    c. Risk Control A3: Temporary Speed Reduction
    d. Risk Control A4: Marine Operations Plan with Tilbury 2 CMAT berth.
    e. Risk Control A5: Waiting and Layby Areas
    f. Risk Control A6: Supplementary Towage
8. Two of the eight additional risk control measures identified were not considered necessary and included:
    a. Risk Control: N1Safety / Guard Boat
    b. Risk Control N2: Expert Local Knowledge
9. Based on the introduction of the six additional risk control measures all hazards assessed for the residual assessment of navigation risk were classified at acceptable / tolerable risk levels to both the PLA and POT.
10. This assessment is preliminary in nature as the final details of the proposed operation are not definitively know at this stage (e.g., exact date and timings of AIL movement and number of units per heavily lift barge, specific tug details, details of the finalise port passage plan of the *Terra Marique,* etc.). As such this assessment will require an update based on finalised marine operation and approval will be required from the PLA for commencement of Causeway construction and transhipment of the AIL by the *Terra Marique* on the river Thames (it is envisaged that this could be put in place by the introduction of a protected provision within the DCO).

9.1. SUMMARY RISK STATEMENT

This Preliminary NRA has considered the navigation impacts of the Causeway operation and the associated marine activities on navigational safety. The results demonstrate that all hazards can be mitigated to acceptable risk levels based on the introduction of the agreed additional risk control measures. Should there be a change in the proposed marine operation or Causeway design, then it would be necessary to consult with the PLA and POT to see whether an update to this Preliminary NRA were required to address the changes

ANNEX A - MTS PASSAGE PLAN -TILBURY DOCK TO CAUSEWAY

PASSAGE PLAN

VESSEL:	**MTS Valour**	**DATE:**	
VOYAGE NO:		**DISTANCE BERTH TO BERTH:**	**3.44 NM**
MAX DRAFT:	**2.8**	**LAST NOTICE TO MARINERS:**	
FROM:	**Tilbury Dock**	**TO:**	**Causeway**
COMPLETED BY:	**A.Khachaturov**	**RANK:**	**Mate**
APPROVED BY:	**F.Wilson**	**RANK:**	**Master**

WPT	WPT NAME	LAT	LONG	COURSE /LEG	DISTANCE	REMARKS
0	*Tilbuty Basin*	51° 27.274 N	000° 20.798 E			*Keep Look out for outbound / inbound vessels to/from Lock & movements in basin* ***Call Tilbury Dock VHF CH 17/ CH 04***
1	*Enter Tilbury Lock*	51° 27.270 N	000° 20.653 E	***267.5°*** 0.08 NM	0.08 NM	*Keep Look out for outbound / inbound vessels to/from Lock* ***Call Tilbury Dock VHF CH 17/ CH 04***
2	*Exit Tilbury Lock*	51° 27.295 N	000° 20.322 E	***276.9°*** 0.21 NM	0.30 NM	*Keep Look out for outbound / inbound vessels to/from Lock* ***Call Tilbury Dock VHF CH 17/ CH 04***
3	*Start Crossing Channel*	51° 27.332 N	000° 20.000 E	***280.4°*** 0.16 NM	0.46 NM	*Keep Look out for outbound / inbound vessels ,Vessels approaching to Tilbury* ***Call LONDON VTS VHF CH 68***
4	*WP No4*	51° 27.238 N	000° 19.806 E	***232.5°*** 0.10 NM	0.56 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
5	*Bevans Wharf*	51° 27.086 N	000° 19.976 E	***145.0°*** 0.22 NM	0.78 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
6	*Northfleet Thames Jetty*	51° 26.902 N	000° 20.474 E	***120.7°*** 0.36 NM	1.14 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
7	*WP No7*	51° 26.848 N	000° 21.196 E	***096.8°*** 0.47 NM	1.61 NM	*Keep Look out for outbound / inbound vessels* ***Call LONDON VTS VHF CH 68***
8	*WP No8*	51° 26.867 N	000° 22.488 E	***088.7°*** 0.82 NM	2.42 NM	*Keep Look out for outbound / inbound vessels, Keep look out for barge movements Denton Wharf area* ***Keep watch VHF CH 68/ CH 16***
9	*Gravesend Reach*	51° 26.895 N	000° 23.682 E	***087.9°*** 0.66 NM	3.08 NM	*Keep Look out for outbound / inbound vessels Start crossing Channel* ***Call LONDON VTS VHF CH 68***
10	***Causeway (Farmers Teeth)***	51° 27.194 N	000° 23.713 E	***003.7°*** 0.36 NM	**3.44 NM**	*Keep Look out for outbound / inbound vessels Arriving on Site* ***Call LONDON VTS VHF CH 68***

PASSAGE PLAN

CHARTS AND PUBLICATIONS
eNp 28,ADRS&ADLL&ATT **BA1186**
SAFE HAVENS:
TBC By the office

TIDE INFORMATION

Will be added on date confirmation

SITE INFORMATION

TBC

ANNEX B - MTS PASSAGE PLAN -CAUSEWAY TO TILBURY DOCK

PASSAGE PLAN

VESSEL:	**MTS Valour**	**DATE:**	
VOYAGE NO:		**DISTANCE BERTH TO BERTH:**	**3.0 NM**
MAX DRAFT:	**2.8**	**LAST NOTICE TO MARINERS:**	
FROM:	**Causeway**	**TO:**	**Tilbury Dock**
COMPLETED BY:	**A.Khachaturov**	**RANK:**	**Mate**
APPROVED BY:	**F.Wilson**	**RANK:**	**Master**

WPT	WPT NAME	LAT	LONG	COURSE /LEG	DISTANCE	REMARKS
0	*Causeway (Farmers Teeth)*	51° 27.192 N	000° 23.746 E			*Keep Look out for outbound / inbound vessels Departing on Site* ***Call LONDON VTS VHF CH 68***
1	*WP No1*	51° 27.014 N	000° 23.738 E	***181.7°*** 0.2 NM	0.2 NM	*Keep Look out for outbound / inbound vessels , Enter Channel* ***Call LONDON VTS VHF CH 68***
2	*Tilbury Fort*	51° 27.001 N	000° 22.505 E	***269.0°*** 0.8 NM	1.0 NM	*Keep Look out for outbound / inbound vessels ,* ***Call LONDON VTS VHF CH 68***
3	*London International Cruise Terminal*	51° 26.978 N	000° 21.864 E	***266.8°*** 0.4 NM	1.4 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
4	*Tilbury Cargo Jetty*	51° 26.982 N	000° 21.065 E	***270.4°*** 0.5 NM	1.9 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
5	*Gravesent Reach*	51° 27.038 N	000° 20.448 E	***278.2°*** 0.4 NM	2.3 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
6	*WP No 6*	51° 27.164 N	000° 20.172 E	***306.3°*** 0.2 NM	2.5 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68/ CH 16***
7	*Approach for Tilbury Lock*	51° 27.296 N	000° 20.158 E	***356.0°*** 0.1 NM	2.6 NM	*Keep Look out for outbound / inbound vessels to/from Lock* ***Call Tilbury Dock VHF CH 15***
8	*Enter Lock*	51° 27.292 N	000° 20.374 E	***091.5°*** 0.1 NM	2.7 NM	*Keep Look out for outbound / inbound vessels to/from Lock* ***Call Tilbury Dock VHF CH 15/ CH 04***
9	*Exit Lock*	51° 27.270 N	000° 20.651 E	***097.2°*** 0.2 NM	2.9 NM	*Keep Look out for outbound / inbound vessels to/from Lock* ***Call Tilbury Dock VHF CH 17/ CH 04***
10	***Tilbury Basin***	51° 27.286 N	000° 20.807 E	***080.7°*** 0.1 NM	**3.0 NM**	*Keep Look out for outbound / inbound vessels to/from Lock* ***Call Tilbury Dock VHF CH 17/ CH 04***

PASSAGE PLAN

CHARTS AND PUBLICATIONS
eNp 28,ADRS&ADLL&ATT **BA1186**
SAFE HAVENS:
TBC By the office

TIDE INFORMATION

Will be added on date confirmation

SITE INFORMATION

TBC

ANNEX C - MTS PASSAGE PLAN -LONDON GATEWAY TO CAUSEWAY

PASSAGE PLAN

VESSEL:	**MTS Valour**	**DATE:**	
VOYAGE NO:		**DISTANCE BERTH TO BERTH:**	**5.38 NM**
MAX DRAFT:	**2.8**	**LAST NOTICE TO MARINERS:**	
FROM:	**London Gateway**	**TO:**	**Causeway**
COMPLETED BY:	**A.Khachaturov**	**RANK:**	**Mate**
APPROVED BY:	**F.Wilson**	**RANK:**	**Master**

WPT	WPT NAME	LAT	LONG	COURSE /LEG	DISTANCE	REMARKS
0	*London Gateway*	51° 30.176 N	000° 29.544 E			*Keep Look out for outbound / inbound vessels* *Departing Berth* ***Call LONDON VTS VHF CH 68***
1	*WP No1*	51° 29.991 N	000° 29.175 E	***231.2°*** 0.27 NM	0.27 NM	*Keep Look out for outbound / inbound vessels , Enter Channel* ***Call LONDON VTS VHF CH 68***
2	*WP No2*	51° 29.922 N	000° 28.685 E	***257.4°*** 0.31 NM	0.59 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
3	*Mucking No1*	51° 29.666 N	000° 28.142 E	***232.9°*** 0.43 NM	1.02 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
4	*Mucking No3*	51° 29.323 N	000° 27.720 E	***217.6°*** 0.44 NM	1.46 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
5	*Mucking No5*	51° 28.752 N	000° 27.242 E	***207.6°*** 0.65 NM	2.10 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 CH 16***
6	*Mucking No7*	51° 28.014 N	000° 26.816 E	***199.8°*** 0.79 NM	2.89 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
7	*Ovens*	51° 27.472 N	000° 26.423 E	***204.4°*** 0.58 NM	3.47 NM	*Keep Look out for outbound / inbound vessels ,* ***Call LONDON VTS VHF CH 68***
8	*WP No8*	51° 27.314 N	000° 26.137 E	***228.5°*** 0.25 NM	3.72 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
9	*Tilbury Buoy*	51° 27.099 N	000° 25.533 E	***240.3°*** 0.43 NM	4.15 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
10	*WP No10*	51° 27.022 N	000° 24.997 E	***257.1°*** 0.35 NM	4.50 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
11	*WP No11*	51° 27.015 N	000° 23.978 E	***269.4°*** 0.60 NM	5.10 NM	*Keep Look out for outbound / inbound vessels , Out of Channel* ***Call LONDON VTS VHF CH 68***
12	***Causeway (Farmers Teeth)***	51° 27.189 N	000° 23.716 E	***316.8°*** 0.28 NM	**5.38 NM**	*Keep Look out for outbound / inbound vessels , Arrival on Site* ***Call LONDON VTS VHF CH 68***

CHARTS AND PUBLICATIONS
eNp 28,ADRS&ADLL&ATT **BA1186** **DP World London Gateway Vessel Information Guide & DP World London Gateway Port Specifications**
SAFE HAVENS:
TBC By the office

TIDE INFORMATION

Will be added on date confirmation

SITE INFORMATION

TBC

ANNEX D - MTS PASSAGE PLAN -CAUSEWAY TO LONDON GATEWAY

PASSAGE PLAN

VESSEL:	**MTS Valour**	**DATE:**	
VOYAGE NO:		**DISTANCE BERTH TO BERTH:**	**5.74 NM**
MAX DRAFT:	**2.8**	**LAST NOTICE TO MARINERS:**	
FROM:	**London Gateway**	**TO:**	**Causeway**
COMPLETED BY:	**A.Khachaturov**	**RANK:**	**Mate**
APPROVED BY:	**F.Wilson**	**RANK:**	**Master**

WPT	WPT NAME	LAT	LONG	COURSE /LEG	DISTANCE	REMARKS
0	*Causeway(Farmers Teeth)*	51° 27.186 N	000° 23.705 E			*Keep Look out for outbound / inbound vessels* *Departing Site* ***Call LONDON VTS VHF CH 68***
1	*Start Crossing Channel*	51° 27.046 N	000° 23.788 E	***159.7°*** 0.13 NM	0.13 NM	*Keep Look out for outbound / inbound vessels , Enter Channel* ***Call LONDON VTS VHF CH 68***
2	*WP No2*	51° 26.878 N	000° 23.806 E	***176.2°*** 0.09 NM	0.23 NM	*Keep Look out for outbound / inbound vessels, Keep Look out for Tugs&Barges movements in Denton Wharf area* ***Keep watch VHF CH 68 / CH 16***
3	*WP No3*	51° 26.863 N	000° 24.904 E	***091.3°*** 0.73 NM	0.95 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
4	*WP No4*	51° 27.033 N	000° 25.846 E	***073.9°*** 0.61 NM	1.57 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
5	*WP No5*	51° 27.311 N	000° 26.465 E	***054.3°*** 0.48 NM	2.05 NM	*Keep Look out for outbound / inbound vessels , Reporting Point* ***Call LONDON VTS VHF CH 68***
6	*Higham*	51° 27.462 N	000° 26.683 E	***042.1°*** 0.20 NM	2.25 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
7	*Alpha Jetty*	51° 27.856 N	000° 26.957 E	***023.5°*** 0.44 NM	2.69 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
8	*WP No8*	51° 28.427 N	000° 27.267 E	***018.7°*** 0.60 NM	3.29 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
9	*WP No9*	51° 29.003 N	000° 27.654 E	***022.8°*** 0.62 NM	3.91 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
10	*Lower Hope*	51° 29.341 N	000° 27.996 E	***032.3°*** 0.39 NM	4.31 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
11	*West Blyth*	51° 29.754 N	000° 28.794 E	***050.3°*** 0.64 NM	4.95 NM	*Keep Look out for outbound / inbound vessels* ***Keep watch VHF CH 68 / CH 16***
12	*Start Crossing Channel*	51° 29.897 N	000° 29.598 E	***074.1°*** 0.46 NM	5.41 NM	*Keep Look out for outbound / inbound vessels , Call LONDON VTS VHF CH 68*
13	*Out of Channel*	51° 30.045 N	000° 29.566 E	***352.3°*** 0.20 NM	5.61 NM	*Keep Look out for outbound / inbound vessels Keep Look out for Vessels arriving / departing London Gateway* ***Approaching to berth*** ***Call LONDON VTS VHF CH 68***
14	***London Gateway***	51° 30.175 N	000° 29.558 E	***357.9°*** 0.13 NM	**5.74 NM**	*Keep Look out for outbound / inbound vessels, Arrival report* ***Call LONDON VTS VHF CH 68***

CHARTS AND PUBLICATIONS
eNp 28,ADRS&ADLL&ATT **BA1186** **DP World London Gateway Vessel Information Guide & DP World London Gateway Port Specifications**
SAFE HAVENS:
TBC By the office

TIDE INFORMATION

Will be added on date confirmation

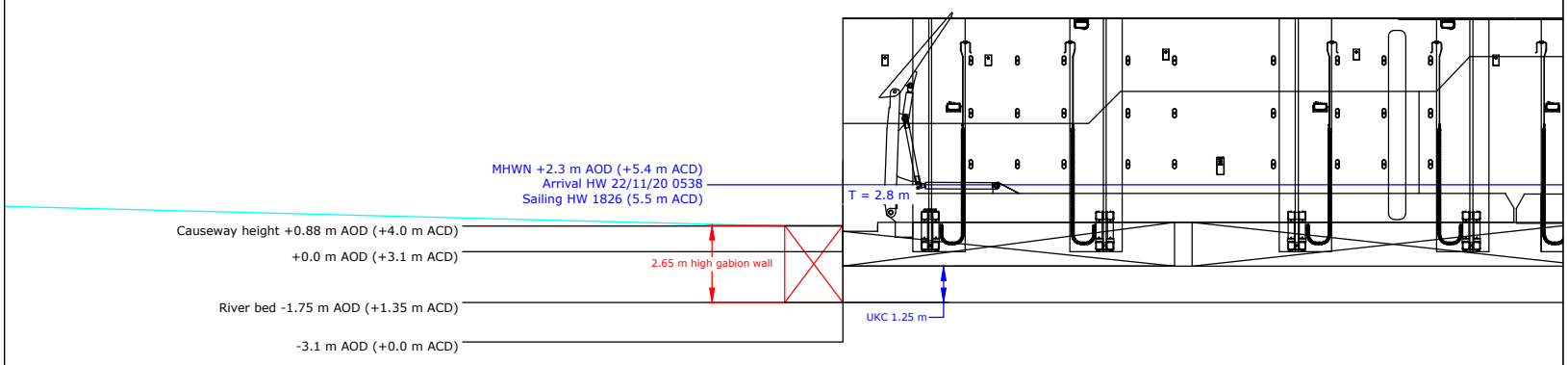
SITE INFORMATION

TBC

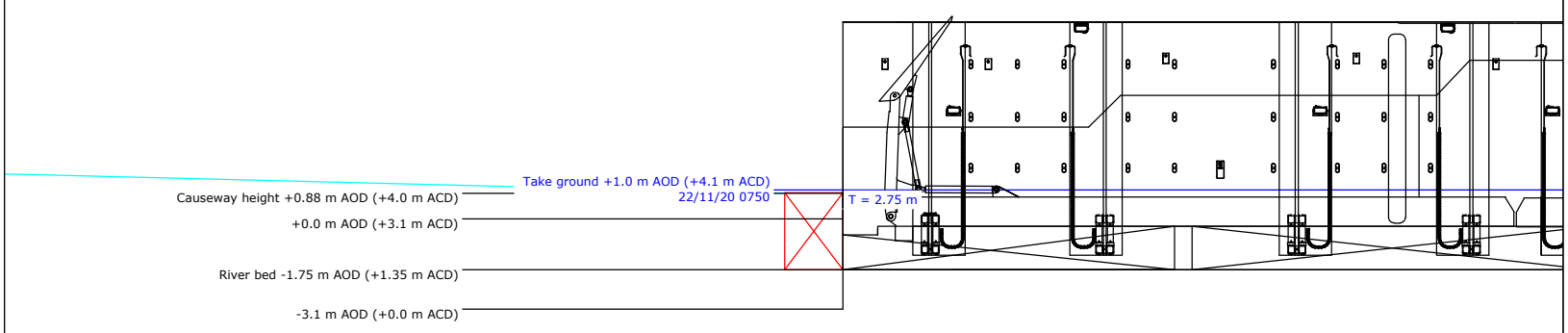
ANNEX E - THURROCK CAUSEWAY FEASIBILITY NEAP TIDES

Neaps

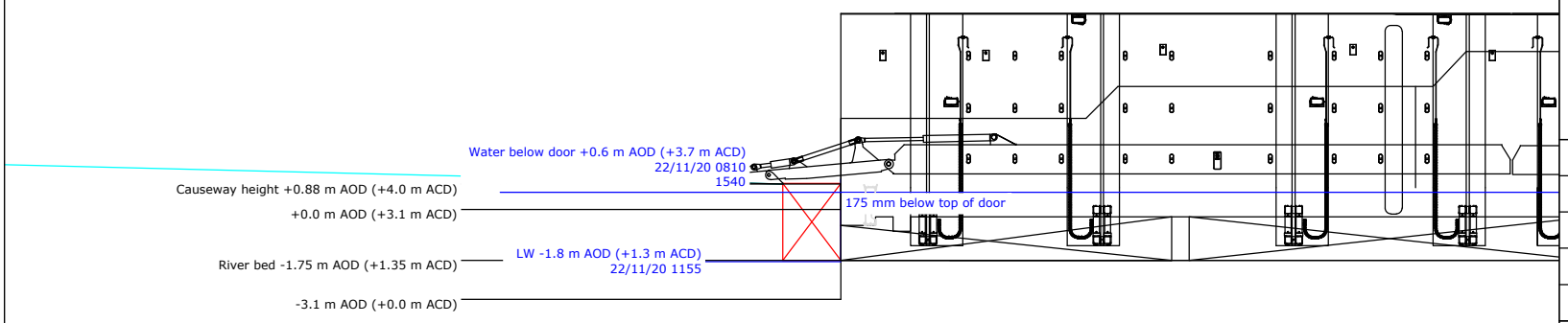
Arrival/sailing condition



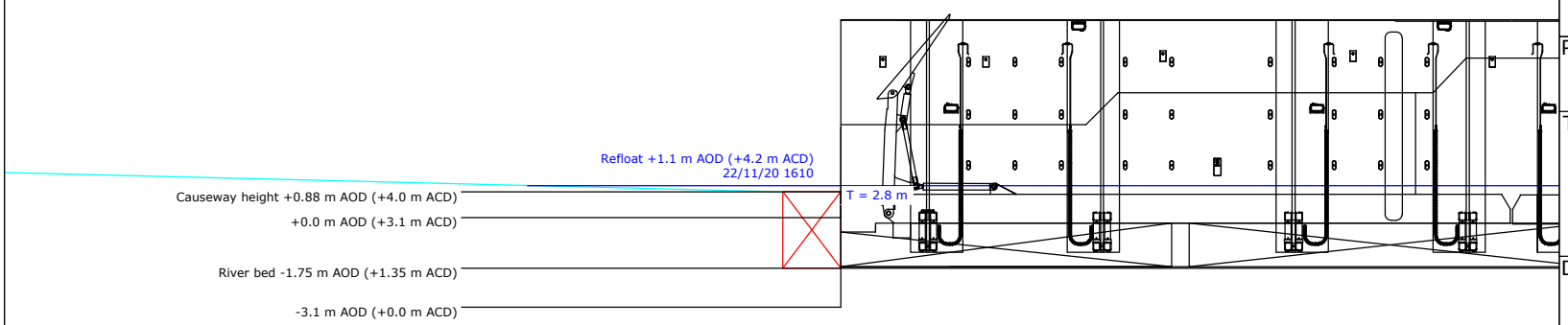
Landing condition



Roll-off condition



Refloating condition



0	30.10.20	First Issue
Rev.	Date	Amendments

Revisions

Prepared by:

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Client: STATERA ENERGY

Project: **Thurrock Power**

Title:
Terra Marique
Causeway Concept Design
Feasibility Study (Neap Tides)

Drawing status: Final report

Scale (A3):	Drawn by:	Checked by:
As shown	SJW	---

Dwg. No:	Sheet:	Rev:
Thurrock Causeway	2 of 2	1

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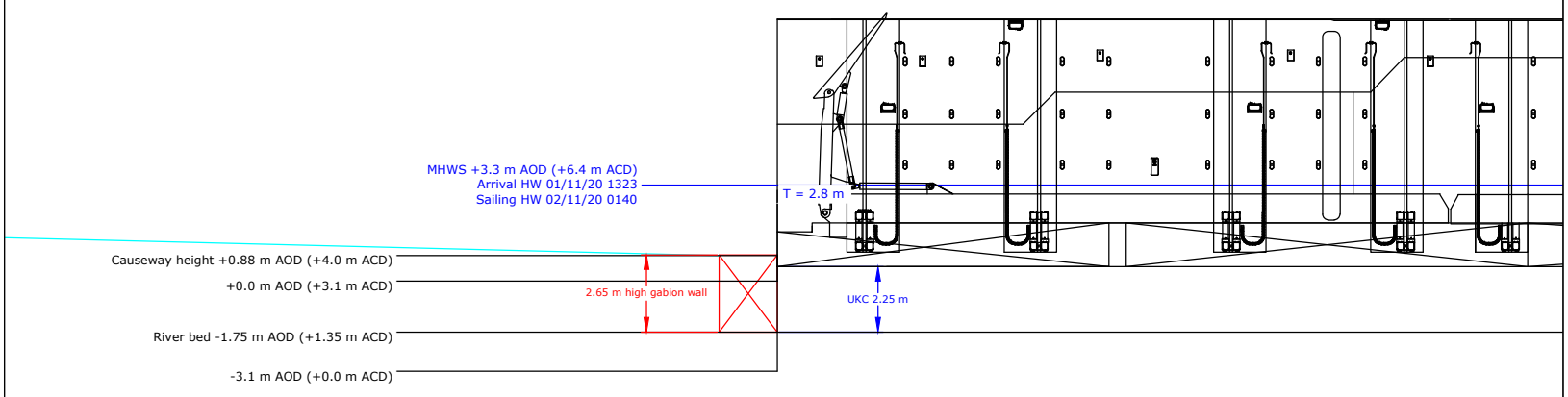
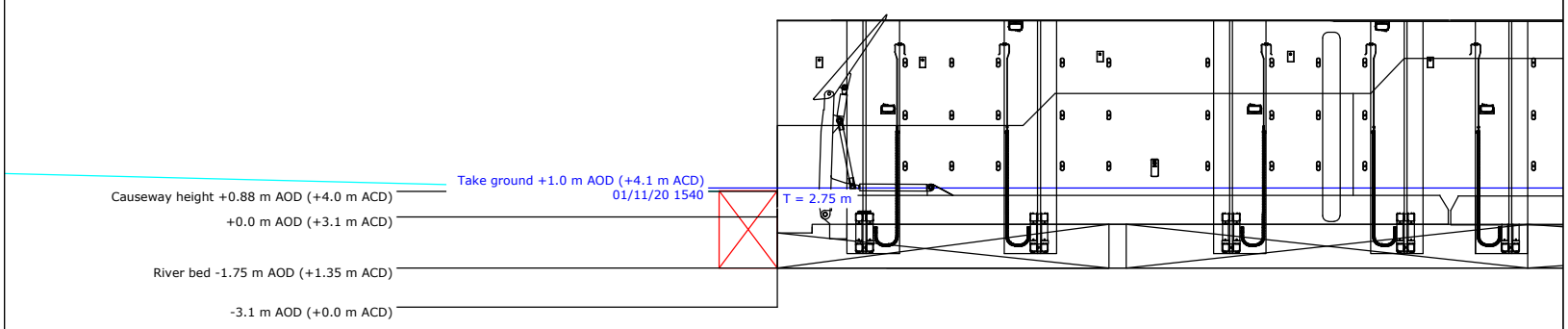
ANNEX F - THURROCK CAUSEWAY FEASIBILITY SPRING TIDES

Springs

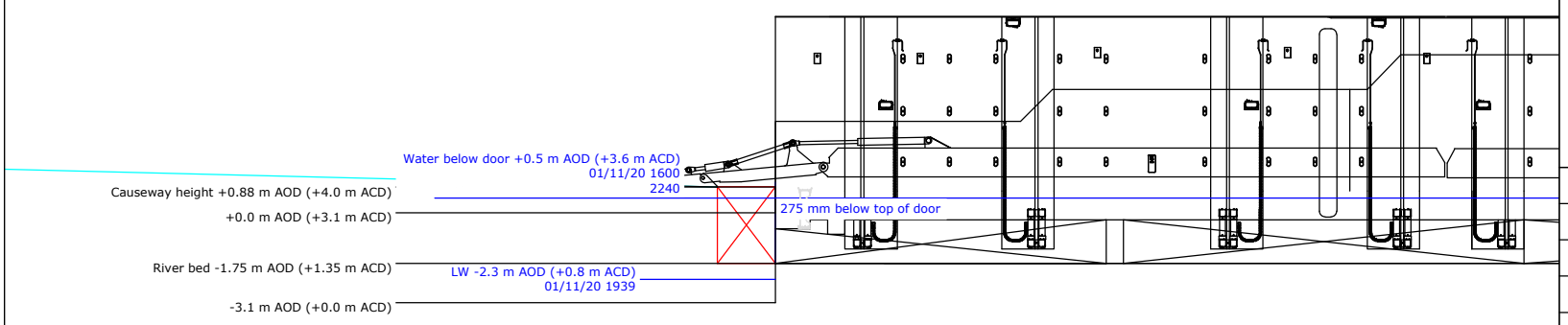
Arrival/sailing condition



Landing condition



Roll-off condition



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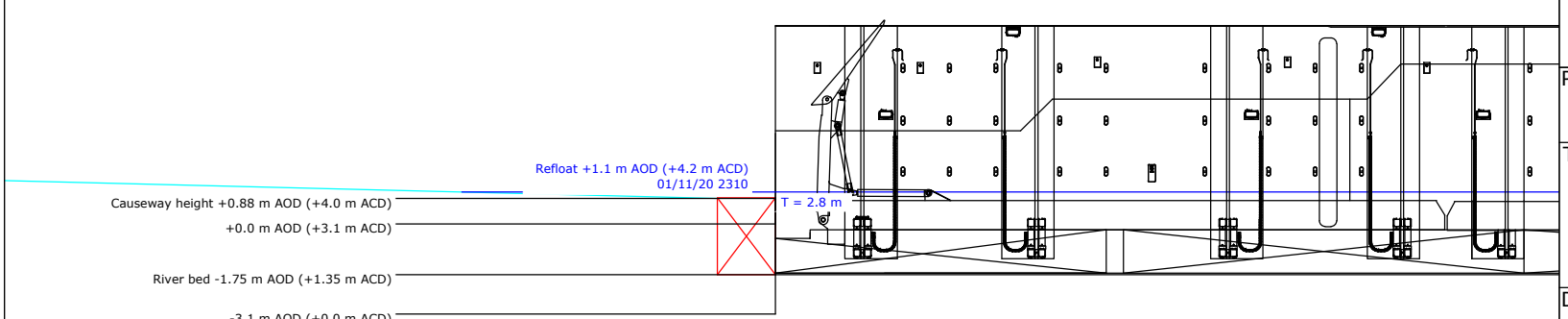

0	30.10.20	First Issue
Rev.	Date	Amendments

Revisions

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Tel: (01785) 850411 Fax: (01785) 851886

Client: STATERA ENERGY

Project: **Thurrock Power**

Title:

Terra Marique
Causeway Concept Design
Feasibility Study (Spring Tides)

Drawing status: Final report

Scale (A3):	Drawn by:	Checked by:
As shown	SJW	---

Dwg. No:	Sheet:	Rev:
Thurrock Causeway	1 of 2	1

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ANNEX G - MEETING MINUTES PLA 08-OCT-2020

Notes of Meeting

Thurrock Power Station Causeway (20-NASH-0100)

Client:	
Project:	Thurrock Power Station Causeway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	08-Oct-2020 (1400– 1500)

Present:	
Port of London Authority (PLA)	Miles Featherstone - MF
NASH Maritime	Ed Rogers - ER
NASH Maritime	Sam Anderson-Brown - SAB
NASH Maritime	Raffi Gracie - RG

1.	**Introductions and Meeting Objectives**
	SAB welcomed all and shared screen to show the PowerPoint presentation that has been circulated. SAB introduced the scheme and provided an agenda and objectives for the meeting: • Development of causeway and berthing area for vessels associated with the development of Thurrock Power Station. NASH Maritime are providing navigational risk assessment and consultation. • Consultation with the PLA to identify any concerns or considerations that have not yet been identified.
2.	**Presentation**
	Assessment Methodology SAB outlined the study area, assessment methodology and presented the risk matrix used. MF confirmed that the methodology presented is suitable. - It is noted that the Terra Marique is the current design vessel, but this is subject to change. - ER noted that the assessment maybe reviewed in the future if there are any design changes. - MF confirmed that the CMAT berth will become operational in the future, with vessels such as the Yeoman Bridge. ER aware of this and this will be considered within the assessment. ***AIS Data Analysis*** SAB presents vessel tracks, traffic density and gate analysis using AIS data collecting between the 22nd September – 5th October 2020.

	- ER and MF agree that it should be considered that traffic may be reduced during this period due to COVID-19 pandemic. - MF confirms that this data is suitable given that Tilbury 2 has only recently become operational - SAB highlighted the arrival and departure of commercial vessels at Tilbury 2, namely NORSKY and NORSTREAM. These vessels have fixed AM and PM arrival and departure schedules, regardless of tide. - The closest commercial vessel tracks are 183m from the proposed causeway location. ER highlighted that the AIS data presented may not record recreational vessels. SAB and ER query the presence of recreational vessels north of the groynes. - MF agreed that recreational vessels need to be considered. - MF confirmed that recreational vessels are advised against using the area north of the groynes. Recreational vessels will not go closer to the causeway than the NORSKY and NORSTREAM. ***Preliminary Hazard Identification*** SAB presented the eight hazards currently identified. - MF confirms that all hazards are valid and that no hazards represented a particular concern. - Suggests separating out collision of Terra Marique with a vessel approaching or manoeuvring at Tilbury 2 berths. ***Preliminary Risk Control Measures*** SAB presented risk control measures. Discussion regarding whether AtoN around the causeway are required. - It was agreed that the need for AtoNs will depend on the final plans for the causeway, considering that lights will require additional structures and therefore could present additional navigational hazards in themselves. - If significant infrastructure such as piles are built, then AtoN (lights) will be required. - MF notes the importance of a Marine Operations Plan with Port of Tilbury.
3.	**AOB**
	MF queried the need for any speed reductions for passing vessels for when the Terra Marique is maneuvering onto to causeway. Previous wash incidents were noted at Gravesend. ER noted that this will be considered moving forward. MF identified the proximity of the first groyne to the causeway as a potential hazard to conventional tug and tows. - Stern tows will be a higher risk because of the increased swinging room required. - This risk could be mitigation by use of a self-propelled vessel or using two tugs.
4.	**Actions**
	SAB to issue draft NRA to MF next week. MF to review and provide ahead of the DCO hearing on the 20th October.

ANNEX H -MEETING MINUTES PLA 09-NOV-2020

Notes of Meeting

Thurrock Power Station Causeway (20-NASH-0100)

Client:	Statera Energy
Project:	Thurrock Power Station Causeway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	09-Nov-2020 (1200– 1415)
Present:	
Port of London Authority (PLA)	Cathryn Spain - CS
NASH Maritime	Ed Rogers - ER
NASH Maritime	Sam Anderson-Brown - SAB
Statera Energy	Andrew Troup - AT

1.	**Introductions and Meeting Objectives**
	- AT introduced himself to CS and gave some background to his involvement with consultation discussions with the PLA thus far. AT queried whether all new operations in PLA waters were required to submit indicative passage plans. CS clarified that this was the case and all operations are subject to full NRA's. - AT thanked CS for her time and for giving reassurance on this point. - AT left the call. - ER summarised those individuals who had contributed to the indicative passage plan so far in order to give wider context. - ER outlined the topics to be covered ruing the call.
2.	**Review of NRA to date**
	- ER outlined a timeframe for the work conducted on the NRA to date and gave a summary of the consultations conducted so far.
3.	**Recap of PLA Comments on draft Navigation Risk Assessment**
	- Discussion regarding how the current NRA relates to the DCO application process – it was agreed that the NRA report would include some wording that made it clear the PLA would require a further review of an enhanced NRA prior to construction, there should be a protected provision within the DCO allowing for this review. - CS clarified that embedded risk controls should be included when scoring inherent risk. - ER explained that additional work had been carried out in order to give detail of the indicative passage plan for the operation and that further data sets had been analysed to reflect the fact that the vessel transits could possibly be down due to Covid-19.
4.	**Project Scheme**
	A) Concept Design - ER gave an overview of the Causeway Concept Design. **B) Operation Passage** - ER advised that NASH feel that the passage of the Terra Marique (TM) from Tilbury (or another port) to the Causeway site and her subsequent berthing and unloading should

	be addressed in the NRA report. The report will not address the arrival of the seagoing Heavy Lift Ship, the offload of the AIL's at Tilbury or their transfer from the seagoing Heavy Lift Ship to the TM. CS agreed that this was appropriate and noted that the key element of the passage that would need to be addressed was the passage the TM undertakes whilst laden. - ER outlined suggested project vessels – It was noted that whilst the Tugs mentioned are interchangeable the TM is fairly unique and if not available for the operation further work may be required to address operational impacts that this may have e.g. berthing. - ER presented plans for passage including: • Tow configuration • Indicative passage plan and MTS indicative plan. • Waiting area and layby area options • Berthing options • Berthing operation • Weather limitations - It was agreed that a channel closure would not be required whilst the TM transited. - CS queried whether TM would remain stable at all levels of tide once ballasted down – ER and SAB to check. - CS confirmed she saw no issue with applying a short temporary speed easement whilst the TM ballasted down but advised such a measure would not be appropriate for the duration of the time the TM is berthed at the Causeway. - CS explained she felt the passage plan detail provided was sufficient to satisfy concerns.
t	**Vessel Traffic Analysis**
	- ER presented Vessel Traffic Analysis for the 2018 and 2020 data sets examined. - The main differences highlighted were the commercial traffic utilising Tilbury 2, the tug and tow activity around East Tilbury Jetty and the decrease in leisure craft due to Covid – 19. - It was agreed that an examination of the 2018 data set satisfied previous concerns that the 2020 data was not a representative sample. - CS felt that possible future increases in intra-port trade due to the London Resort DCO were unlikely to impact the Causeway operation because the developments are unlikely to coincide. - ER explained that NASH are conducting further analysis of data to ascertain vessel transit numbers at varying states of tide – this will be included in the final NRA report.
6.	**Navigation Risk Assessment**
	- ER shared an excel sheet documenting the NRA matrix used so far. - CS confirmed the methodology used was appropriate. **A) Hazard Identification** - The identified hazards were reviewed, and all agreed they were appropriate, CS was happy that no additional hazards were necessary, although it was agreed to share the excel sheet so CS could undertake a more thorough review once an updated draft hazard log was completed. - CS noted that recreational craft are discouraged from navigating north of the groynes to the west of the proposed causeway site. **B) Hazard Scoring** - CS reiterated that inherent risk should be scored based on embedded risk control measures in place. **C) Risk Controls** - The risk control measures were reviewed, and it was agreed: • CS would confirm PLA requirements for Aids to Navigation - could just be day marks

	• A requirement to navigate with due care and attention could be included as an embedded risk control but a temporary speed easement would be added as an additional risk control measure. • Pilotage was compulsory and therefore an embedded risk control, there is no requirement for local knowledge being an additional risk control measure as PEC holders /pilots will require training as the Causeway is a new berth. A discussion was had on ensuring this local knowledge was suitable to causeway operations (given the berth would be new – and it was agreed this would be reviewed prior to commencement of works – possibly through simulation. • A notice to mariners would be a sensible risk control measure and should include details of any temporary speed easement and be regularly updated. • The PLA should be included in any Marine Operations Plans between the Causeway Operator ant POTLL. This was due to the fact that the causeway is located in PLA SHA waters and as such it was necessary for PLA to approve any traffic management plans to ensure they were appropriate, did not impact passing vessel traffic and did not contradict a detailed passage plan, required prior to commencement of operations.. • CS felt there was no requirement for a safety / Guard Boat as an additional risk control measure and that she was satisfied the passage of the TM could be dealt with by PLA VTS within normal operating parameters. • Expert Local Knowledge should be removed as an additional control measure as it is covered with pilotage as an embedded control.
7.	**Actions**
	- ER / SAB to update Risk Assessment and share with CS - ER / SAB to organise further consultation meeting once CS has had a chance to review updated risk assessment to confirm hazard scoring and determination of agreed risk control measures. - CS to provide clarification on PLA's view regarding appropriate aids to navigation. - ER / SAB to send presentation slides for review. - ER / SAB to provide clarification on whether TM will remain secure at all levels of tide when ballasted down.

ANNEX I - MEETING MINUTES POTLL 05-OCT-2020

Notes of Meeting

Thurrock Power Station Causeway (20-NASH-0100)

Client:	
Project:	Thurrock Power Station Causeway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	05-Oct-2020 (1400– 1500)

Present:	
Deputy Harbour Master Port of Tilbury	Nick Evans - NE
NASH Maritime	Ed Rogers - ER
NASH Maritime	Sam Anderson-Brown - SAB
NASH Maritime	Raffi Gracie - RG

1.	**Introductions and Meeting Objectives**
	SAB welcomed all and shared screen to show the PowerPoint. SAB introduced the scheme and provided an agenda and objectives for the meeting: • Development of causeway and berthing area for a vessel associated with the development of Thurrock Power Station. NASH Maritime are providing navigational risk assessment and consultation. • Consultation with the POTLL to identify any concerns or considerations that have not yet been identified.
2.	**Presentation**
	Lock restrictions on entry and exit to Tilbury. - Discussed promoters plans for seagoing heavy lift vessel to transfer cargo to heavy lift barge (similar to Terra Marique) utilising Port of Tilbury infrastructure. - There are 60-75 movements a week in and out of Tilbury. - Terra Marique or other similar design vessel will have to fit around current shipping schedules and services (existing contracts) - 4m draught is unrestricted at all states of tide - 16m+ beam requires second tug to go through lock - Tug and tow over 80m has to be assessed individually – (independent risk assessment similar to passage plan risk assessment developed for PLA should be sufficient) *Dredging and DCO boundaries* - 14.48 - 14.98m depths in CMAT berth dredge pocket only, the approach to the CMAT has not been dredged - NE to confirm bed levelling and dredging was complete

	- Going through DCO dredge application currently - It was agreed that the dashed red (Tilbury 2 DCO boundary) is the northernmost limit of vessels approaching the berth and NE did not expect CMAT vessels to transit to the north. *Norstream and Norsky (Ro-RO vessels): current regularly running vessels to Tilbury 2* - These vessel make 2 arrivals a day to either the upstream dolphin berth or downstream berth. During the study period, the downstream berth (located closest to the proposed causeway) was utilised but NE explained that previously Master's preference was to utilise upstream berth. However Masters have choice about this. - The vessel arrivals at prescheduled times, which are represent an accurate baseline for current use of Tilbury 2. - It was noted that there was 183m distance between proposed causeway location and the closest Norstream and Norsky vessel tracks. - It was noted that there were variable approaches between the Norstream and Norsky to the berth, with the Norstream more likely to swing upstream and approach the Tilbury 2 from the west. CMAT Berth - CMAT berth expects only a few trips a month when active, much less activity than for the RoRo berth (a ship a week at CMAT? - CMAT berth – uncertain how far discussions are with berth usage but NE anticipates large aggregate vessels to Tilbury and possibility for transshipment to smaller vessels for upriver delivery - It is understood that any vessel bound for the CMAT berth will require a minimum of two tugs and will have a draught of13.5-14m draught. - *Yeoman Bridge* identified as design vessel for CMAT berth. *Preliminary Hazard Identification* - NE notes regular recreational traffic to the north of the main navigation channel. - NE notes many clubs in area (eg Gravesend Yacht Club) that are well aware of restrictions. - NE: noted many large projects upcoming, and there may be an increase in intra port tugs and barges, e.g. DHL – although is was noted that tug and tows currently don't transit the causeway location - NE: had no concerns regarding the identified hazards for the risk assessment.
3.	**Navigation Safety comments**
	- NE: Based on the arrival and departure in AM and PM from different RoRo berths – berth choice of captain, as trade picks up this will change, can moor on series of dolphins, currently using lower berth because of conditions, plan to extend and have bigger vessels (RoRo vessels of up to 240m and possibly up to 260m) - NE: Volumes are currently down everywhere (COVID) – and NE noted that two weeks data might not be reflective baseline conditions – risk regarding recreational traffic is hard to judge due to non-carriage of AIS equipment, and he asked whether 2 weeks was sufficient. ER responded that this represents a reasonable baseline providing good understanding of use of the river, and that through this consultation an gaps can be filled in. - NE: Noted the structure in the charted location would be unlikely to impact current use of T2 RoRo berths.

	- With use of operational procedures between Tilbury 2 and the causeway operation then any conflicts on and off the causeway area is not anticipated to be an issue.
4.	**Actions**
	- NE to confirm what information can be given regarding vessel movements, vessel size etc. at CMAT - NE to confirm dredged area and any plans for dredging of approaches within DCO area. - SAB to share draft report with NE once complete.

ANNEX J - MEETING MINUTES POTLL 20-NOV-2020

Notes of Meeting

Thurrock Power Station Causeway (20-NASH-0100)

Client:	Statera Energy
Project:	Thurrock Power Station Causeway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	20-Nov-2020 (1400-1530)

Present:	
Port of Tilbury London Ltd	Nick Evans - NE
NASH Maritime	Ed Rogers - ER
NASH Maritime	Sam Anderson-Brown - SAB

1.	**Introductions and Meeting Objectives**
	- SAB introduced topics to be covered and shared Power Point presentation.
2.	**Review of NRA to date**
	- SAB outlined a timeframe for the work conducted on the NRA to date and gave a summary of the consultation meetings conducted so far. - NE commented that engagement was positive and that he was pleased to see further work had been undertaken to mitigate the POTLL's concerns.
3.	**Recap of POTLL Comments on draft Navigation Risk Assessment**
	- SAB outlined a summary of POTLL concerns and the measures that had been taken to address them. - NE agreed concerns were as presented and commented that concerns relating to a requirement for more detail around the passage plan element of the NRA and the risk control measure relating to a Marine Operations Plan with the POTLL were the most important from a POTLL perspective.
4	**AIS Data Benchmarking**
	- SAB presented Department for Transport figures for port traffic between 2009 to 2019. - NE agreed that data showed September to be a representative month.
4.	**Project Scheme**
	A) Concept Design - SAB gave an overview of the Causeway Concept Design, noting updated berthing pocket design. **B) Operation Passage** - SAB advised that NASH feel that the passage of the Terra Marique (TM) from Tilbury (or another port) to the Causeway site and her subsequent berthing and unloading should be addressed in the NRA report. The report will not address the arrival of the

	seagoing Heavy Lift Ship, the offload of the AIL's at Tilbury or their transfer from the seagoing Heavy Lift Ship to the TM. - NE agreed this was appropriate. - SAB outlined suggested project vessels – It was noted that whilst the Tugs mentioned are interchangeable the TM is fairly unique and if not available for the operation further work may be required to address operational impacts that this may have e.g. berthing – NE agreed. - SAB presented plans for passage including: • Tow configuration • Indicative passage plan and MTS indicative plan. • Waiting area and layby area options • Berthing options • Berthing operation • Weather limitations - NE agreed that Primary and Secondary Tug in attendance during departure of AIL transshipment terminal and passage was appropriate. - NE requested that NASH clarify that proposed temporary speed reduction in immediate vicinity of causeway will not adversely impact Tilbury 2 operations – NASH to confirm in draft report. - NE felt that sufficient additional information had been provided in order to satisfy POTLL concerns relating to passage plan and causeway operation.
t	**Vessel Traffic Analysis**
	- SAB presented Vessel Traffic Analysis for the 2018 and 2020 data sets examined. - The main differences highlighted were the commercial traffic utilising Tilbury 2, the tug and tow activity around East Tilbury Jetty and the decrease in leisure and intra port trade due to Covid – 19. - It was agreed that an examination of the 2018 data set satisfied previous concerns that the 2020 data was not a representative sample.
6.	**Navigation Risk Assessment**
	A) Hazard Identification - The identified hazards were reviewed, and all agreed they were appropriate. - NE agreed that the addition of hazards relating specifically to a collision with the TM and vessels arriving / departing the Tilbury 2 ro-ro berth as well as a separate hazard for the CMAT berth satisfied previous concerns. **B) Risk Controls** - The risk control measures were reviewed. - SAB gave overview of Embedded risk control measures and Additional risk control measures. - It was noted that the draft NRA did not include Embedded risk control measures in inherent risk scores. Revised inherent risk scores will include Embedded risk controls and therefore will be reduced when compared to the draft NRA. - ER left the call **C)** Risk Assessment Scoring Matrix - SAB and NE jointly reviewed risk scoring for Hazards relating to T2 ro-ro and CMAT berths and NE commented that he was happy with Hazards identified and additional risk control measures recommended.
7.	**Actions**
	- SAB to share slides from meeting. - SAB to issue minutes for review and comment. - NASH to issue revised report to NE for comment.

ANNEX K - HAZARD LOGS

Hazard ID	Inherent Risk Rank	Residual Risk Rank	Area/Task	Operation	Hazard	Comments on Disposition	Cause	Consequence	Inherent Risk					Control Measures	Residual Risk				
									Likelihood		Severity		Score		Likelihood		Severity		Score
1	8	1	Defined causeway Operational Area	Causeway	Contact of Terra Marique (including project vessels) with causeway, Tilbury 2 or other structures.	The Terra Marique will exit the Authorised Channel east of the Tilbury 2 terminal and transit on to the Causeway at High tide. In addition to Tilbury 2 there are a series of 6 groynes in the immediate vicinity as well as the East Tilbury Jetty. Tidal flow velocities can exceed 3.5 knots with the ebb (outgoing tide) although typical ebb speeds are in the region of 2 knots. However, tidal velocities around high water and towards the edge of the river will be significantly less. The likelihood of the Terra Marique making contact with infrastructure as a result of potentially strong tidal flows in such conditions is mitigated by the provision of supplementary tug vessels. MetOcean limits will also be applied for the operation.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 6. Rise and fall of tide. 7. Wash from passing vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - Minor or no injuries - Minor damage to vessel - Minor damage to Causeway, Tilbury 2 or other structures. - Negligible impact on the environment with no lasting effects - Unlikely to generate any adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of major injuries to crew and workers - Major damage to vessel - Moderate damage to Causeway, Tilbury 2 or other structures - Slight impact on the environment with no lasting effects (Tier 1) - Local / National adverse publicity	3	Possible	2	Moderate	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A2 Mooring Piles A6 Supplementary Towage	2	Unlikely	2	Moderate	4
2	8	1	Defined causeway Operational Area	Causeway	Contact with causeway by passing vessels (All types).	Gravesend Reach is used by a wide variety of vessel types including, ferries, general cargo vessels, tankers, ro-ro vessels, and less regular users such as cruise ships and naval vessels. Most vessels transit via the PLA Authorised Channel. However, a possible route for recreational craft is north of the main Authorised Channel passing between the main channel the Causeway and Tilbury 2. In addition, Ro-Ro cargo vessels and bulk carriers will transit to Tilbury 2 and in doing so will exit the Authorised Channel. It is considered very unlikely that a vessel bound for Tilbury 2 would make contact with the Causeway. In order for such an event to occur the vessel would need to have deviated significantly from its planned course – possibly caused only by mechanical failure. The Causeway is only accessible during hightide and it is likely that any commercial vessel on course to make contact with the Causeway would ground before making contact. It is more likely that recreational vessels could make contact with the Causeway including any navigation marks put in place to notify mariners of the obstruction. However, this is mitigated by the fact that the PLA's recreational craft guidance expressly states that vessels should not navigate north of the lateral makers on the groynes adjacent to the Causeway site. Therefore, it would be unusual for a recreational vessel of any size other that a small craft such as a kayaker or dinghy to navigate in close proximity to the causeway.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility	MOST LIKELY OUTCOME - Minor injuries to crew on either vessel - Minor damage to vessel - Minor damage causeway - Negligible impact on the environment with no lasting effects - Unlikely to generate any adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of moderate injuries to crew and workers - Major damage to vessel - Moderate damage to Causeway - Slight impact on the environment with no lasting effects (Tier 1) - Local / National adverse publicity	3	Possible	2	Moderate	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners	2	Unlikely	2	Moderate	4
3	2	1	Defined causeway Operational Area	Causeway	Collision of Terra Marique (including project vessels) with vessels arriving and departing Tilbury 2 Ro-Ro Berth.	As the Terra Marique navigates between the PLA Authorised Channel and Causeway there is a risk that collisions could occur between vessels arriving and departing the Tilbury 2 Ro-Ro berths and the Terra Marique. Due to available depths in the area vessels approaching Tilbury 2 need to transit in deep water, this means they will remain approximately 150 m away from the Causeway itself. In addition, at present there are only four movements on and off Tilbury 2 a day and these are scheduled arrivals and departures by time of day, and not dependant on the state of tide. It is possible for the Causeway marine operation to work around these time – therefore the risk of collision is not considered to be significant and can be largely managed with existing risk control measures.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - Minor injuries to crew on either vessel - Minor damage to vessel - Minor damage causeway - Negligible impact on the environment with no lasting effects - Unlikely to generate any adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of major injuries of fatalities to crew, passengers and workers - Major damage to vessel - Slight impact on the environment with no lasting effects (Tier 1) - Local / National adverse publicity	2	Unlikely	4	Very Serious	8	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4
4	1	1	Defined causeway Operational Area	Causeway	Collision of Terra Marique (including project vessels) with vessels arriving and departing CMAT berth.	The CMAT berth at Tilbury 2 will be operational for large deep draught vessels during high tide – when the Causeway (and Terra Marique) will also be operational. The need for deconfliction of the two operations in this instance will be necessary to avoid the risk of a collision as the two vessels make their respective approaches. Given that it is likely that the CMAT berth will be utilised approximately two to three times a month and there will be between 30 to 60 AIL shipments over a 6 month period made by the Terra Marique, there should be no need for both vessels to arrive at the respective sites on the same high tide. On occasions when a CMAT arrival by a large vessel is scheduled Causeway marine operations should not occur.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - Minor injuries to crew on either vessel - Minor damage to vessel - Minor damage causeway - Negligible impact on the environment with no lasting effects - Unlikely to generate any adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of major injuries of fatalities to crew, passengers and workers - Major damage to vessel - Slight impact on the environment with no lasting effects	3	Possible	4	Very Serious	12	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A4 Marine Operations Plan with Tilbury A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4
5	2	1	Defined causeway Operational Area	Causeway	Collision of Terra Marique (including project vessels) with passing commercial vessels (All types).	Gravesend Reach is used by a wide variety of vessel types and as the Terra Marique navigates between the Authorised Channel and Causeway there is a risk that collisions could occur between passing vessels. This risk should be mitigated by the issuing of a comprehensive Notice to Mariners giving details of the Causeway operation and the provision of waiting and layby areas to ensure that the Terra Marique will remain clear of the Authorised Channel whilst waiting to make her approach to the Causeway. Analysis of vessel traffic movements adjacent to the Causeway indicate that at around high water there are around 6 transit per hour – it would be incumbent on the tow master of the Terra Marique to cross the channel when it is clear to do so.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - Minor injuries to crew on either vessel - Minor damage to vessel - Negligible impact on the environment with no lasting effects - Unlikely to generate any adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of major injuries of fatalities to crew, passengers and workers - Major damage to vessel - Slight impact on the environment with no lasting effects	2	Unlikely	4	Very Serious	8	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4
6	2	1	Defined causeway Operational Area	Causeway	Collision of Terra Marique (including project vessels) with passing recreational vessels.	Downstream of the Causeway site at Mucking No 5 the preferred small craft route crosses from the south side of the PLA Authorised Channel to the north side. Although, the small craft route does not require recreational vessels to pass the Causeway on the northern side of the PLA Authorised Channel it is likely that some skippers will decide to continue navigating on the northern side of the Authorised Channel past the Causeway site. They are therefore, the most likely passing vessel to come into close proximity to the Terra Marique as she makes her approach to the causeway. It is also likely that the Terra Marique may need to hold station between the PLA Authorised Channel and the Causeway until high tide, this could position her close to or obstructing the recreational route. The propose waiting area however is located inside the groynes and therefore should not impact recreational vessels on transit. The Terra Marique will also have a PLA pilot of PEC holder on board and who will be familiar with recreational craft activity in the area.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - Minor injuries to crew - Minor damage to vessel - Negligible damage to Terra Marique - Slight impact on the environment with no lasting effects (Tier 1) - Local adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of major injuries and multiple fatalities to crew - serious damage to recreational vessel rendering it un-operational - Minor damage to Terra Marique - Slight impact on the environment with no lasting effects	2	Unlikely	4	Very Serious	8	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4

7	2	1	Defined causeway Operational Area	Causeway	Collision of Terra Marique (including project vessels) with passing tug and tow.	Tug and tows frequently use the East Tilbury Jetty and are more likely to come into close proximity with the Terra Marique than most other passing vessels because of this. The GPS Ionia and GPS India arrived at East Tilbury between one and two hours before HW during the study period and approached the Jetty well to the west of the Causeway. It is likely that the Terra Marique may need to hold station between the PLA Authorised Channel and the Causeway whilst awaiting high water, this would position her close to East Tilbury Jetty and would mean that she may be standing off the Causeway as the tugs approach East Tilbury Jetty . However, the presence of a groyne to the east of the Causeway and to the west of the East Tilbury Jetty creates a physical barrier between the Jetty and Causeway limiting the chances of a collision between the Terre Marique and passing tug and tows. The inclusion of a waiting area within the operating plans also means that if the Terra Marique does need to hold station whilst she waits for high water, she will be clear of East Tilbury Jetty.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - Minor injuries to crew - Minor damage to vessel - Negligible damage to Terra Marique - Slight impact on the environment with no lasting effects (Tier 1) - Local adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Possibility of major injuries and multiple fatalities to crew - serious damage to Tug vessel rendering it un-operational - Minor damage to Terra Marique - Slight impact on the environment with no lasting effects (Tier 1)	2	Unlikely	4	Very Serious	8	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4
8	2	1	Defined causeway Operational Area	Causeway	Collision caused as a result of avoiding Terra Marique (including project vessels) transiting during causeway operation.	The Terra Marique will navigate between the Authorised Channel and the Causeway and in doing so will cross the same section of river utilised by vessels using the Tilbury 2 ro-ro and CMAT berths as well as recreational craft and tug and tows using the East Tilbury Jetty. To avoid the risk of collision as a result of avoiding the Terra Marique careful consideration will need to be given to deconfliction of the operations and measures should be taken to warn recreational craft of the Terra Marique's intention to transit to the Causeway site, such as regular Notices to Mariners.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 8. Strength of tidal flow	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 un-operational -Slight impact on the environment with no lasting effects (Tier 1) - National adverse publicity	2	Unlikely	4	Very Serious	8	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4
9	15	1	Defined causeway Operational Area	Causeway	Grounding of Terra Marique (including project vessels) as a result of causeway operation.	There will be very limited under keel clearance when navigating on to the Causeway. Departure / arrival times will have to be calculated very carefully in order to coincide with high water. It is possible that wash from passing vessels could also push the Terra Marique off course during final approaches to berth, this change of course could result in grounding. The provision of mooring piles to indicate the edge of the Causeway and correct berthing area will mitigate the risk of grounding.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 4. Avoidance of third-party vessel 5. Limited performance of the vessel 6. Rise and fall of tide. 7. Wash from passing vessel 8. Strength of tidal flow	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 - Major damage to vessel rendering it un-operational - No impact on the environment - local adverse publicity	2	Unlikely	2	Moderate	4	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A2 Mooring Piles A6 Supplementary Towage	2	Unlikely	2	Moderate	4
10	15	16	Defined causeway Operational Area	Causeway	Grounding of non project vessels as a result of causeway operations (All types).	The risk of grounding of passing third party vessels as a result of the Causeways is very minimal, as is third party grounding which could only occur if a vessel were navigating north of the lateral marks placed on the groynes. This is only possible at high tide and can only be done by shallow draught vessels. Recreational craft are advised to avoid navigating in this area by the PLA and larger commercial vessels are likely to ground before making contact with the Causeway.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 6. Rise and fall of tide. 7. Wash from passing vessel 8. Strength of tidal flow	MOST LIKELY OUTCOME - No injuries - Minor damage to vessel - No impact on the environment - Local adverse publicity REASONABLE WORST CREDIBLE OUTCOME - Major injuries - Moderate damage to vessel - No impact on the environment - local adverse publicity	2	Unlikely	2	Moderate	4	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A2 Mooring Piles	1	Rare	2	Moderate	2
11	8	11	Defined causeway Operational Area	Causeway	Breakout of Terra Marique during berthing / alongside.	It is possible that the Terra Marique could break free whilst moored alongside the Causeway. This could be a particular problem with strong tidal flows, rise and fall of tides, periods of adverse weather or from wash / draw off from passing vessels. However, it is envisaged that there will be suitably designed and installed mooring infrastructure to accommodate the Terra Marique whilst waiting for the tide to rise and fall. For example, the Terra Marique utilises a spud anchor system which she can deploy once in position which will also mitigate the risk of breakout, a temporary speed reduction whilst the Terra Marique transitions to being aground and ballasts down will also mitigate the risk of breakout.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 6. Rise and fall of tide. 7. Wash from passing vessel 8. Strength of tidal flow	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 - Moderate damage to vessel - No impact on the environment - local adverse publicity	2	Unlikely	3	Serious	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A2 Mooring Piles A3 Temporary Speed Reduction A6 Supplementary Towage	1	Rare	3	Serious	3
12	8	11	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Contact of Terra Marique (including project vessels) with infrastructure whilst on passage outside causeway operation area.	The Terra Marique will need to utilise the PLA Authorised Channel when navigating to and from the AIL transhipment terminal and the Causeway. The Terra Marique will be assisted in and out of the AIL transhipment site by appropriate supplementary towage as required by the chosen AIL transhipment Statutory Harbour Authority. There are a number of jetties and moorings situated outside the Authorised Channel that should also be avoided. In order to make contact with these structures the Terra Marique would need to deviate significantly from the Authorised Channel and any such occurrence would most likely be as a result of a breakdown. However, the Terra Marique will be accompanied by two tugs, and will have her engines ready, whilst transiting to the Causeway site to mitigate any risk of making contact with river infrastructure.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 8. Strength of tidal flow	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 or single fatality to crew and workers - Moderate damage to vessel - No impact on the environment - National adverse publicity	2	Unlikely	3	Serious	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	3	Serious	3
13	8	11	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Collision of Terra Marique (including project vessels) with passing commercial vessels outside the defined causeway operation area.	Gravesend Reach is used by a wide variety of vessel types, as the Terra Marique navigates the Authorised Channel there is a risk that collisions could occur between passing vessels. However, this risk is no greater than could be expected for any other vessel navigating utilising the Authorised Channel and other similar tug and tows occur on a regular basis – through application of existing risk control measures this hazard is well managed already by the PLA and other SHA on the Thames.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 8. Strength of tidal flow	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 un-operational - Slight impact on the environment with no lasting effects (Tier 1) - National adverse publicity	2	Unlikely	3	Serious	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	3	Serious	3

14	2	1	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Collision of Terra Marique (including project vessels) with passing recreational vessels outside the defined causeway operation area.	For the most part it is understood that recreational craft will utilise the small craft channel which extends 15 metres to the north and south of the Authorised Channel. There is a possibility that a collision between the Terra Marique and recreational craft could occur as the Terra Marique enters and leaves the Authorised Channel. A regularly updated notice to mariners should mitigate this risk along with the exiting embedded risk controls.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 8. Strength of tidal flow	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 un-operational - Slight impact on the environment with no lasting effects (Tier 1) - National adverse publicity	2	Unlikely	4	Very Serious	8	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	4	Very Serious	4
15	8	11	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Collision of Terra Marique (including project vessels) with passing Tug and Tow outside the defined causeway operation area.	Intra port freight traffic and tug and tow traffic is common in the Gravesend Reach. As the Terra Marique navigates the Authorised Channel there is a risk that collisions could occur between passing vessels.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 6. Rise and fall of tide. 7. Wash from passing vessel 8. Strength of tidal flow	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 un-operational - Slight impact on the environment with no lasting effects (Tier 1) - National adverse publicity	2	Unlikely	3	Serious	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Area A6 Supplementary Towage	1	Rare	3	Serious	3
16	8	16	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Collision caused as a result of avoiding Terra Marique (including project vessels) during passage (All vessels)	The Terra Marique modest speed may create a hold up in passing traffic and this could lead to congestion and a greater chance of collision between vessels seeking to avoid the Terra Marique. Supplementary towage will help to mitigate this hazard as well as the utilisation of waiting and layby areas outside the Authorised Channel.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 6. Rise and fall of tide. 7. Wash from passing vessel 8. Strength of tidal flow	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 un-operational - Slight impact on the environment with no lasting effects (Tier 1) - National adverse publicity	2	Unlikely	3	Serious	6	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners A5 Waiting and Layby Areas A6 Supplementary Towage	1	Rare	2	Moderate	2
17	15	16	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Grounding of Terra Marique (including project vessels) whilst on passage to causeway outside the defined causeway operation area.	The Terra Marique will need to utilise the PLA Authorised Channel when navigating to and from the AIL transhipment terminal and the Causeway. The Terra Marique will be assisted in and out of the transhipment terminal by appropriate supplementary towage as per the direction of the chosen AIL transhipment terminal. There are a number of shoals situated outside the main Authorised Channel that should be avoided. In order to ground the Terra Marique would need to deviate significantly from the Authorised Channel and any such occurrence would most likely be as a result of a breakdown. The Terra Marique will be accompanied by two tugs whilst transiting to the Causeway site to mitigate any risk of her leaving the Authorised Channel and grounding.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 8. Strength of tidal flow	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 - Major damage to vessel rendering it un-operational - No impact on the environment - local adverse publicity	2	Unlikely	2	Moderate	4	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A6 Supplementary Towage	1	Rare	2	Moderate	2
18	18	11	Passage from AIL transhipment Terminal to Defined causeway operation area	Passage	Grounding of non-project vessels as a result of Terra Marique Passage (All types).	The Terra Marique's modest speed may create a hold up in passing traffic and this could lead to congestion and a greater chance of vessels inadvertently leaving the Authorised Channel in order to avoid the Terra Marique. This could result in grounding, particularly for deep drafted vessels. Supplementary towage will help to mitigate this hazard as well as the utilisation of waiting and layby areas outside the Authorised Channel.	1. Master / Skipper error 2. Mechanical defect / failure 3. Adverse weather conditions / reduced visibility 5. Limited performance of the vessel 8. Strength of tidal flow	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 - Major damage to vessel rendering it un-operational - No impact on the environment - local adverse publicity	1	Rare	3	Serious	3	**Embedded** E1 Charting E2 Aids to navigation E3 Navigate with due care and attention E4 Terra Marique Specific Vessel Passage Plan and RAMS E5 Pilotage **Additional** A1 Notice to Mariners	1	Rare	3	Serious	3