IMMINGHAM EASTERN RO-RO TERMINAL DCO APPLICATION

PINS REFERENCE TR030007

COMMENTS ON DEADLINE 3 SUBMISSIONS BY DFDS

Introduction

1. This document consists of comments on various documents submitted at Deadline 3 (11 September 2023) for the above application. The documents commented upon are:

   a. The revised draft Development Consent Order [**REP3-002**]

   b. The Applicant's Response to DFDS's Written Representation [**REP3-008**]

   c. The Applicant's Response to DFDS's Additional Navigation Risk Assessment [**REP3-009**]

   d. The Applicant's Response to ExQ1 submissions by Interested Parties [**REP3-016**]

   e. The Humber Harbour Master's Comments on DFDS D2 submissions [**REP3-024**]

Revised draft DCO [REP3-002]

2. A revised draft Development Consent Order was submitted by the Applicant at Deadline 3 [**REP3-002**]. While it has incorporated some changes suggested by DFDS in its Deadline 2 submission [**REP2-039**], the following changes have not been made and DFDS continues its case that they should be:

- Article 2: the definition of 'construct' is too wide, as discussed at ISH4;
- Article 6(1) the exception of variation of the ability to maintain remains unnecessary;
- Article 7(b) still does not refer to building schedule (this could also go in Requirement 7);
- There appear to be some footnote references within the text of the clean version which are not in bold, these should be in bold to avoid confusion.
- Article 21(1) still has an annual cap of 660,000 units rather than a daily cap of 1,800 units, and no monitoring is provided;
- Article 21(3): the tailpiece has been amended but such amendments usually refer to 'new or different' environmental effects;
- Schedule 1, there is no change to works, including the lettered ancillary works at the end;
- Schedule 2, new Requirement somewhere around requirements 2-4, to place a restriction on simultaneous construction and operation unless and until such a situation has been properly assessed in the environmental statement;
- Schedule 2, Requirement 4(2)(c) still has a tailpiece;
- Schedule 2, Requirements 7 is headed 'External appearance and height of the authorised development' but does not include any height-related provisions. It is suggested this requirement should be amended to limit heights to those which have been assessed in the environmental statement and as set out in the building schedule [**APP-078**];
- Schedule 2, Requirements 8 is duplicated (save for the addition of 'general') by requirement 15 and one should be removed – not having 'general' would be preferable.
- Schedule 2, Requirement 10 (noise insulation) is unchanged and potentially provides no protection at all – what is offered by the Applicant should be required to reach a specified standard of protection;
- Schedule 2, Requirement 15 - DFDS would support the Examining Authority's suggestion at Issue Specific Hearing 4 that this requirement be amended to include external approval of mitigation measures, for example by the Secretary of State for Transport, in light of the overlapping governance of the Applicant and its subsidiaries;
- Schedule 2, Requirement 18 as with Requirement 15, DFDS would support this requirement be amended to include external approval of mitigation measures, for example by the Secretary of State for Transport;
- Schedule 2, Requirement 18 (when impact protection implemented) is simply a weaker version of the previous version – instead of the harbour authority directing that Work No. 3 be built, they can only recommend this, the drafting should be amended to add an obligation on the Applicant to

construct Work No. 3 or its replacement before either construction or operation of the project depending on whether it would increase safety of the former as well as the latter; and

- Schedule 4 should include protective provisions in favour of DFDS, since Deadline 2 the Applicant has indicated it provide protective provisions, DFDS is still awaiting a draft from the Applicant.

The Applicant's Response to DFDS's Written Representation [REP3-008]

3. Paragraph 2.3 '*the Applicant disagrees with the views expressed in section 30 which, misleadingly attempts to highlight how IERRT vessels will need to manoeuvre close to chemical tankers on the eastern jetty. In reality, the level of vulnerability for those vessels will be considerably less than that experienced by vessels (containing equally dangerous liquid bulks) on the western jetty whilst DFDS's own vessels are manoeuvring in and around the Outer Harbour. Here, also, there is little room for error or the ability to deal with machinery breakdowns and failures.'* DFDS disagrees with this comparison of the Immingham Outer Harbour (IOH) and area of the Proposed Development. As explained by DFDS at Issue Specific Hearing 3 on 27 September, the conditions in the IOH are considerably different from those in the area of the Proposed Development, which DFDS would expect the Harbour Master and Dock Master to be in agreement with. The reasons for this are as follows:

a. Contingency Space. There is over 1100m of deep water to the north of the entrance to the IOH (and soft mud beyond this) giving lots of open water into which a vessel can escape in the event of a machinery problem or abort. Conversely there is restricted space north of IERRT with around 300m to the north where the IOT main berth is located.

   There is virtually no tide within the IOH making the final manoeuvre less challenging, whereas there will always be tide running through the IERRT. This means that whilst IOH vessels are only contending with the wind when in the final stages of berthing the IERRT vessels are having to manage both tide and wind on the final stages of their manoeuvre. The effect the tide has on a vessel should not be underestimated and when combined with wind can result in huge forces acting upon a vessel. Using approximations from the 'OCIMF Mooring Equipment Guidelines (4th Edition)' the forces acting on the vessel increase quickly as the vessel heading in relation to the tide increases as demonstrated in the table below.

Offset	Side force (tonnes)	Ratio to force at 5°
0°	0	-
5°	9	1.0x
10°	18	2.0x
15°	28	3.2x
20°	38	4.3x

   Based on 4 knots current speed. Vessel draft is 8m and water depth is an average of about 10.9m

b. The approach to the IOH has two unique manoeuvres, one for the flood tide and one for the ebb tide. By having 2 separate manoeuvres tailored to the tide IOH vessels can better control the risks.

c. DFDS masters are performing a stabilized approach and entrance to outer harbour. This means that ships' speed relative to the ground is minimised, almost no speed ahead or astern, and then a tide-assisted sideway sliding.

d. Within the IOH there is considerably less vulnerable infrastructure other than the terminal pier itself. The only other structure (the Immingham Bulk Terminal) has impact protection piling on it's southern side to prevent possible contact with the IBT gantry cranes.

4. Paragraph 2.6 the Applicant states that it '*does not agree that the construction of IERRT will remove stemming opportunities for vessels awaiting a lock slot.*'. It seems inevitable to DFDS that in order to operate safely, the Harbour Master and his representatives within VTS will need to control the space around the IERRT when vessels are manoeuvring to and from the proposed terminal. DFDS are unable to understand how the East Jetty stemming area can be in use at the same time as vessels manoeuvring on and off the proposed IERRT. Using two of the Applicant's simulations (Run 2 and Run 8), of arrival and departure on the ebb tide, DFDS have superimposed a vessel stemming for the lock on the east side (see Appendix 1) . It is obvious in these illustrations that it is not safe for a vessel to be stemming off the eastern jetty at these times. This would then demonstrate that vessels would need to stem either to the west, which could cause potential conflict with IOH operations or stem at the No 9 Holme Ridge buoy as per Standing Notices To Mariners SH22 both of which cause longer approach times for the lock and slow down the lock operation.

5. Paragraph 2.7 the Applicant does not appear to fully appreciate that a scheduled liner service operates in a small window both for arrival and departure '*separation is achieved not just via spatial zoning but also via timings*'. It is anticipated they will arrive and sail at pre-determined times of roughly 0600-0800 for arrival and 1800-2000 for departure. It is therefore unrealistic to suggest these services will be spaced apart by more than a few minutes and as such in these limited windows the in dock operation will be compromised.

6. Paragraph 2.12 The Applicant notes '*This [tug] barge is located at the eastern extremity of the eastern jetty and all simulations were carried out in the full knowledge and awareness that this barge would remain in situ*', DFDS find this somewhat fanciful. If the presence of the barge was appreciated why was it not shown in diagrams of the simulations? This key piece of infrastructure has been in place for over 20 years and appears on all nautical charts including those produced by the Applicant's own hydrographic department. The tug barge is a vulnerable piece of port infrastructure close to the IERRT and its conscious omission from the simulations would not make sense. DFDS therefore believe it to have been a mistake on the part of the Applicant and their simulation experts that demonstrates the hurried fashion in which these simulations appear to have been undertaken.

7. Paragraph 2.14- Dredging – Siltation is an issue shared amongst all stakeholders on the Humber and it is a constant battle to maintain depths around port infrastructure and the navigation channels on the Humber. DFDS are concerned that the applicant seems satisfied that siltation caused by the capital

dredge deposits will increase in areas such as the IOH but as they believe the proposed development will be ‘self scouring’ that this is not a point of concern for IP’s. Maintaining agreed depths at berths and terminals is an essential component of estuarial safety that ensures all Humber traffic can carry out operations in a safe and efficient manner. DFDS remain concerned that by using the deposit grounds indicated by the Applicant that levels of siltation will be beyond the capability of the current dredging fleet that will ultimately compromise safety for all estuary users regardless of the possibility of siltation at the IERRT.

8. DFDS remains disappointed that the Applicant continues to ignore its genuine concerns regarding the manner in which simulations have been carried out. The concerns regarding the tidal flow at IOT, the omission of the tug barge, the use of certain ship models, the excessive use of machinery, the unrealistic reliance on tugs and the complete lack of comprehensive simulation to Berth 3 have still not been addressed by the Applicant. Simulation is the best indication as to the safe operation of any proposed development and despite repeatedly raising our concerns regarding the process, and lack of oversight by the Humber’s Statutory officeholders, the Applicant has failed to engage on these matters.

9. Paragraph 3.5 - The Applicant indicates that they do not accept the methodology utilised by DFDS to provide a high-level assessment of the terminal’s capacity. However, the Applicant has utilised a similar methodology when assessing existing infrastructure within Immingham, Killingholme and Hull as presented in **APP-079** (ES Appendix 4.1– Market Forecast Study Report). It is unclear as to why the Applicant accepts the assessment approach in one scenario, and not in another.

10. Paragraph 3.8 - A detailed assessment of the terminal’s capacity has not been provided by the Applicant, noting that its response to Question TT.1.1 in **REP2-009** was simply that the terminal has capacity for 1,800 units per day / 660,000 units per year. The Applicant has indicated an intent to revise Chapter 2 of the ES with the new annual figure in response to Question BGC.1.16 and this is awaited. The Applicant’s Transport Consultant has confirmed that they are not the authors of this particular revision and that the analysis is being completed by another third party who has to date not been involved in the Transport Working Group discussions, which is concerning. DFDS would also anticipate that this submission will provide a description of any further mitigations required (for example additional truck stop capacity, or gatehouse operational systems) to be identified within this revision of the ES regarding how the Applicant intends to manage congestion external to the terminal.

11. Paragraph 3.8 – The Applicant has stated that the daily maximum number of units is 1,800. This is however inconsistent with the controlling limit as presented in Article 21(1) of the draft DCO of 660,000 units per year [**REP3-002**]. In the instance that the terminal achieves this maximum volume, the practical operations of the terminal will dictate fluctuations of trade across the year, month and week. The Applicant has already stated an anticipated peaking factor of 125%, therefore if the total annual number of units (660,000) were to be divided by 364 operational days, and factoring in the 125% peaking factor, this would achieve a daily peak volume of 2,200 units. DFDS have proposed a number of options to the Applicant to get consistency between the Transport Assessment and the draft DCO, being:

a. Modify the Transport Assessment to consider a peak day of 2,200 units; or

b. Modify the draft DCO to a maximum annual throughput of 524,160 units (1,440 units per day on average multiplied by 364 operational days); or

c. Add to the draft DCO (in addition to the annual control of 660,000 units) a daily control of 1,800 units.

12. Paragraph 3.10 – As per all other points raised by DFDS above, below and within prior representations, the Applicant's Transport Assessment is not consistent with DFDS's assessment.

13. Paragraph 3.12 – No further information regarding the East versus West Gatehouse assignment has been provided within the Applicant's response. DFDS' response remains as per paragraphs 49 to 53 of **REP3-022**, and our response to Question TT.2.06.

14. Paragraph 3.15 – No further information regarding the Gatehouse capacity has been provided within the Applicant's response. DFDS' response remains as per paragraphs 49 to 53 of **REP3-022.**

15. Paragraph 3.16 – Further investigations have been completed by DFDS which identified that the Passenger Car Unit (PCU) conversion factor was incorrect within the Applicant's current Transport Assessment (**AS-008**) methodology. DFDS discovered that each HGV was counted as a single PCU equivalent in the current Transport Assessment modelling. A conversion ratio should have been applied to each HGV depending on its size, though on average this factor is around 2.3 (i.e. this would more than double the volume of Heavy Goods Vehicles modelled which will have a material impact on the modelling results). DFDS are awaiting the revision of the Transport Assessment to correct the PCU conversion error.

16. Paragraph 3.23 – The Applicant's assessment in **REP2-010** also includes an arithmetical error as discussed in paragraph 36 to 39 of **REP3-022**. The Applicant has yet to provide justification of their basis for their 10% tractor-only assumption. It is DFDS' view that the Applicant's assessment underestimates the tractor-only number when specifically looking at unaccompanied Ro-Ro traffic. This can be clarified by the provision of further data by Stena, similar to the data that has been presented by DFDS in Table 1 of **REP1-030** (i.e. counts of truck and trailers against tractor only at the Killingholme terminal gatehouse).

17. Paragraphs 3.26 to 3.30 – As per paragraph **Error! Reference source not found.** of this note (in response to paragraph 3.16), there is an underlying issue within the Applicant's current Transport Assessment (**AS-008**) regarding the PCU conversion which needs to be addressed prior to responding to the items raised in respect of junction capacity and impacts on the A1173.

The Applicant's Response to DFDS's Additional Navigation Risk Assessment [REP3-009]

18. Paragraph 1.9 the Applicant states '…*that any navigational risk assessments applicable within the jurisdiction of the Port of Immingham Statutory Harbour Authority and indeed the Statutory Harbour Authority for the Humber, to be legitimate and applicable, must be undertaken in the context of the port operator's determined risk thresholds.*' However, the basis upon which the Applicant's risk thresholds are determined is not clear, nor where they were discussed during the various workshops, and has not been provided to the various stakeholders prior to issue the Applicant's NRA [**APP-089**]. If the SHA's risk thresholds are already determined, then this is presumably available for discussion and promulgation with respect to how the Port or SHA's existing baseline NRA categorises and assesses risk. Relating specifically to risk thresholds and tolerability, it is also unclear how the undefined likelihood brackets can align with any pre-defined tolerability, nor how risk categorisation used in the Applicant's risk matrix can be aligned to any pre-defined tolerability thresholds when a risk classified as "significant" can be tolerable or intolerable. The Applicant's determination of tolerability is difficult to align with industry good practice when risk to People resulting in one fatality is shown as equally tolerable to multiple fatalities for the same likelihood (noting again the expected difficulty in aligning undefined likelihood brackets with any pre-defined risk threshold). Further response on tolerability is covered below in paragraph 24.

19. Paragraph 1.10 the Applicant stages '*The DFDS submitted additional NRA fails to acknowledge this practical reality nor does it take the SHA's risk requirements into account. It has instead, merely applied its own standard of assessment for navigational risk, as commissioned by an objector to the Applicant's proposed development – without reference to the SHA*'. The premise upon which the DFDS NRA [**REP2-043**] has been undertaken is with a safety focus and impartiality, being facilitated by NASH Maritime (as independent navigation risk experts). DFDS identified the need for this independent NRA due to their ongoing safety related concerns which have been repeatedly expressed from the standpoint of an experienced operator at the Port of Immingham. The "standard of assessment" used in the DFDS NRA that is commented by the Applicant in this paragraph is not new and has been successfully used on previous DCO applications, including the Able Marine Energy Park (whose methodology was approved by ABP Humber and the Planning Inspectorate when consenting that project) which is also a PMSC-compliant approach to navigational risk assessment. The Applicant's criticism of the standard of assessment adopted by the DFDS NRA fails to acknowledge these previous proven applications and their ability to produce a robust, transparent and objective risk assessment.

20. Paragraph 1.12 the Applicant questions the use of a scoring mechanism applied within the DFDS NRA and states '*In DFDS's additional NRA, any outcome that is scored at '6' or above (on a 1 to 10 scale) has been considered as intolerable. This is an arbitrary and simplistic view of the assessment of tolerability and is an incorrect application of the tolerability concept.*' The Applicant has failed to identify the scoring mechanism as a means to ensure

impartiality, objectivity and consistency is applied throughout the entire risk assessment. To consider scoring of risks as "an arbitrary and simplistic view of tolerability" again fails to acknowledge the same scoring system has previous proven applications within the Able Marine Energy Park NRA (see Appendix 2 of this document), Solent Gateway NRA (see Appendix 3 of this document, the additional IOT NRA [**REP2-064**], and the use of a scoring system being recommended within the Applicant's own reference document: MGN 654 via it's Annex 1 for Methodology for Assessing Navigational Risk. The Applicant also fails to realise the reason this approach to tolerability has been used previously, and will continue to be used in the future, is because it is founded on reasoned judgement and benchmarked against industry guidelines. There is no specific requirement around the definition of where tolerability should be set and specific tolerability should be set using agreed "standards of acceptability", as required by the PMSC. The tolerability can be adjusted to suit the specific application of the risk assessment and the impacted stakeholders. However, for all applications there is a need for justified reasoning and, where possible, benchmarking of the tolerability thresholds used. The approach adopted by the DFDS NRA is based on the UK HSE's decision-making process for societal risk to people (defined by UK HSE Reducing Risk: Protecting People (R2P2) document- Appendix 4 of this document) which treats an intolerable threshold as fatality of 50 people with a probability of not more one in 5000 per annum. Cumulatively this equates to a risk of 1 person every 100 years, which is the definition of intolerable region used in the DFDS NRA, being a score of 6. The Applicant's perception that the score-based tolerability is "arbitrary and simplistic" shows a fundamental lack of understanding of navigation risk assessment and how a robust NRA should be undertaken using appropriate rationale and transparent justification. To undertake an NRA without a structured and robust approach can lead to incorrectly assessed risks and inadequately defined risk controls, which continues to be a high concern for DFDS. By contrast however, the Applicant has defined their tolerability without expanding upon the basis which their tolerability was decided. Subsequently the Applicant has also conducted a Cost Benefit Analysis to determine what they consider to be acceptable mitigations but without providing any detail or justification of how this Cost Benefit Analysis was undertaken or how it related to risk and tolerability.

21. Paragraph 1.15 the Applicant misunderstands the application of the As Low As Reasonably Practicable (ALARP) principle within the NRA when stating *'…it is noted that DFDS's additional NRA combines its outcome value of '6' as a threshold for both tolerability and at ALARP. To combine the two into a single measure is not, in the Applicant's view, either a sensible nor indeed a safe way to proceed*.' The principle of ALARP is applied to high risk hazards that require additional risk controls in order to be considered acceptable or tolerable. The score of 6 distinguishes risks that are so high they are flatly intolerable, and risks that may be tolerable if they satisfy the ALARP principle – that is, if additional risk controls are able to reduce the risk sufficiently without unnecessary cost, effort, time, disruption, etc to implement. The higher the risk, the more effort and cost is justifiable to reduce that risk to ALARP and make the risk tolerable. These risks are classified as "tolerable if ALARP". The score of 6 is not the threshold for both tolerability and ALARP, it is the separation value that distinguishes the risks that are flatly intolerable and must be reduced (a score of 6 or higher) and the risks that can considered as tolerable if, and only if, the risk is made as low as reasonably practicable by the introduction of additional risk controls (a score of 3 up to 6). This is the correct application of ALARP in navigation risk assessments and is shown in:

a. The example risk matrix in the PMSC Guide to Good Practice [**REP1-016**], paragraph 4.3.20 (showing an ALARP band between acceptable and intolerable).

b. In the text of the PMSC [**REP1-015**], paragraph 4.3.5, which talks to '*whether hazards are deemed to fall within the ALARP band*'.

c. The example risk assessment methodology within MGN 654, Annex 1[1], Appendix C5 (showing calculated risk scores, risk matrix and a tolerability matrix with equivalent ALARP principle defined as a band of scores between 3 and 5).

d. The treatment of the ALARP principle in its application to an NRA shown in the Solent Gateway NRA, Able Marine Energy Park NRA, the additional IOT NRA and ABP's Immingham Green Energy Terminal (IGET) Preliminary Environmental Impact Report (PEIR)[2] (Section 12.3.4).

22. Paragraph 1.18 the Applicant states '*The authors of the DFDS additional NRA have incorrectly assumed that the same tolerability can be applied from two different NRAs with two different timescales for the frequency descriptors to draw their conclusions. This results in a '6' in the DFDS additional NRA correlating with a Major risk once every 1000 years, whereas a '6' in the 'Solent Gateway NRA' is for the same level of risk consequence (Major) every 25 years.*' The frequency descriptors used in the DFDS NRA (and also used in the Able Marine Energy Park NRA) are based on probability. That is, the percentage chance of the event occurring in a 1 year period which is represented as the equivalent expected return period and is the most appropriate way to define likelihood brackets within an NRA. For example, a 1 in 10 year, 1 in 100 year or 1 in 1000 year event. The frequency descriptors used in the Solent Gateway NRA were used on request by ABP Southampton who provided these and additional information from their MarNIS system that was provided to NASH Maritime for undertaking that NRA (this was to assist the integration into and benchmarking against the port's own baseline risk assessment). This was understood to be tailored to the expected occurrence at that specific port and is not the return period of a probability. It is not clear, however, why the Applicant has expressed a criticism over the use of probability-based likelihoods in the DFDS NRA when their own NRA has not adopted any objectively defined distinction between its likelihood categories, nor has it provided any indication on how regularly these events can be expected to occur. Their criticism in this regard seems more appropriate of their own NRA, which makes choosing the correct likelihood category fraught with error and misjudgement. This then also raises the concern of how tolerability can be adequately determined without properly understanding how regularly an event can be expected to occur.

23. Paragraph 1.19 the Applicant raises concern over the extent of stakeholder engagement undertaken in the DFDS NRA. They state '*It is very evident that the DFDS additional NRA is not representative of Port Stakeholders, nor could it be in the circumstances. This is, of itself, a fundamental flaw in the NRA*

[1] https://assets.publishing.service.gov.uk/media/60894584e90e076ab34f6f1c/MGN_654_Annex_1_NRA_Methodology_2021.pdf

[2] https://imminghamget.co.uk/wp-content/uploads/2023/01/12_IGET-PEIR-Chapter-12-Marine-Transport-and-Navigation.pdf

process and as such, the DFDS additional NRA cannot, in the view of the Applicant, be viewed as fit for purpose and should be given no weight as part of the examination process'. The statement that the DFDS NRA is not representative of Port Stakeholders does not appear to consider the original need for this the additional independent risk assessment being commissioned by one of the port's major stakeholders, DFDS. Nor does it acknowledge the same need was deemed necessary by another of port's major stakeholders, IOT, having also commissioned a separate, independent risk assessment. Again, the Applicant's criticisms apply to its own NRA which has failed to represent its own stakeholders' perspectives on risk and safety. Whilst a full in-person stakeholder engagement process would be the preferred practice, this was simply not realistic in the limited 4-week period required to complete the DFDS NRA. However, it must be recognised that the DFDS NRA has not been undertaken in the complete absence of the stakeholder engagement. The individuals involved in the DFDS risk assessment process have been involved in the entire stakeholder engagement process to date and are fully familiar with all information covered throughout this. They are also appropriately experienced local stakeholders who have an understanding the local operations, local port with its challenging environment, Humber estuary, and marine operations, including operation of a ro-ro facility. Furthermore, the limited information on the previous stakeholder consultations covered in the Applicant's NRA was also considered when preparing the DFDS NRA.

24. Paragraph 1.40 the Applicant states: '*By failing to realise that one of the two axis descriptors has changed (namely, the consequence descriptors change from port business, to people, to planet/environment, to property), DFDS presents a tolerability model that considers a fatality equally as tolerable (for the same frequency) as a tier 2 pollution event. This adds to the confusion of the scoring system suggested by DFDS in the additional NRA due to their failure to recognise intolerable risks that may only score highly in one receptor area.'* The Applicant does not appear to appreciate how appropriate definition of consequences can be used to defined tolerability in order to maintain a consistent interpretation of tolerability. The definition of these categories is linked to tolerability and the categorisations can, in theory, be adjusted and tailored to the application of the risk assessment, the stakeholders risk tolerance levels and standards of acceptability of the local authority and/or relevant stakeholders (such as IOT's requirements against UK HSE). The consequence categorisation ranking used in the DFDS NRA was equivalent to the Applicant's NRA and the Solent Gateway NRA and closely comparable to the Able Marine Energy Park NRA which all used the approach of defining a single tolerably definition based on the consequence ranking which provides greater clarity and understanding for stakeholders. The Applicant's specific reference to the tolerability to Tier 2 pollution event does not appreciate the that this event could involve the Secretary of State's representative (SOSrep) who has the authority to shut down the waterway. This would then affect all waterways users and give rise to far greater consequences. The Applicant's concern over how pollution events are benchmarked against tolerability is echoed by a far greater concern from DFDS when considering the Applicant's NRA which shows:

a. A single fatality being equally tolerable as multiple fatalities.

b. The certainty of, and potentially regular occurrence of, moderate reputational damage, tier 1 pollution or £750,000 damage also being tolerable.

c. Risks that are classified as “Significant” that could either be tolerable or intolerable depending on their likelihood definition (which is highly subjective).

d. Extreme consequence for people resulting in multiple fatalities being tolerable if “the impact of the hazard might occur but is unlikely (within the lifetime of the entity)”. That is, hazards where multiple fatalities might occur in 50 years being treated as tolerable.

25. Furthermore, the Applicant’s comment regarding confusion appears to be more appropriately placed when considering their own NRA as there is no clear understanding on how the likelihood definitions have been assigned with any confidence, nor how the risk assessed aligns with tolerability, nor the basis upon which the tolerability has been assigned, nor how the judgement on appropriate mitigation has been decided through the Cost Benefit Analysis.

26. Paragraph 1.50 the Applicant states ‘*Risk ID 2 considers a collision between a tanker and a project vessel (RoRo associated with IERRT), whereas risk IDs 10, 13, and 20 consider an allision with port infrastructure (IOT Trunkway, Finger Pier and Eastern Jetty respectively). All three of these risks at the inherent (embedded) risk assessment stage consider a worst credible scenario to include – multiple fatalities, tier 3 oil pollution event, >£8million in property damage, and international news coverage with >£8million loses to port business, once every 1,000 years. Put another way, this assessment states that the embedded risk controls are so effective that they mitigate worse credible scenarios from occurring any more than once every 1,000 years for each of these risks (10, 13 and, 20).*’ The Applicant’s comments show a fundamental lack of understanding of probability and its application within NRAs. A 1 in 1000 year event does not simply mean the event will only occur once in 1000 years, but rather that is the probability of occurrence in any given year of 0.001 (or 0.1%) which relates to a return period of once in 1000 years. For example, a 1 in 100 year storm event does not only occur once in 100 years, but could occur 3 years in a row, but then statistically would not be expected to occur for 300 years. The potential for a catastrophic event occurring due to the IERRT at the IOT or at the Eastern Jetty, although have a low probability of occurrence, should still happen and it is this risk, with appropriate mitigations, that needs to be assessed.

The Applicant's Response to ExQ1 submissions by Interested Parties [REP3-016]

27. **NS.1.1 -** DFDS were present at the HAZID workshop in August 2022 and did participate in determining the risks but only 33% of the HAZARDS were discussed at the workshop. The remaining hazards were commented on in writing, for example, risk C7 and O6 can be mentioned where some or all of our comments were disregarded as noted in DFDS's letter to the Applicant dated 29 August 2022 (see e-page84 of **REP2-048**). Furthermore DFDS questions the effect of some of the further applicable controls, such as berthing criteria when these criteria were not suggested as a result of the simulations.

28. The Applicant seems to ignore the fact that they themselves had several months to organise such engagement whereas due to the time constraints of the DCO examination process, DFDS have had approximately three weeks to complete their NRA. To suggest that it would have been possible to organise large scale engagement is unrealistic. However, in light of the time constraints DFDS have engaged with subject matter experts with years of experience of navigating on the Humber, thus to suggest there was no stakeholder engagement is factually incorrect.

29. In light of the Applicant's failure to hold the promised 'Commercial Workshop' and the last minute decision to cancel the 'Senior Manager Safety Workshop' it had offered to DFDS, which have still not taken place, together with the continuing ignoring of DFDS' and others' concerns, the Applicant's engagement has not been as comprehensive as they seek to portray.

30. **NS.1.14** – please see paragraph 3 above.

31. **NS.1.19 -** The vessels the Applicant has used to simulate what the Proposed Development can handle are vessels of a 240m, a breadth of 35m, and a draught of up to 8m, are the JLZ class vessels, all 6 of these vessels are operated by DFDS which will not be using the Proposed Development, As noted previously, DFDS do not find the simulations conducted with the Jinling class vessels appropriate to support the Applicant's case that the Proposed Development can handle vessels of that size because of the unique manoeuvrability of the Jinling class vessels. Only in the stakeholder simulations did the Applicant use vessels which are actually likely to operate on the proposed new berths, but these are not consistent with the size of vessel the Applicant states the Proposed Development can accommodate. If the Applicant intends to berth other types of vessels, which are not RoRo or RoPax vessels, for instance car carriers, then those types of vessels should also be simulated.

32. DFDS is relieved to hear Pure Car Carriers (PCC's) will not be operating to the IERRT and note the Applicant's confirmation that the IERRT infrastructure is not designed for it and that any use by PCC's has not been tested or simulated. Aside from the issues flagged by the Applicant, PCC's are materially less manoeuvrable than the vessels which the Applicant has indicated might use the facility and very materially less manoeuvrable than the vessels

which the Applicant has used in simulations to date. Accordingly, DFDS believes that any attempt to use the IEERT for PCC's would be wholly inappropriate and would represent a very material risk which has not been tested or assessed. Given the considerable risk these types of vessel would present, DFDS requests that that this issue should be reflected in the DCO with the inclusion of a condition that no such vessels should be permitted to use the IERRT. Given the Applicant's assertion that the facility is not designed or tested for use by PCC's we assume this should not be an issue for the Applicant.

33. In the event that the Applicant were to conclude at some point in the future that it would be safe to operate PCC's at IERRT, it would of course always be open to the Applicant to apply to vary this condition provided that it has first conducted a full assessment including comprehensive stakeholder simulations involving port users and interested parties to demonstrate to the satisfaction of all such stakeholders that this could be done safely.

34. **NS.1.20 -** To run the bow thruster for 30 minutes is a class requirement and these should not be confused with safe operation and is not good practice. In a real world manoeuvre where the vessel does not have any reserve power this cannot be deemed safe, in order to identify which manoeuvres should be determined a success, marginal, aborted or failed, such thresholds should be determined beforehand.

35. **NS.1.21 and NS.1.22** – DFDS remain convinced that manoeuvres to and from the proposed IERRT will result in lost lock productivity and therefore impact materially on inner dock operations and customers. The Applicant has failed to demonstrate how any such loss of lock productivity can be avoided. The Applicant has denied that the Proposed Development will impact the stemming areas for Immingham Dock and therefore the efficiency of the lock operation. DFDS remain of the opinion that the IERRT will render the eastern jetty stemming area redundant at least for the period when vessels are arriving and departing from the terminal. This is anticipated to be 0600-0800 for arrival and 1700-1900 for departure. DFDS operates a number of services to the inner dock and needs to understand what impact assessments have been carried out by the Applicant to reach the conclusion that in inner dock operations will be unaffected.

36. DFDS has always acknowledged that it does not have experience of the current in the area of the Proposed Development. However, DFDS does have considerable experience of tide north of the IOT and that the tide, as represented in the simulations, is inconsistent with our considerable real world experience. As DFDS has pointed out on numerous occasions this is significant as it plays an important role in how the vessel initiates the manoeuvre to arrive in a position ready to complete the second stage onto the berth. DFDS are unaware of the number of Jinling vessels the Harbour Master has manoeuvred in the Immingham area, but DFDS knows from our real world experience, that it does have a material bearing on the outcome of the trials.

37. **NS.1.23 -** the Applicant suggests that the AWAC data they have obtained may cause the Admiralty to change the tidal flow data as indicated on Admiralty Charts in the Immingham area. The tidal diamond to which DFDS referred was in the main channel north of the IOT, an area in which DFDS have considerable real world experience and an area in which the Harbour Master and their simulation expert have admitted the tide data was wrong in the simulations. This data for this tidal diamond is identical to tidal data published on HES charts, HES publications and the Pilot Training Handbook. DFDS seeks

clarity on whether the Applicant is planning to change the tidal data in these publications to reflect this and details of what consultation regarding this the Applicant has had with their pilots.

The Harbour Master, Humber's Comments on DFDS D2 submissions [REP3-024]

38. DFDS note with concern the limited input from the Harbour Master and the Dock Master both in terms of verbal and written contributions to hearings or submissions. Both positions are extremely important when it comes to safe navigation and their input must be truly independent and unconstrained at all times.

39. Paragraph 3.1.8 - The Humber Master Humber (HMH) notes that, in regards to the effect of ship's wash on a tug: '*was not raised as an issue by the tug operators, either at the simulations at which HMH was present, or to him separately*'. DFDS notes that as far as DFDS is aware the HMH only participated in the stakeholder simulations in November 2022 (all of which were conducted to Berth 1, the least challenging berth) which in general were conducted with less power usage and less tug usage than previous simulations but also using much smaller vessels than the Jinling class ships. HMH noted in a meeting with DFDS 13 October 2022 that he had not read the simulation reports APP-090 (Superseded by **AS-022**) and APP-091 (superseded by **AS-023**) and so at this point was unaware of these issues that DFDS raised.

40. Paragraph 3.1.2 – The timings of the proposed IERRT vessels are expected to largely coincide with those of DFDS services bound for the IOH. As such the suggestion that vessels could stem 'uptide' off the Western Jetty rather than the Eastern seems to ignore the fact that it will be at times when the IOH is busy with arrivals or departures and in suggesting this option is simply displacing the disruption from one customer to another.

41. Paragraph 3.1.3 – the Standing Notice To Mariners SH22 states: '*Order of turn will be determined strictly by stemming times at the passing of either the Outer Binks Light Buoy or Outer Sea Reach Light Buoy or Outer Rosse Reach Light Buoy as appropriate and as recorded by VTS, Humber.'* This indicates that stemming is on a 'first come first served basis'.

42. Paragraph 3.1.4 - this response ignores the unique dangers posed by the IERRT which means issues may be beyond the control of HES in terms of the berths proximity to berths at which tanker vessels are loading and discharging hazardous liquid cargoes.

43. Paragraph 3.1.6 – The Harbour Master appears to have misunderstood our general assertion here that the way in which tugs were used in the simulations is unrealistic both in terms of positioning relative to the stern ramp and the fact that the simulation does not account for the effect of ships wash onto the tugs and the loss of directional stability this creates.

44. Paragraph 3.1.8 - as the simulations do not recreate the effect of a ship's wash on a tugs skeg (the large fin beneath the tug's hull) which provides directional stability) it means that the tug operators would not have felt the effect of this wash, nor is it realistically represented visually so the skippers would not have been aware of the amount of power the vessel was using or appreciating the very real world danger this represents.

45. Paragraph 3.1.9 - DFDS carries out simulation with multiple stakeholders at various simulation centres around Europe and always strives to make these as stringent and realistic as possible. DFDS does operate such criteria at other simulation locations (at the direction of the simulation centre experts) and will in future simulations ensure these are understood and followed in all simulations carried out with the applicant moving forward. However, to the best of our knowledge at no point in any previous DFDS simulations has the bow thruster run at 100% for such extended periods nor such excessive engine power employed to complete a manoeuvre as our experienced masters know this to be unrealistic and dangerous.

46. Paragraph 3.3 - it is not the case that DFDS assumes the IERRT vessels will move freely whilst all other vessels are inconvenienced. The point DFDS is flagging is that adding 6 movements a day (4 net movements) in an area that is already very busy will inevitably lead to congestion and in order to achieve separation of vessels there has to be inconvenience to existing traffic irrespective of the order in which this is achieved.

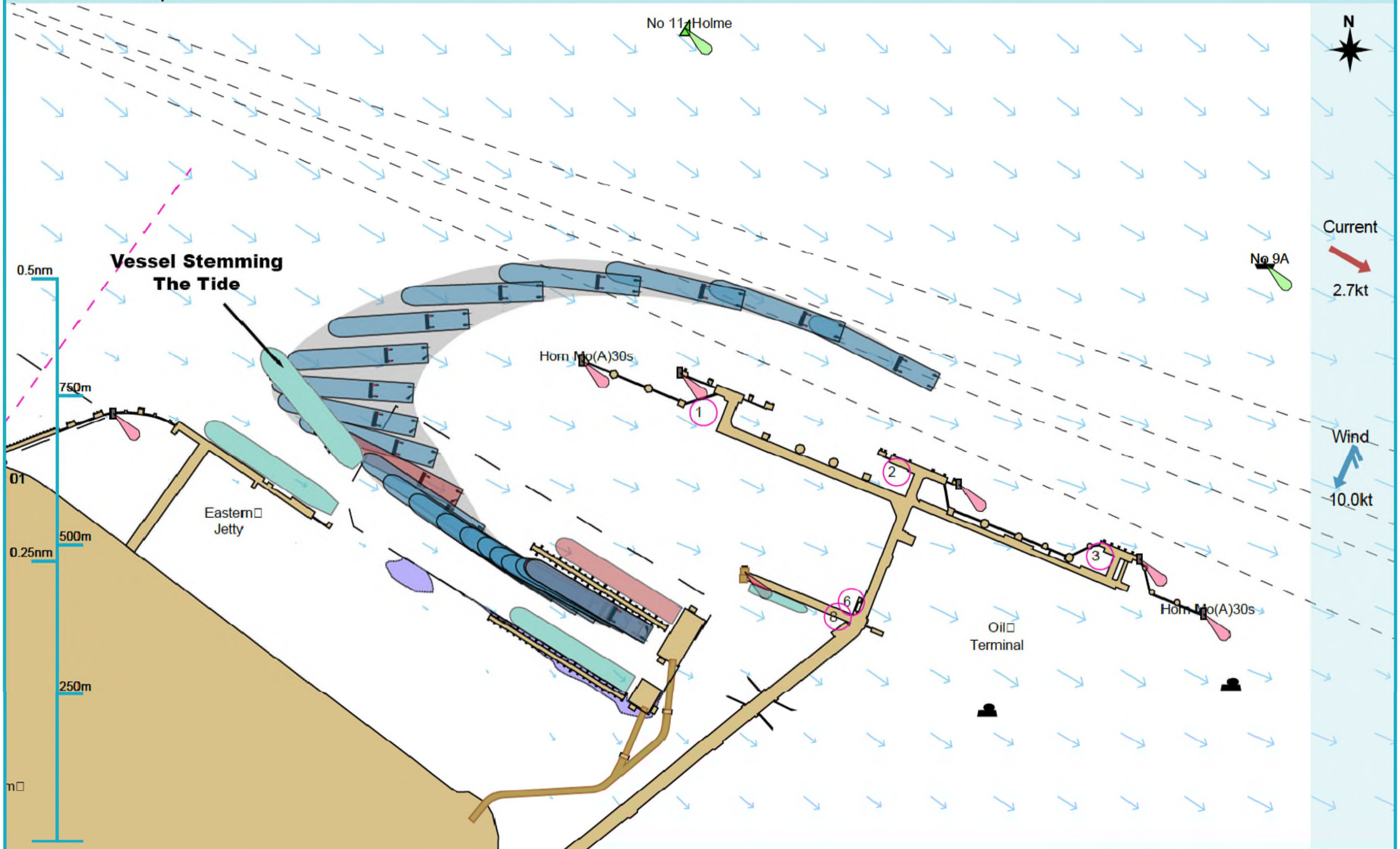
DFDS Comments on Deadline 3 Submissions

Appendix 1

Arrival Ebb

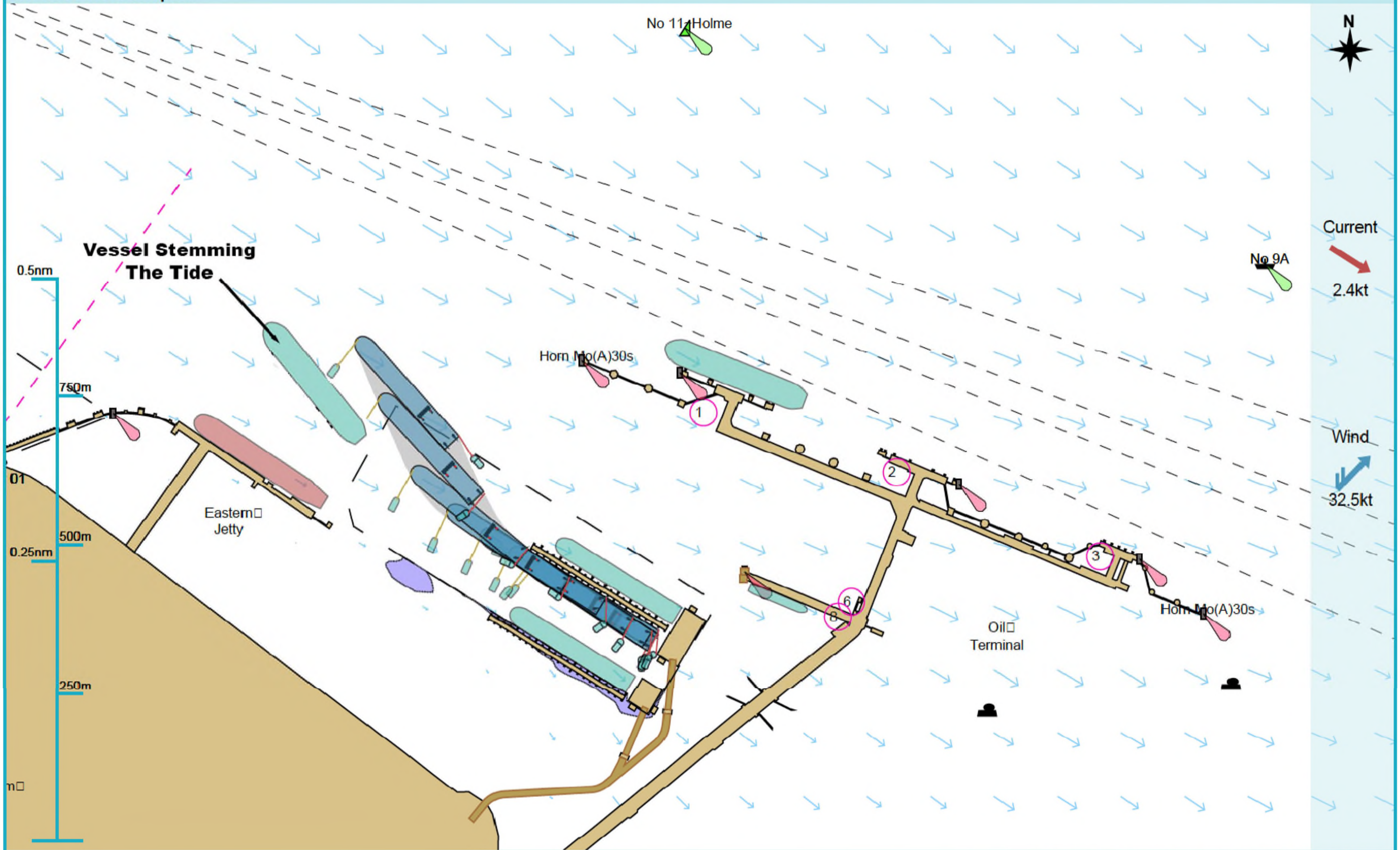
Departure Ebb

Manoeuvre track plot



Ships plotted every 1 mins, highlight every 10 mins

Manoeuvre track plot



Ships plotted every 1 mins, highlight every 10 mins

DFDS COMMENTS ON D3 SUBMISSION

APPENDIX 2

ABLE MARINE MATERIAL CHANGE NRA

APPENDIX UES14-1

NAVIGATION RISK ASSESSMENT

ABLE MARINE ENERGY PARK
(Material Change 2 – TR030006)

ABLE UK

ABLE HUMBER MARINE ENERGY PARK NRA UPDATE

Report Number:	21UK1704
Issue:	Issue 01
Date:	14 June 2021

MARINE AND RISK CONSULTANTS LTD

ABLE UK

ABLE HUMBER MARINE ENERGY PARK NRA UPDATE

Prepared for: Able UK

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14 June 2021

EXECUTIVE SUMMARY

Able UK has requested Marine and Risk Consultants Ltd (Marico Marine) undertake a Navigation Risk Assessment (NRA) of the Able Marine Energy Park (AMEP) development on the river Humber following an application for a material change to the consented development under Schedule 6 of the Planning Act 2008 and Part 2 of the Infrastructure Planning (Changes to, Revocation of, Development Consent Orders) Regulations 2011.

An NRA was previously completed in 2011 and submitted in support of the DCO application: the Able Marine Energy Park Development Consent Order (DCO) 2014 (Statutory Instrument 2014 No. 2935). The NRA assessed the development as authorised.

This NRA considers the direct impacts resulting from the presence of the proposed amended project and associated construction vessels and dredging activities to commercial, recreational and fishing vessels. The proposed activities associated with the Project have been assessed and it has been concluded that the Project should have a minimal effect on the existing risk profile which should be managed and contained, assuming compliance with embedded mitigation and regulations governing movements, pilotage, towage, VTS and procedures.

A general decrease in risk scores is noted across all hazard categories when compared to the NRA undertaken in 2011 in support of the original DCO application. Factors influencing this decrease in risk score include:

- An overall decline in Humber vessel transits past the Project (>50% reduction in passing transits from AIS) (**Section 3.3**);
- Improvement of the Humber-wide SMS and implementation of embedded mitigations over time;
- The embedding of many originally proposed additional mitigation measures into the project design (**Section 5**);
- The review and associated reduction in construction phase vessel movements associated with dredging activities identified within scoping;
- The simplification of the quay design via the removal of the specialist berth (**Section 2**)**;** and
- The reduction of cumulative projects considered within the 2011 NRA that were not taken forward (**Section 4.1**).

Although all hazards were scored as ALARP or lower, it is recommended that consideration is given to the implementation of the recommended possible additional risk control measures to further reduce the hazards to which they apply, particularly those within the ALARP band which should be reduced unless there is a disproportionate cost relative to the benefits obtained.

CONTENTS

FIGURES

TABLES

ANNEXES

ABBREVIATIONS

Abbreviation	Detail
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
AMEP	Able Marine Energy Park
AHPL	Able Humber Ports Limited
BHD	Backhoe Dredger
CCTV	Closed Circuit Television
CHA	Competent Harbour Authority
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
COMAH	Control of Major Accident Hazards
DWT	Deadweight Tonnes
EIA	Environmental Impact Assessment
ES	Environmental Statement
FSA	Formal Safety Assessment
HES	Humber Estuary Services
HLV	Heavy Lift Vessel
HW	High Water
ICW	In Collision With
IMO	International Maritime Organisation
INS	Information Service
kt	Knot (unit of speed equal to nautical mile per hour, approximately 1.15 mph)
LOA	Length Over-All
LW	Low Water
m	Metre
Marico Marine	Marine and Risk Consultants Ltd
MSMS	Marine Safety Management System
MCA	Maritime and Coast Guard Agency
ML	Most Likely
MLA	Marine Licence Application
nm	Nautical Mile
NRA	Navigation Risk Assessment

Abbreviation	Detail
PMSC	Port Marine Safety Code
PWC	Personal Watercraft
RHIB	Ridged Hulled Inflatable Boat
SHA	Statutory Harbour Authority
SHB	Split Hopper Barge
TOS	Traffic Organisation Service
TSHD	Trailing Suction Hopper Dredger
VHF	Very High Frequency (radio communication)
VTS	Vessel Traffic Services
WC	Worst Credible
WIV	Wind Installation Vessel

1 INTRODUCTION

Able UK has requested Marine and Risk Consultants Ltd (Marico Marine) undertake a Navigation Risk Assessment (NRA) of the Able Marine Energy Park (AMEP) development on the river Humber following an application for a material change to the consented development under Schedule 6 of the Planning Act 2008 and Part 2 of the Infrastructure Planning (Changes to, Revocation of, Development Consent Orders) Regulations 2011.

An NRA[1] was previously completed in 2011[2] and submitted in support of the DCO application: the Able Marine Energy Park Development Consent Order (DCO) 2014 (Statutory Instrument 2014 No. 2935). The NRA assessed the development as authorised.

This NRA considers the direct impacts resulting from the presence of the proposed amended project and associated construction vessels and dredging activities to commercial, recreational and fishing vessels. However, comments will additionally be made on the impacts to the wider river area and cumulative impacts, where applicable.

Material amendments of significance to shipping and navigation are detailed below:

- Amendments to the quay line including:
  - Removal of the specialist berth at the southern end of the quay; and
  - Creation of a 61 m x 288 m recess in the quay line at the northern end of the quay to accommodate a barge berth of -11m CD to allow for the possibility of end load in and load out of cargo.

It should be noted, the Scoping Opinion and subsequent preliminary environmental information considered an increased number and duration of vessel movements compared to the original EIA and this was associated with an increased usage of deposit sites within the Humber Estuary. This reflected the fact that in the consented scheme, 1.1M tonnes of dredged clay was to be disposed of to terrestrial areas landward of the existing Killingholme Marshes flood defence wall, whereas it is now proposed that this material is disposed of within the Humber Estuary. Subsequent review has determined that vessel movements associated with the construction phase are actually equivalent or slightly reduced

[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-000402-14.2%20-%20Navigation%20Risk%20Assessment.pdf

2 BMT Isis (2011) TR030001-000402-14.2 – Navigation Risk Assessment

when compared to the consented scenario (**Table 3**). The impact of increased vessel movements associated with an increased usage of deposit sites identified within the scoping study has, therefore, been scoped out of assessment within this NRA. No materially different construction operations are proposed and no increase in the overall dredge tonnage is predicted.

Given that the previous NRA was undertaken over ten years ago, a review of the baseline vessel traffic profile will additionally be undertaken to establish any large-scale changes in vessel activity. The NRA methodology will additionally be reviewed and updated in accordance with current industry best practice in agreement with ABP Humber.

1.1 REFERENCE DOCUMENTS AND GUIDANCE

The NRA has been undertaken drawing on the input data and documents outlined within **Table 1**.

Table 1: Reference Documents

Document Reference	Description
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030006/TR030006-000009-TR030006%20-%20Scoping%20Report.pdf	Scoping Report
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030006/TR030006-000036-TR030006%20%E2%80%93%20Scoping%20Opinion.pdf	Scoping Opinion
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-000402-14.2%20-%20Navigation%20Risk%20Assessment.pdf	2011 DCO Navigation Risk Assessment
https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-000319-14%20-%20Navigation.pdf	Chapter 14 – Navigation, Environmental Statement
21UK1704_AU_PEIR_21_02	Preliminary Environmental Impact Report (PEIR)
210428A – Construction Vessel Movements.pdf	Construction phase vessel movements schedule including dredging programme

Document Reference	Description
AME-029-00000 DCO Boundary Layout.pdf	DCO boundary layout drawing

1.2 GUIDANCE

The NRA has been conducted based on the Formal Safety Assessment (FSA)[3] approach to risk assessment utilising a combination of data analysis and stakeholder/expert judgement to determine risk levels.

Applicable guidance that has informed the assessment of risk is given within **Table 2**.

Table 2: Guidance

Guidance	Description
Harbour Works Consent Procedures	ABP harbour works consents procedures and guidance setting out consents procedures for the carrying out of works below mean high water marks.
IMO (2018) Revised Guidelines for Formal Safety Assessment (FSA) MSC-MEPC.2/Circ.12/Rev.2	Guidelines for undertaking International Maritime Organisation (IMO), Formal Safety Assessment Compliant Navigation Risk Assessments.
International Regulations for Preventing Collisions at Sea 1972 (as amended) (ColRegs)	Guidance to prevent collisions at sea.
Marine Works (Environmental Impact Assessment) Regulations 2007 No.1518	Regulations governing EIA's for marine works licence consent.

2 PROJECT DESCRIPTION

2.1 STUDY AREA

The proposed material change to the AMEP development layout and associated DCO boundary area are shown within **Figure 1**.

[3] IMO (2018) Revised Guidelines for Formal Safety Assessment (FSA) MSC-MEPC.2/Circ.12/Rev.2

The 2011 NRA considered a study area from Immingham Oil Terminal to King George Dock. The study area for the purposes of the NRA Update and Updated ES has been extended as shown in **Figure 4** to **Figure 14** to incorporate the dredge deposit sites. However, additional comments will be made on the impacts to the wider river area where applicable for consideration of cumulative impacts.

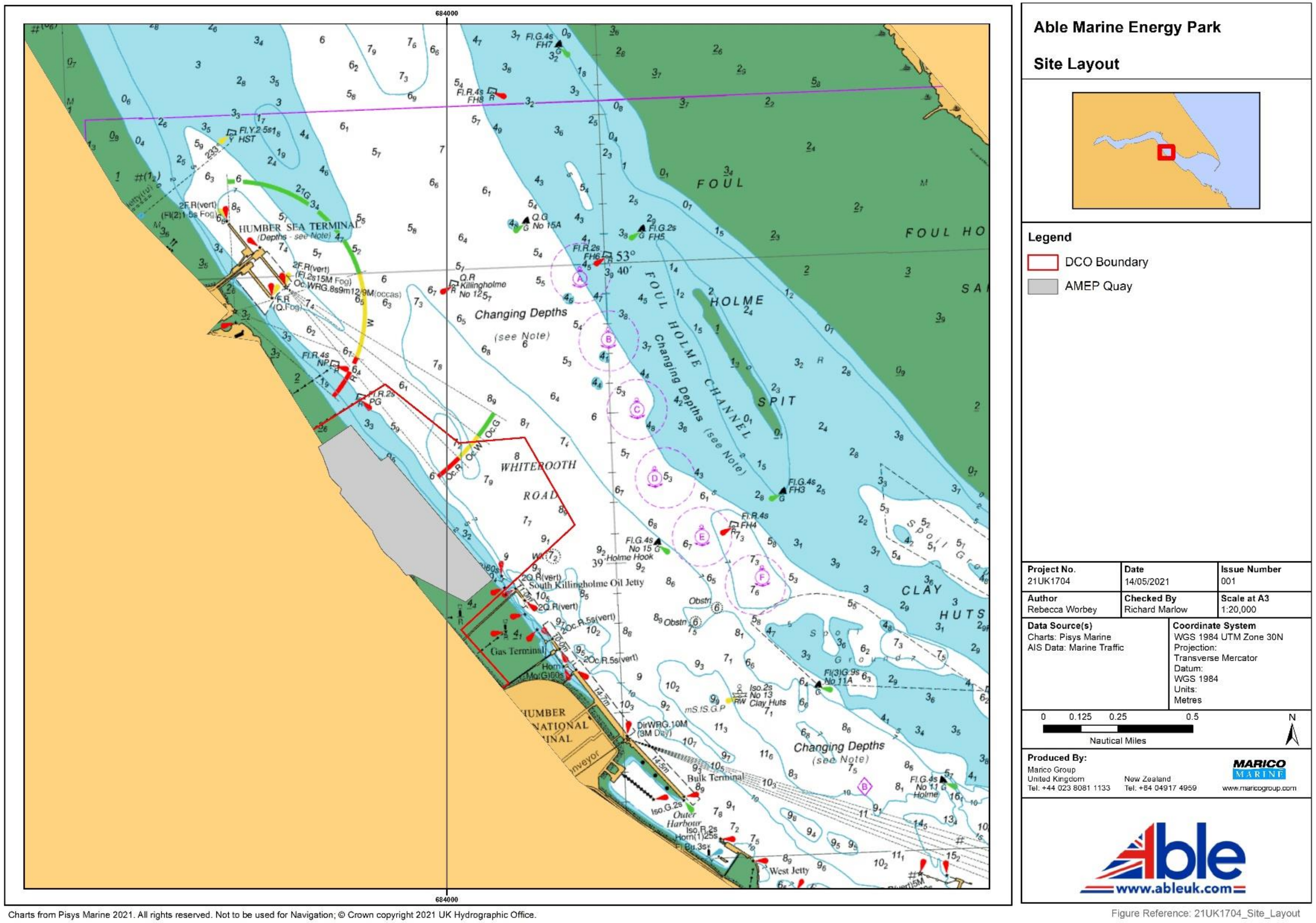


Figure 1: Amended Able Marine Energy Park Layout.

2.2 LIFECYCLE AND PHASING

The NRA has considered two distinct development phases:

- The Construction Phase (see **Chapter 2.2.1**), including:
    - Construction of quay; and
    - Dredging.
- The Operation Phase (see **Chapter 2.2.2**), including:
    - Additional vessel movements associated with operational site activities.

2.2.1 Construction Phase

Dredging will be undertaken during the construction phase of the project. For the purposes of this assessment, dredging is assumed to comprise the following operations:

- A small TSHD (1500m3 hopper capacity) removing c.370,000 m3 of soft material, sands and gravels from the berthing pocket and approaches to facilitate access for other construction plant in one campaign disposing at HU080;
- A BHD or CSD with 3 barges excavating and transporting c1.17m m3 clays from the berthing pocket and approaches to HU081 and HU082 in two campaigns to reflect the sectional completion of the quay; and
- A large TSHD (8000m3 hopper capacity) removing c.430,000 m3 of glacial material, sands and gravels from the berthing pocket and approaches to HU080 to enable full operation of the facility.

Alternative scenarios may occur in practice, so the sensitivity of the risk assessment to alternatives that give rise to additional vessel movements is addressed later in this report at **Section 8.1.1**.

The total volume of dredge arisings is calculated to be approximately 1.6M Tonnes if anchor piles are used and 2M tonnes if flap anchors are used to tie back the quay wall.

Erodible material removed using a TSHD will be deposited at HU080. Inerodible material removed by BHD or CSD will be deposited either at HU081 or HU082 with the available capacity of HU081 and HU082 assessed to be 550,000m^3 and 590,000m^3 respectively.

In addition, aggregate (hydraulic fill) will be imported from offshore dredge areas to provide fill material for the construction site using a medium sized TSHD. These vessels will therefore arrive loaded and depart in ballast.

Anticipated construction phase vessel movements are shown in **Table 3**. Total movements proposed during the construction phase are anticipated to be 5,464 over 28 months equating to an average of

6.5 additional movements per day with a peak of 27 movements per day during peak daily dredging which will occur during back-hoe or cutter-suction dredging operations with barges assumed to operate to the programme shown in **Figure 2.**

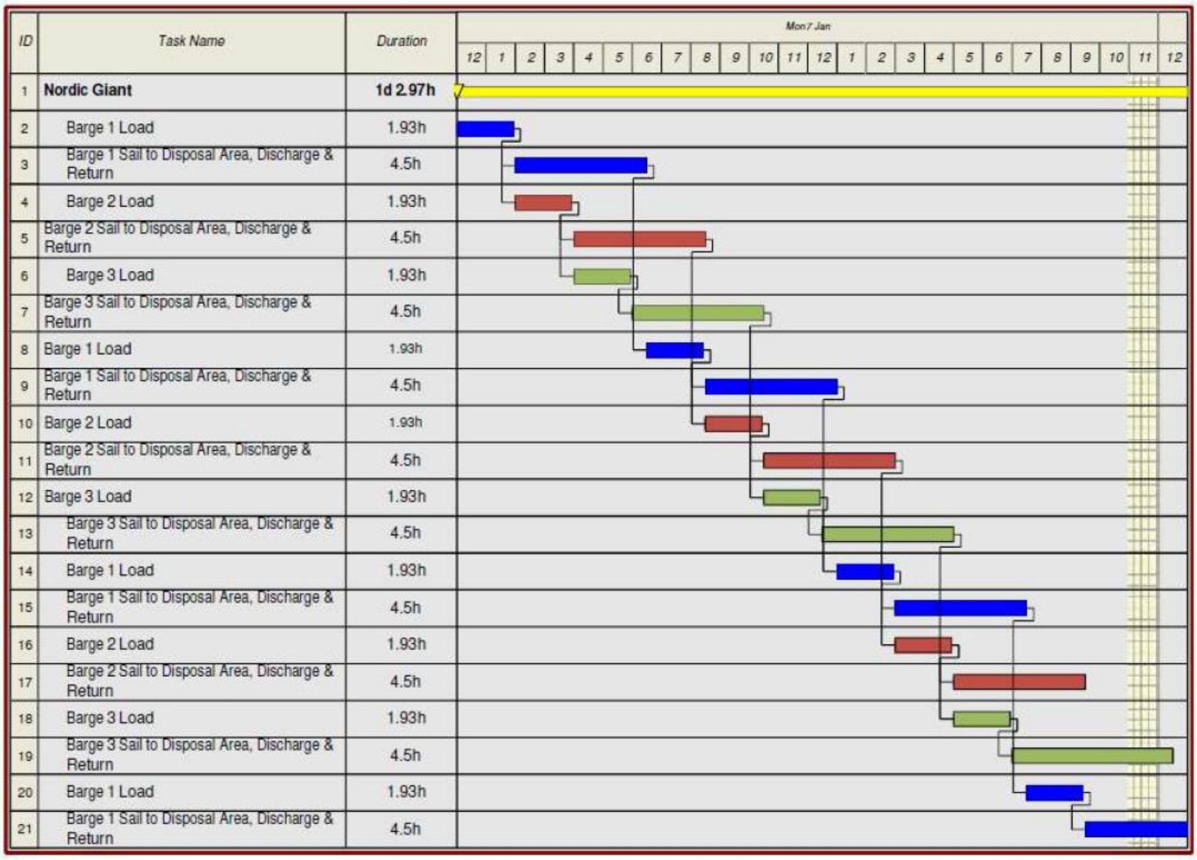
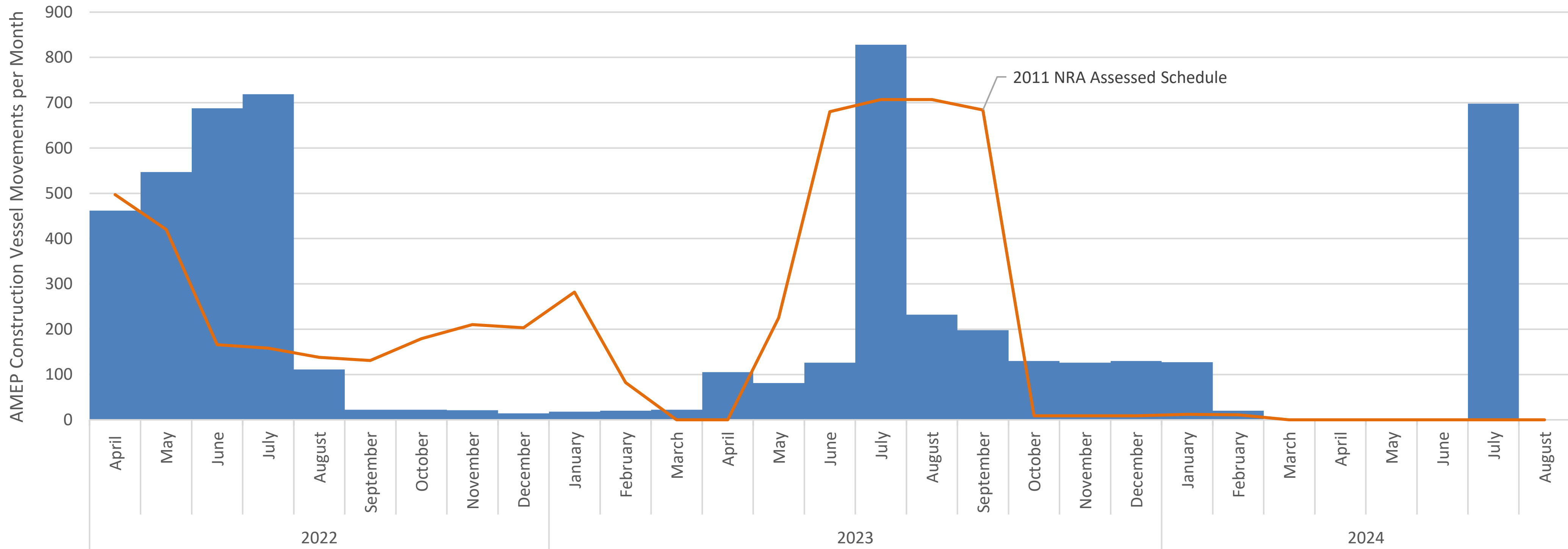


Figure 2: Back-hoe and Split Barges Daily Programme (Source: Able UK)

Table 3: Construction Phase Vessel Movements

		2022									2023												2024								
Equipment	Application	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Vessels Importing Hydraulic Fill																															
TSHD 1	Importing Fill													3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5								
Operating Days/Month														30	23	30	31	31	30	31	30	31	30								
Total Vessel Movements per Month														**105**	**81**	**105**	**109**	**109**	**105**	**109**	**105**	**109**	**105**								**1,040**
Dredging Vessels																															
TSHD 2	Dredging / disposal	15.4	15.4																												
TSHD 3	Dredging / disposal																	6	6												
Operating Days/Month		30	18															17	12												
BH1	Operating Only on Site																0												0		
SB1	Transport to Disposal		7.5	7.5	7.5	7.5											7.5												7.5		
SB2	Transport to Disposal		7.5	7.5	7.5	7.5											7.5												7.5		
SB3	Transport to Disposal		7.5	7.5	7.5												7.5												7.5		
Operating Days/Month			12	30	31	6											31												31		
Total Vessel Movements per Month		**462**	**547**	**675**	**698**	**90**											**698**	**102**	**72**										**698**		**4,041**
Supply Vessels to the Installation Rigs																															
GE1_WR	Operating Only on Site																														
MP1 + Tug	Transporting Material			0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7			0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7							
Operating Days/Month				18	31	30	31	31	30	20	25	28	31			30	31	31	30	31	30	31	31	28							
Total Vessel Movements per Month				**13**	**22**	**21**	**22**	**22**	**21**	**14**	**18**	**20**	**22**			**21**	**22**	**22**	**21**	**22**	**21**	**22**	**22**	**20**							**384**
All Vessels																															
Total Vessel Movements per Month		**462**	**547**	**688**	**719**	**111**	**22**	**22**	**21**	**14**	**18**	**20**	**22**	**105**	**81**	**126**	**828**	**232**	**198**	**130**	**126**	**130**	**127**	**20**					**698**		**5,464**
Assessed 2011 NRA Total Vessel Movements		497	420	166	158	138	131	179	210	203	282	82			225	680	707	707	684	9	9	9	12	11							**5,518**



2.2.2 Operation Phase

The proposed vessel movements during the operational phase are shown in **Table 4.** A slight reduction in vessel movements is noted in comparison to the consented design due to the elimination of specialist vessel berth (**Figure 1**).

Table 4: Operational Phase Vessel Movements

Consented Scenario			New NRA		
Vessel Type	Annual Number of Trips	Annual Number of Movements	Vessel Type	Annual Number of Trips	Annual Number of Movements
Foundation Transfer Vessel	12	24	N/A	0	0
Installation Vessel	100	200	Installation Vessel	100	200
1,500 Tonne Support Vessel	100	200	1,500 Tonne Support Vessel	100	200
6,000 - 10,000 Tonne Cargo Ship	50	100	6,000 - 10,000 Tonne Cargo Ship	50	100
	262	**524**		**250**	**500**

Indicative vessel types anticipated to berth at the AMEP quay during the operational phase are shown in **Figure 3.** The offshore wind Ro-Ro vessels with a carrying capacity of approximately 8888 t DWT, a draft of between 6 and 7 meters, an approximate length overall (LOA) of 141.6 meters and beam of 20.6 meters are proposed.

Figure 3: ROTRA VENTE and ROTRE MARE, Siemens Gamesa

3 BASELINE NAVIGATION SCENARIO

Almost one quarter of the UK's seaborne trade, by tonnage, passes through the Humber; this includes 25 per cent of the country's natural gas and 25 per cent of its refined petroleum products with the port handling in the region of 30,000 international shipping movements each year[4].

Associated British Ports (ABP) operates four ports on the River Humber - Hull, Goole, Grimsby and Immingham of which Grimsby and Immingham are within the assessment study area. ABP is also the Statutory and Competent Harbour Authority (SHA / CHA) overseeing navigation for the whole Humber Estuary.

A wide range of industrial works are situated on or near the estuary including non-ABP ports, oil refineries, chemical plants and power generation facilities. These include the Immingham Oil Terminal (IOT), Associated Petroleum Terminals (APT), South Killingholme Oil Jetty and the C.Ro Port (Killingholme, generally known as Humber Sea Terminals [HST]) within the study area.

The Humber Passage Plan, developed to facilitate the safe movement of large vessels in the Humber, applies to all vessels of over 40,000 DWT or with a draught greater than 11 metres and to gas carriers of over 20,000m^3 irrespective of draught.

ABP Humber Estuary Services (HES) monitor navigation safety and provide advice to vessels within the estuary through its Vessel Traffic Services (VTS). HES Is the CHA providing pilotage for all traffic using the Humber Estuary. Additionally, a Marine Safety Management System (MSMS) is operated by HES in accordance with the Port Marine Safety Code (PMSC).

Able Humber Ports Limited will have responsibility as a statutory harbour authority over the AMEP berths and immediate approaches; however, ABP by virtue of the Humber Conservancy Acts (1852-1907) and the Harbour Reorganisation Scheme 1966, will remain the Conservancy and Navigation Competent Harbour Authority for the River Humber (including the Lower Trent to Gainsborough) in addition to the Local Lighthouse Authority (Merchant Shipping Act 1894).

The original assessment of commercial and recreational navigation was produced more than 10 years ago in 2011 requiring a review and update of the baseline to assess any new or different significant effects. Data gathering has been undertaken in order to inform the review of the baseline navigation profile.

[4] ABP Humber Estuary Services Website (2021)

Indicative tidal heights for January 2020, to coincide with the duration of commercially sourced AIS data (**Section 3.1**) is shown in **Table 5**. Spring tides are typically up to 6.9m at Hull while neap tides are typically up to 3.5m. Data from the on-line gauges is transmitted continuously to Vessel Traffic Services (VTS) at Spurn, for the benefit of river users. This is especially useful when a negative surge occurs which may result in a tidal level more than ½ metre below that predicted.

Table 5: Indicative Tidal Heights –Humber Sea Terminals (Admiralty Total Tide) – January 2020

Date	High	Height (m)	Low	Height (m)
16/01/2020	10:00	6.8	04:01	1.1
	22:02	7	16:02	1.6
17/01/2020	10:56	6.5	04:52	1.4
	22:59	6.7	16:53	2
18/01/2020	00:12	6.4	07:02	2
	13:18	6	19:16	2.5
19/01/2020	00:12	6.4	07:02	2
	13:18	6	19:16	2.5
20/01/2020	01:36	6.2	08:15	2
	14:27	6.1	20:38	2.4
21/01/2020	02:49	6.3	09:20	2
	15:28	6.3	21:47	2.1
22/01/2020	03:54	6.4	10:17	1.9
	16:21	6.5	22:45	1.8
23/01/2020	04:50	6.6	11:06	1.7
	17:06	6.8	23:35	1.5
24/01/2020	05:38	6.7	11:50	1.6
	17:48	6.9	-	-
25/01/2020	06:22	6.8	00:20	1.4
	18:27	7.1	12:30	1.6

Date	High	Height (m)	Low	Height (m)
26/01/2020	07:01	6.8	01:02	1.3
	19:04	7.1	13:07	1.6
27/01/2020	07:36	6.7	01:40	1.3
	19:38	7.1	13:41	1.6
28/01/2020	08:09	6.6	02:14	1.4
	20:10	7	14:12	1.7
29/01/2020	08:40	6.5	02:44	1.5
	20:41	6.9	14:42	1.8

3.1 INPUT DATA

The following input data has been utilised for the assessment:

- Stakeholder consultation Feedback;
- Four weeks' AIS Data:
  - Two weeks between 12 to 25 August 2019; and
  - Two weeks between 16 to 29 January 2020;
- DfT port statistics; and
- Historical incident data.

It was noted in consultation with ABP HES that 2020 is considered largely unrepresentative of the typical traffic profile of the port owing to Coronavirus. AIS data was therefore selected from August 2019 and January 2020 (pre-coronavirus) to more accurately reflect the current traffic profile.

3.2 STAKEHOLDER CONSULTATION

Information was gathered through consultation with key local stakeholders, including the Harbour Master, to establish the baseline risk profile and inform impact and hazard identification.

Stakeholders consulted as part of the NRA are listed in **Table 6**. The minutes of the stakeholder meetings are contained within **Annex B**.

Table 6: Stakeholder Consultation Meetings

Date of Meeting	Stakeholder	Comments	Response	Reference
14 April 21	ABP HES	The wind cats transiting to and from Grimsby represent a new activity since the last NRA was undertaken.	Noted.	-
		Wind farm vessels transporting wind turbine equipment heading to Greenport Hull represent a new activity since the last NRA was undertaken.	Change in traffic considered within the baseline analysis.	**Section 3.3**
			Change in baseline considered within updated risk assessment scoring.	**Section 8**
		Greenport Hull has commenced operation since the previous NRA.	Change in traffic considered within the baseline analysis.	**Section 3.3**
			Change in baseline considered within updated risk assessment scoring.	**Section 8**
		Hull Riverside Bulk Terminal was not built; however was in planning at the time of the last NRA and so may have been considered within the cumulative assessment.	Cumulative impacts reviewed.	**Section 4.1**
		Sunk dredge deepening was in the planning during the last NRA assessment but has not been undertaken.	Cumulative impacts reviewed.	**Section 4.1**
		There are no planned future developments within the study area.	Cumulative impacts reviewed.	**Section 4.1**
		Passenger vessels passing the site are likely the Pride of Hull and Pride of Rotterdam, but one of the Hull passenger services has recently ceased (since the last NRA and AIS data obtained).	Change in traffic considered within the baseline analysis.	**Section 3.3**
			Change in baseline considered within updated risk assessment scoring.	**Section 8**
		No significant change to the prevalence of the fishing industry since the last NRA.	Noted.	-
		No significant change in leisure movements since last NRA.	Noted.	-

Date of Meeting	Stakeholder	Comments	Response	Reference
		Overall, there has been approximately a 10% decline in vessel movements across the estuary which has been lower still during 2020 as a result of COVID-19.	Change in traffic considered within the baseline analysis.	**Section 3.3**
			Change in baseline considered within updated risk assessment scoring.	**Section 8**
		Traffic largely passes well clear of the development. Vessels bound for Humber Sea Terminals will be most impacted; however, it is anticipated that the impact should not be dissimilar to that previously assessed.	Construction phase risk assessment reviewed and updated.	**Section 8**
			Operational phase risk assessment reviewed and updated.	**Section 8**
		As far as ABP is aware there have not been any new COMAH developments since the 2011 NRA.	Noted.	-
		Mooring study should be undertaken by the berth operators / new HA to ensure adequate arrangements (Breakout Hazard mitigation).	Mooring Study recommended as a possible additional mitigation measure.	**Section 9**
		Care should be undertaken when disposing of dredge deposits at HU082/HU081 to ensure that the deposits do not encroach the channel.	Dredge Disposal Plan recommended as a possible additional mitigation measure.	**Section 9**
		An agreed plan will need to be established in advance for the disposal of dredge materials.	Schedule 8, paragraph 45 of the DCO already requires a dredge and disposal strategy to be agreed with the MMO before the commencement of disposal activities.	**Section 9**
		HES is particularly concerned to ensure pilot allocation to dredgers is fairly managed to avoid disruption to other customers. (Dredgers may need to have PEC holders on board or wait for pilot availability).	Sufficient availability of pilots recommended as a possible additional mitigation measure, but this will be for HES to manage.	**Section 9**

Date of Meeting	Stakeholder	Comments	Response	Reference
		As the Harbour Authority, AHPL will have to develop their own Marine Safety Management System, and ownership of responsibilities will need to be clear.	Schedule 9, paragraph 20 already requires AHPL to submit a to the Harbourmaster for approval, a written statement of proposed safe operating procedures.	**Section 9**
15 April 21	ABP Immingham	AIS data reflects expected traffic profile.	Noted.	-
		No recent navigational incidents within the study area.	Historical incidents reviewed.	**Section 3.4**
		Likely to be sedimentation issues with the new recessed barge berth becoming a sediment trap and increasing grounding risk of project vessels. Dredge levels will need to be maintained through regular maintenance dredging.	Additional surveys of study area recommended as a possible additional mitigation measure.	**Section 9**
		Tug availability may be an issue.	Noted.	-
		Hazards should be adequately managed / mitigated by HES and passage planning.	Noted.	**Section 5**
		Mooring study should be undertaken by the berth operators / new HA to ensure adequate arrangements (Breakout Hazard mitigation).	Mooring Studies recommended as a possible additional mitigation measure.	**Section 9**
		Can't see a need for additional simulation.	Noted.	-
		No future developments planned for consideration within the cumulative assessment.	Cumulative impacts reviewed.	**Section 4.1**
		There have not been any new COMAH developments since the 2011 NRA that would require inclusion within the NRA update.	Noted.	-
		MC noted that Goole, Hull and Immingham including the Able development have been granted free-port status and therefore the traffic levels may increase in the future.	Cumulative impacts reviewed.	**Section 4.1**

Date of Meeting	Stakeholder	Comments	Response	Reference
15 April 21	Exolum /Associated Petroleum Terminals (APT)	The development is in a very busy part of the Humber. RoRo traffic into HST will be passing very close to the DCO area. Interactions with SKJ, for example, simultaneous berthing, will need to be considered.	Restrict simultaneous movements recommended as a possible additional mitigation measure.	**Section 9**
		Overall, there has been a reduction in vessel traffic in the Humber.	Change in traffic considered within the baseline analysis.	**Section 3.3**
		SKJ – received 173 ships last year: 178 in 2019, 214 in 2018 and 243 in 2017. First quarter berth occupancy figures for 2021 show an increase on 2020.	Change in traffic considered within the baseline analysis.	**Section 3.3**
		Spring line parted on a ship berthed on SKJ in 2019 due to interaction with vessel going up to HST.	Hazard 'Break-out' assessed as part of NRA.	**Section 8**
		Sedimentation levels and the impact that they may have on the dredge pocket off SKJ, and the areas behind the jetties used by mooring boats, is a concern. Currently there is little maintenance dredging required around SKJ which needs to be maintained to -11m. Sedimentation of approach channels may also be an issue.	Additional surveys of study area recommended as a possible additional mitigation measure.	**Section 9**
		Extra siltation would negatively impact access to the mooring dolphins at SKJ. If siltation was such that it prevented access by boat then jetties would need to be fitted.	Additional surveys of study area recommended as a possible additional mitigation measure.	**Section 9**
		The proposed frequency of vessel movements in the operational phase (approximately 1 per day) look to be reasonable.	Noted.	-
		Mooring study should be undertaken by the berth operators / new HA to ensure adequate arrangements.	Mooring Study recommended as a possible additional mitigation measure.	**Section 9**

Date of Meeting	Stakeholder	Comments	Response	Reference
		Mitigation measures proposed within 2011 NRA look reasonable.	Noted.	-
20 April 21	MCA	The development is fully within ABP Humber harbour limits. The MCA expects the proposed assessment methodology for 'Commercial and Recreational Navigation' to be updated for the revised Environmental Statement, and on the understanding Associated British Ports Ltd (ABP) as the Statutory Harbour Authority for the Humber Estuary remains fully consulted, is content with the NRA and that the NRA complies with PMSC requirements, the MCA is unlikely to have any concerns at this time.	Noted.	-
		To address the ongoing safe operation of the marine interface for this project, MCA would point developers in the direction of the Port Marine Safety Code (PMSC) and its Guide to Good Practice. They will need to liaise and consult with the Statutory Harbour Authority and develop a robust Safety Management System (SMS) for the project under this code.	Marine Safety Management System recommended as a possible mitigation measure	**Section 9**
		Final drawings should be submitted to the UKHO. Charts should be updated.	Update Navigation Charts included as an embedded mitigation measure.	**Section 5**
		Appropriate information should be circulated to interested parties.	Promulgation of Information including Notice to Mariners included as an embedded mitigation measure.	**Section 5**
		Trinity House should be consulted regarding changes to Aids to Navigation and any other aspects of relevance identified within the NRA.	Marking and lighting recommended as a possible additional mitigation measure.	**Section 9**
21 April 21	CLdN / C.Ro Ports	Activities (RoRo operations) remain unchanged since previous NRA was undertaken. However, larger vessels (including the "next generation" G9 class vessels at 234m LOA) are now	Change in baseline considered within updated risk assessment scoring.	**Section 8**

Date of Meeting	Stakeholder	Comments	Response	Reference
		being utilised and therefore they require a larger swinging area when turning to berth.		
		There are six berths at Humber Sea Terminals. Although they are not all currently in use at one time, they may be utilised in the future.	Noted. Cumulative impacts reviewed.	**Section 4.1**
		CLdN expressed concern that the increased demand for pilotage from dredging vessels may impact on other customers and their own operations if the dredgers did not have sufficient PEC holders available. CLdN would expect the Pilotage Authority to manage pilot allocation to ensure existing customers and time critical services were not adversely impacted.	Managed by HES as part of routine operations. Availability of pilots recommended as a possible additional mitigation measure.	**Section 5** **Section 9**
		Communication will be essential at all project stages including between AMEP, the Dredging Contractor, C.Ro and other river users. Communication must particularly be maintained during dredging operations. Delays caused by inability to swing to the berth due to obstruction will have considerable commercial and operational impact.	Promulgation of Information including Notice to Mariners included as an embedded mitigation measure.	**Section 5**
			Dedicated project marine manager recommended as a possible additional mitigation measure.	**Section 9**
		A dedicated project marine movement co-ordinator would be an effective mitigation measure during both construction and operational phases.	Dedicated project marine manager recommended as a possible additional mitigation measure.	**Section 9**
		There is a pinch point at Immingham Oil Terminal. Project dredging vessels (especially less manoeuvrable towed barges, should (if possible) use the 'Foul Holme Channel' to keep clear of larger / scheduled river traffic. Priority should be given to C.Ro and other large vessels berthing at Immingham which operate according to strict timetables and which would be more impacted by delays.	Restrict simultaneous movements recommended as a possible mitigation measure.	**Section 9**

Date of Meeting	Stakeholder	Comments	Response	Reference
-	Humber Workboats	Declined to comment.	-	-
-	UK Dredging	Declined to comment.	-	-

3.3 VESSEL TRAFFIC ANALYSIS

AIS data was commercially sourced, as detailed in **Section 3.1**, to enable the assessment of the current baseline traffic profile in the vicinity of the Project and to undertake quantitative analysis to establish any potential impacts the Project and proposed material change may have upon the existing navigation profile.

Vessels were subdivided into categories relevant to vessel operations within the Humber. The assessed vessel categories are identified within **Table 8.** It should be noted that, while recreational activities are rare, recreational vessels are present in small numbers (**Figure 14**). For consistency, recreational vessels have, therefore, been included within the NRA.

Vessel movement data has additionally been provided by ABP Humber as shown in **Table 7** which indicates 21,651 total vessel movements within the Humber Estuary during 2020.

Table 7: Total Vessel Movements (ABP Humber)

Total Vessel Movements				
2016	**2017**	**2018**	**2019**	**2020**
24,876	25,540	25,637	24,625	21,651

Table 8: Vessel Categories

Category	Description
Tankers	Including product tankers, crude oil tankers, gas carriers, bunker barges.
General Cargo Vessels	Including general cargo, containers, non-liquid bulk carriers, ferries, wind farm construction vessels.
Project Cargo Vessels	Including project cargo vessels and abnormal loads including project barges transporting wind farm infrastructure, for example; monopiles and jackets and vessels cold moved to dock.
Construction Vessels	Including project dredgers, tugs, workboats and other construction vessels.
Workboats/Other	Pilot boats, workboats, dredgers, wind farm support vessels and fishing vessels (not engaged in fishing). Sailing yachts, motor yachts, sailing dinghies, Rigid Hull Inflatable Boats (RHIB) etc.

3.3.1 Analysis by Vessel Type

A two-week representative data period from both summer and winter has been assessed (see **Section 3.1)** to ensure any seasonal variations are captured.

Vessels have been analysed according to vessel type and spatial distribution in **Figure 4** to **Figure 14.** While tankers, passenger vessels and fishing vessels are noted passing clear of the Project and DCO boundary, cargo vessels pass within the DCO boundary en route to Humber Sea Terminals. A total of 83 cargo transits, or approximately 6 per day, intersected the DCO boundary in both summer and winter en route to Humber Sea Terminals.

Figure 12 to **Figure 14** illustrate fishing and leisure vessel transits, which are also included in the workboat / other category (**Figure 10** and **Figure 11**).

This category shows intensive tracks throughout the study area, but these are largely accounted for by tug movements (near harbour facilities) and Pilot vessel movements (approaches to the estuary).

Approximately 50 vessels per day were identified from AIS transiting past the AMEP project site in January 2020 and 58 per day in August 2019. The 2011 NRA estimated approximately 115 transits per day from AIS indicating a greater than 50% reduction in transits. It should, however, be noted that only four days of AIS were obtained for assessment within the 2011 NRA which is not considered a large enough dataset from which to derive trends.

The most common vessel types to transit past the site are cargo vessels accounting for 55% and 70% of traffic in summer and winter respectively, followed by workboat/ other category vessels at 27% and 22%. Fishing vessels accounted for <1% of traffic past the site with only 2 vessels recorded from the one month of AIS data and recreational vessels accounted for 2% of all vessel traffic in summer and were absent in winter. Similarly, passenger vessels show distinct seasonality increasing from 6 transits in winter (<1 per day) to 46 in summer or approximately 3 transits per day.

Transits past the Project are shown by vessel length in **Figure 20** with the most common vessel lengths characteristic of cargo and workboat / other type vessels.

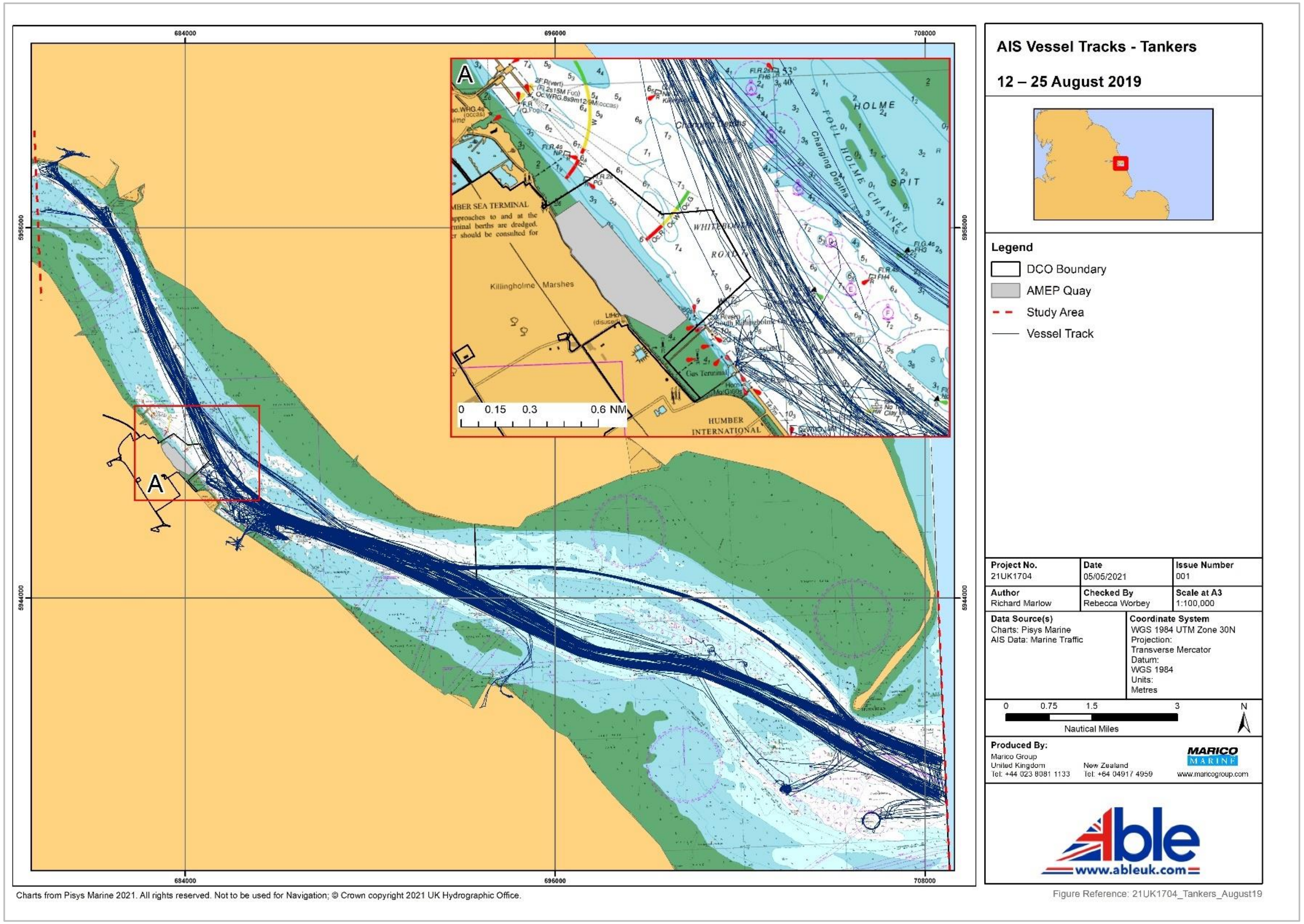


Figure 4: Tanker Vessels (12 – 25 August 2019)

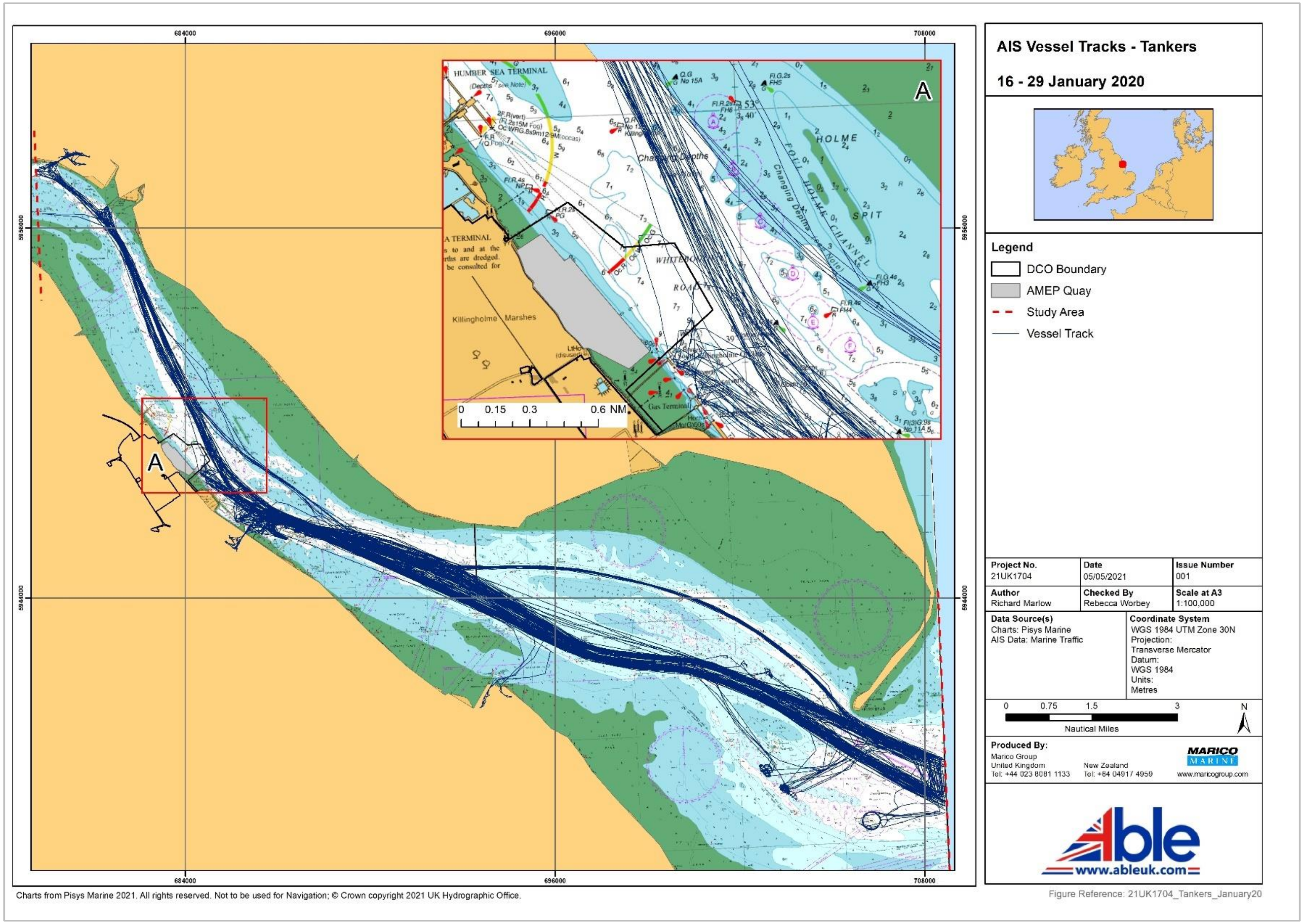


Figure 5: Tanker Vessels (16-29 January 2020)

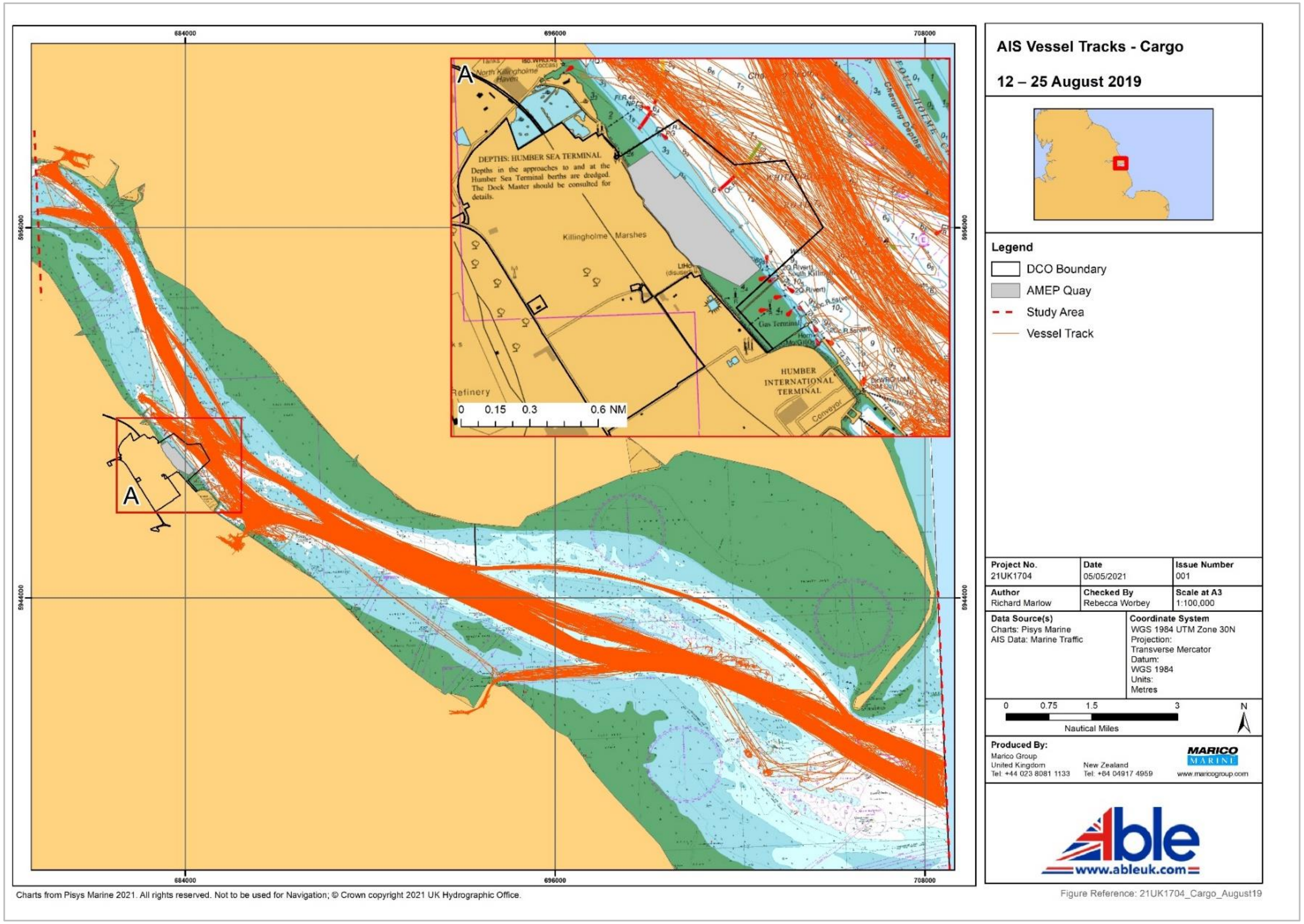


Figure 6: Cargo Vessels (12 – 25 August 2019)

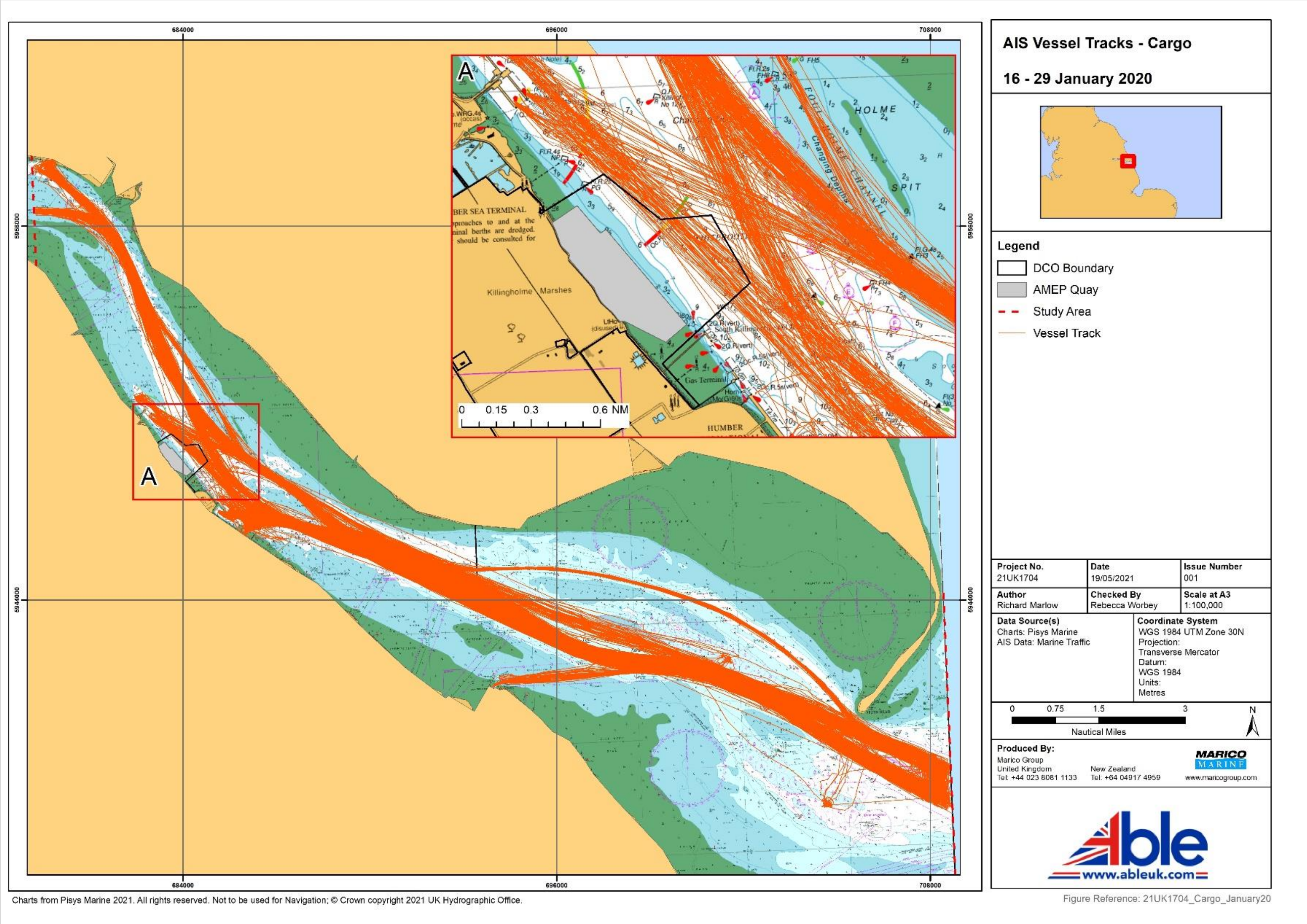


Figure 7: Cargo Vessels (16 – 29 January 2020)

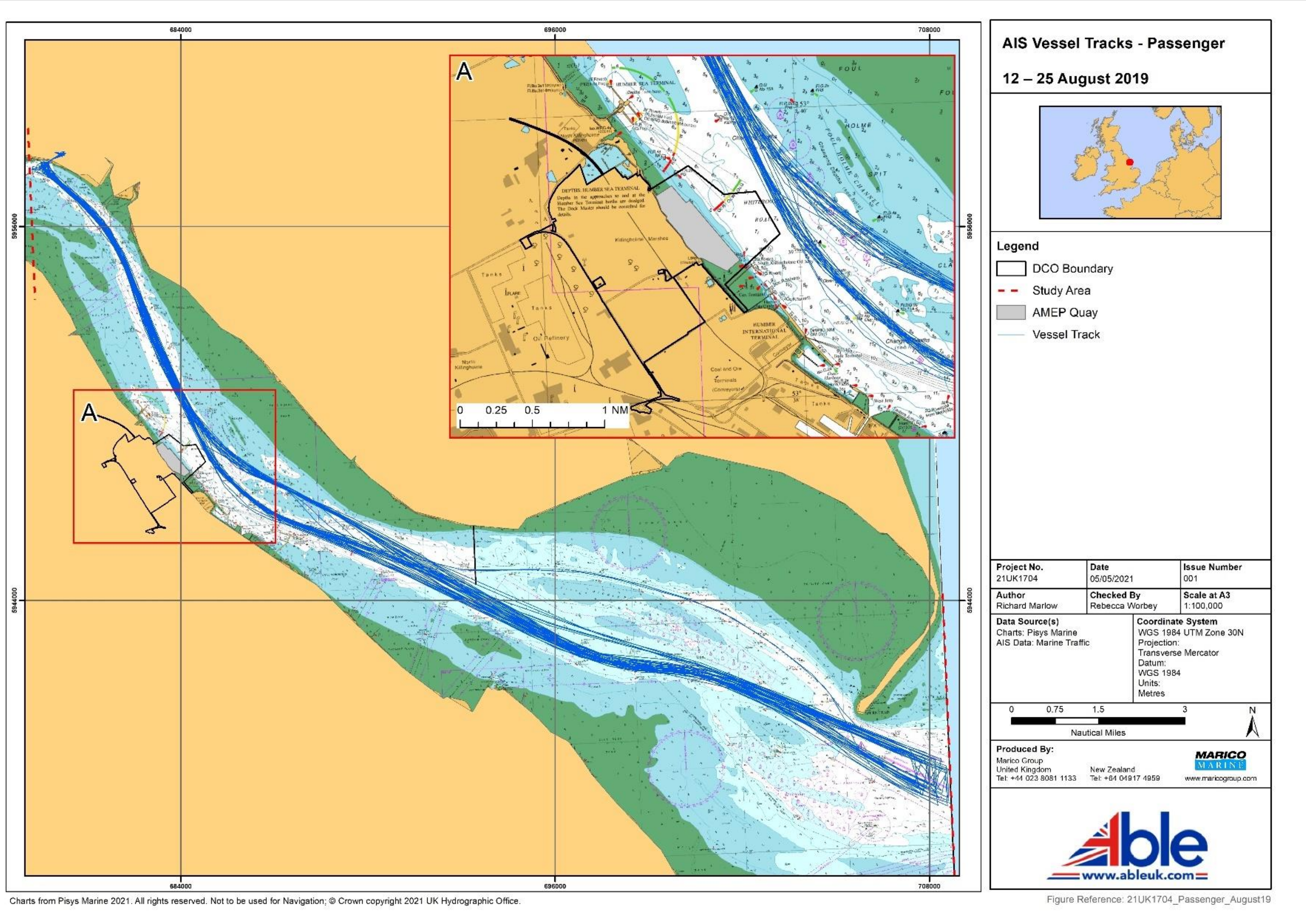


Figure 8: Passenger Vessels (12 – 25 August 2019)

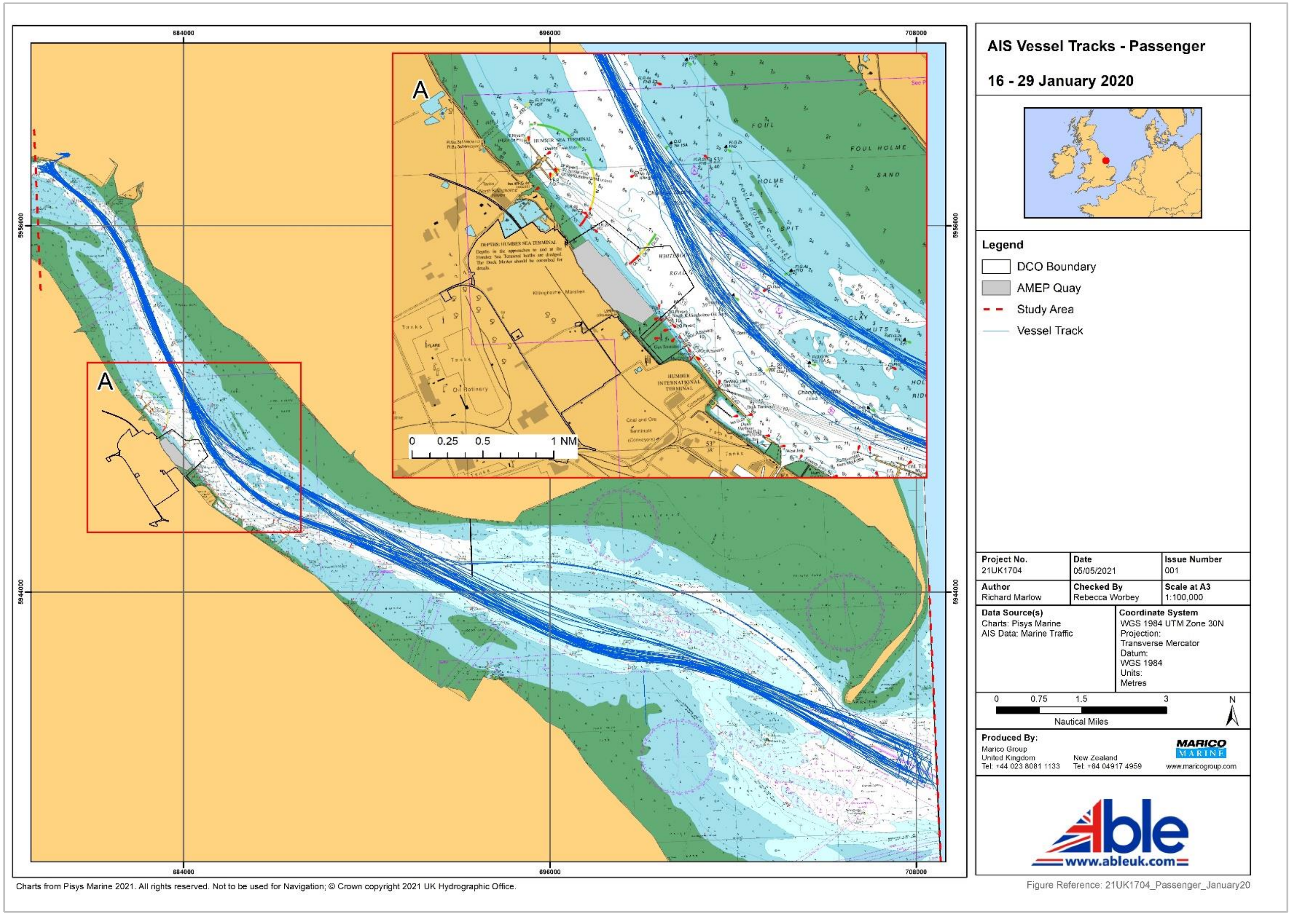


Figure 9: Passenger Vessels (16 – 29 January 2020)

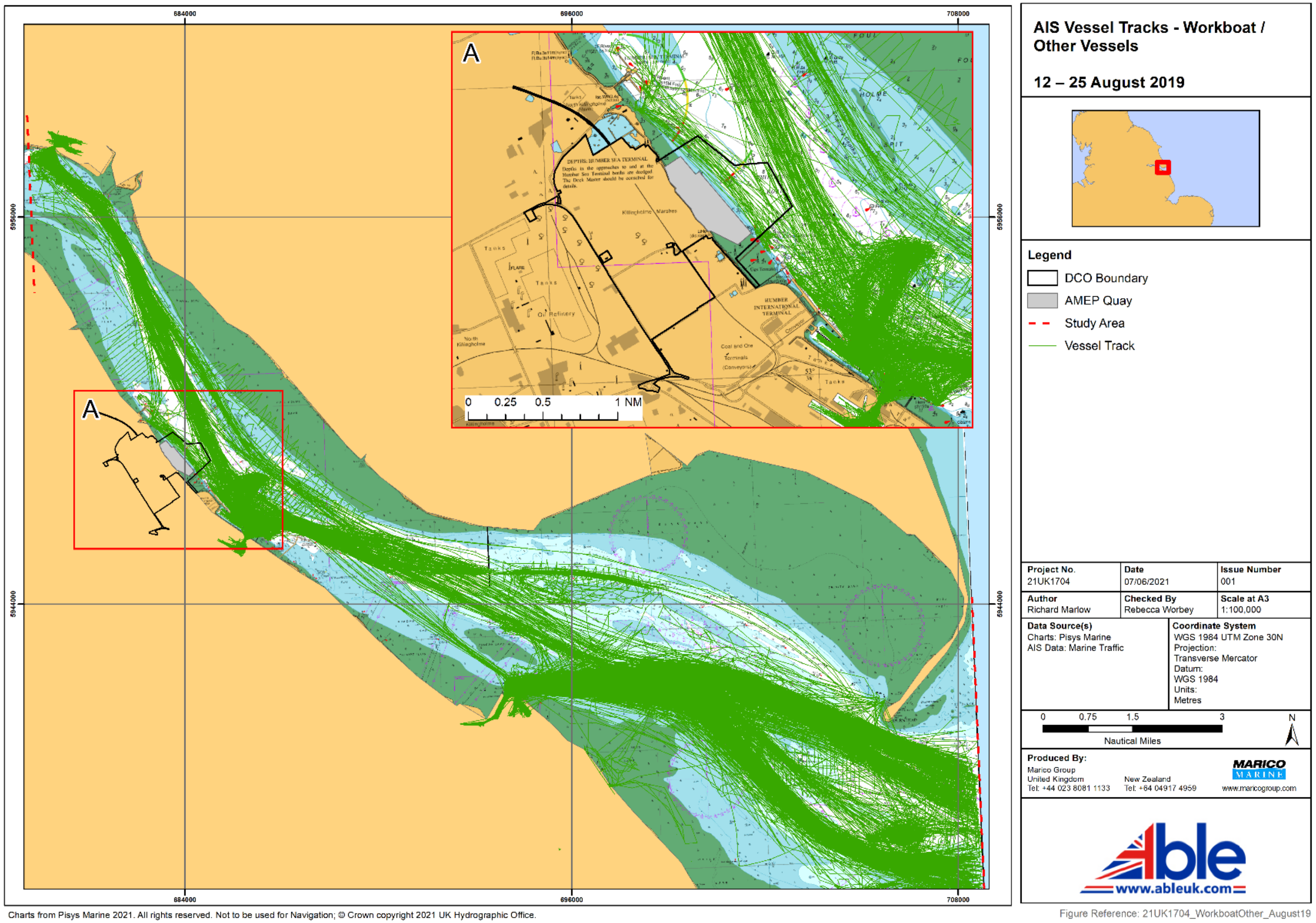


Figure 10:Workboat / Other Vessels (12 – 25 August 2019)

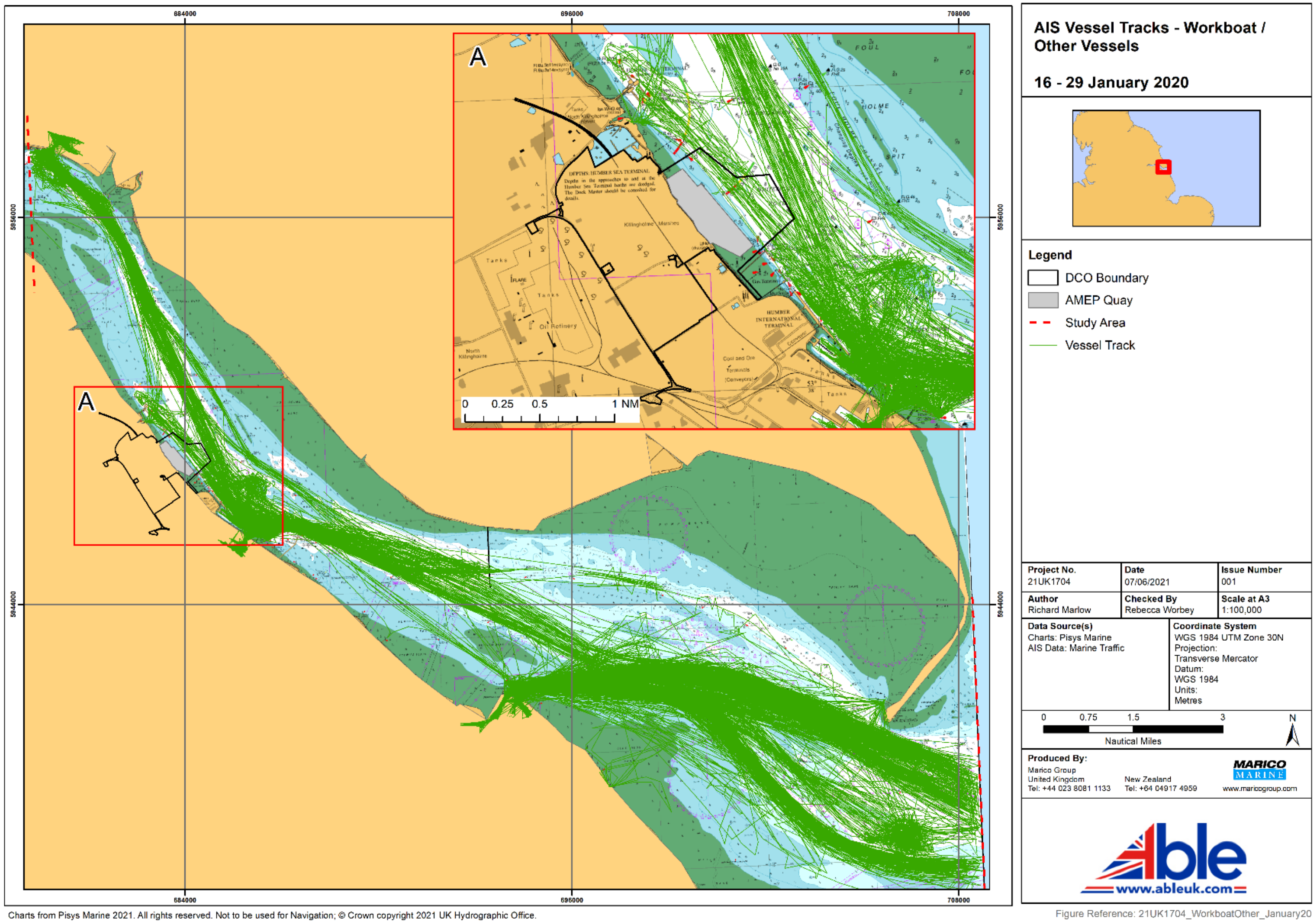


Figure 11:Workboat / Other Vessels (16 – 29 January 2020)

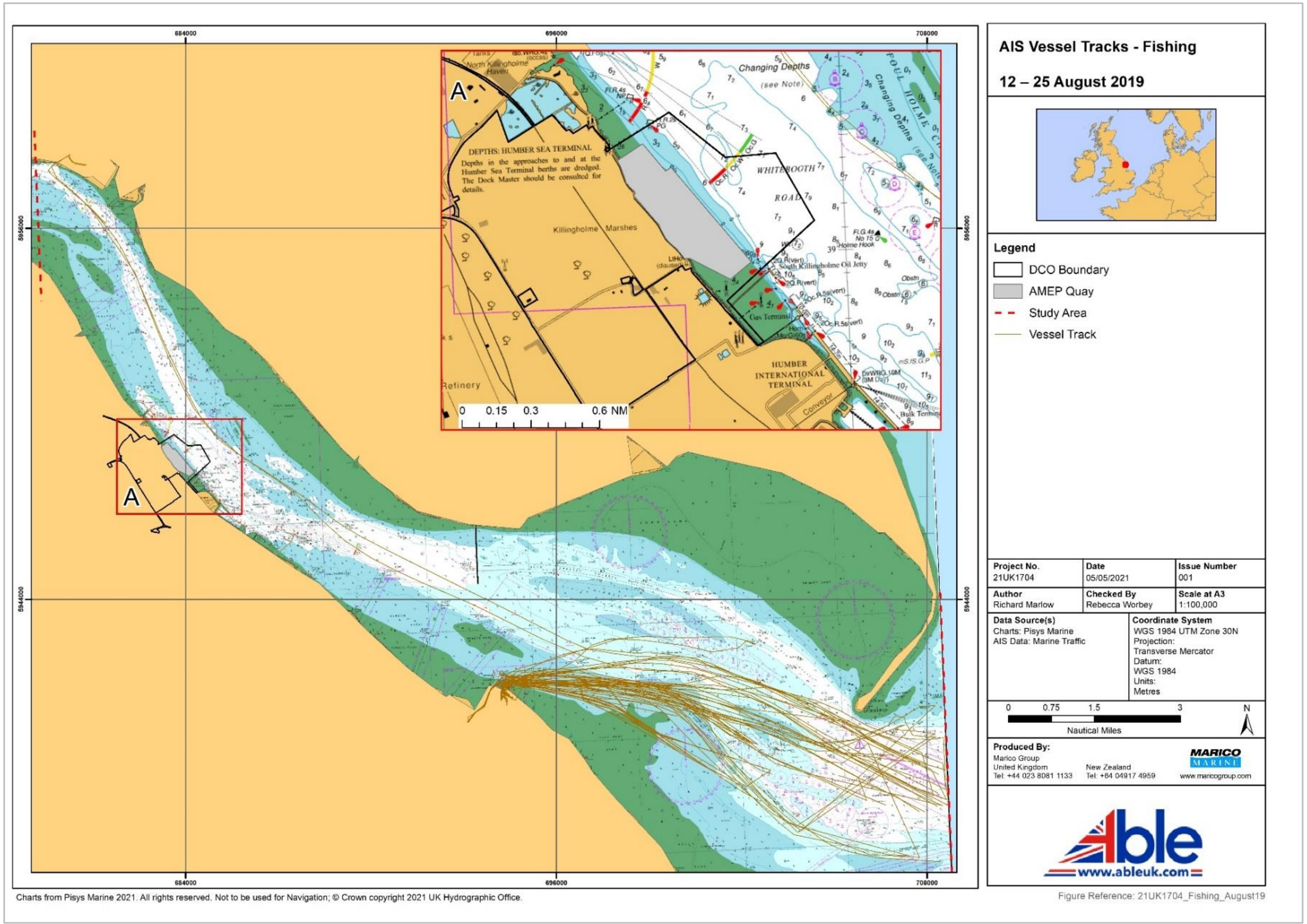


Figure 12: Fishing Vessels (12 – 25 August 2019)

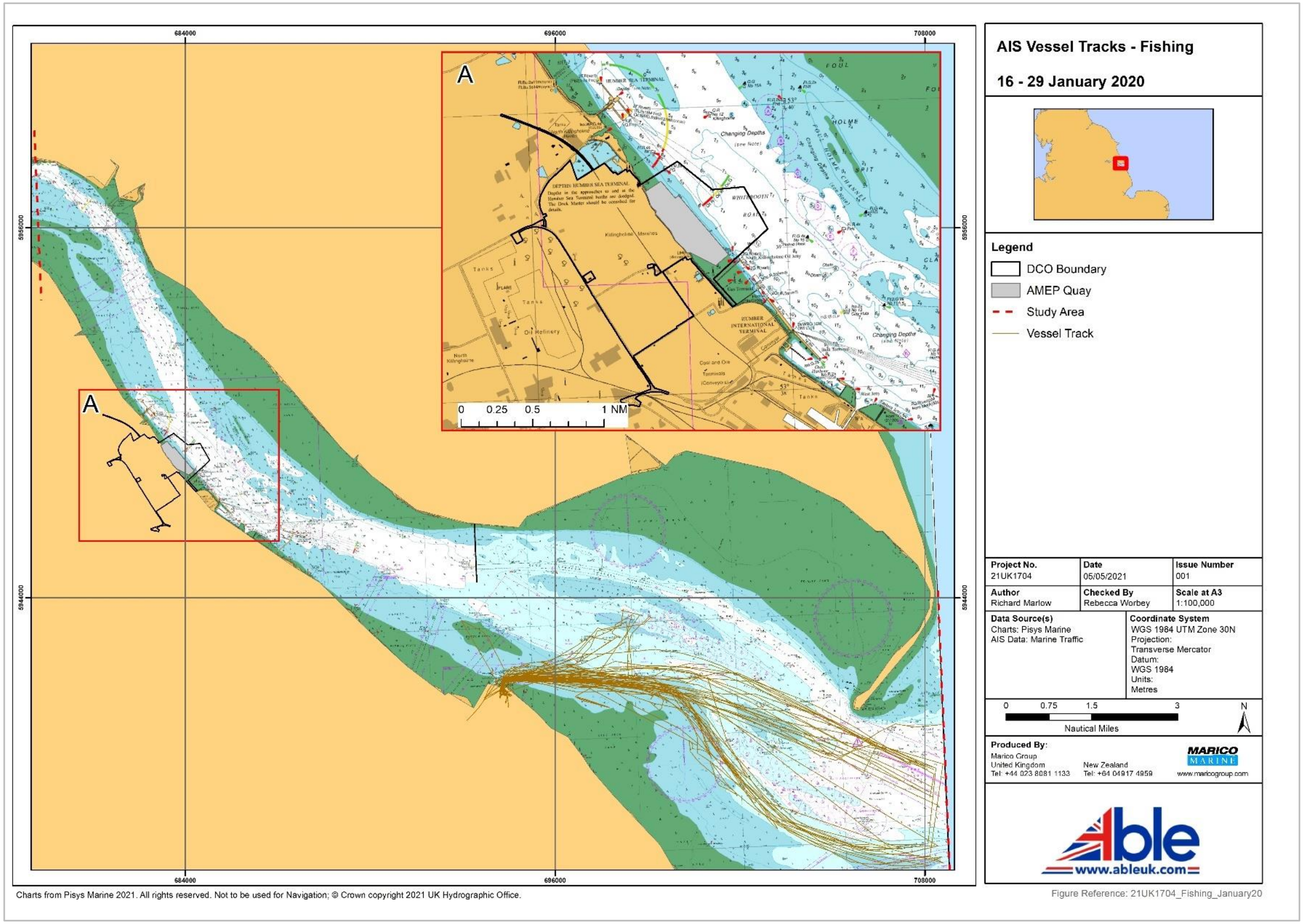


Figure 13: Fishing Vessels (16 – 29 January 2020)

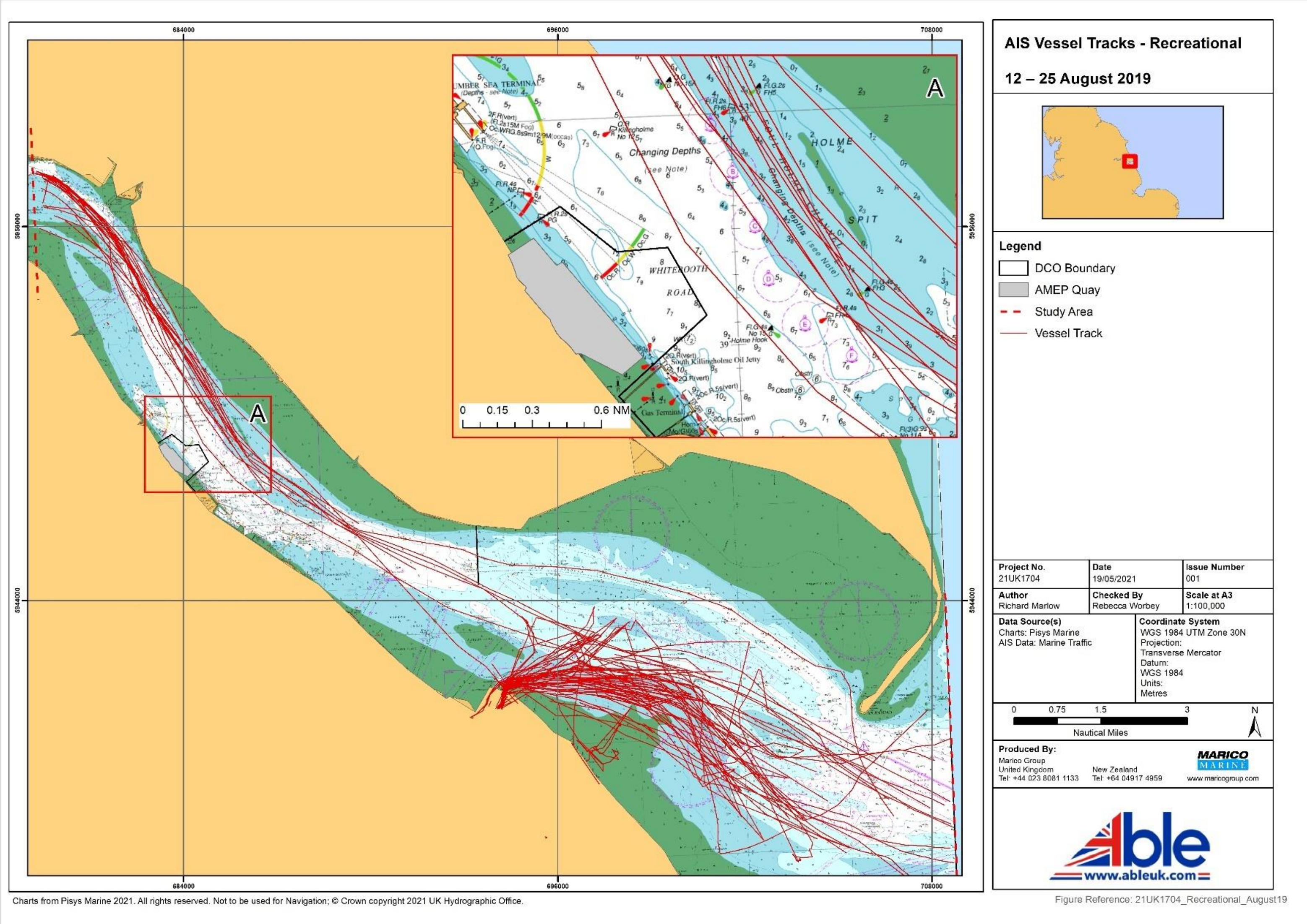


Figure 14: Recreational Vessels (12 – 25 August 2019)

To provide direct comparison to the data obtained from Department for Transport (Dft) and assessed within the 2011 NRA, up to date DfT vessel traffic data was additionally procured. **Figure 15** to **Figure 17** shows the change in Humber Estuary port tonnage, passenger vessel movements and total vessel movements respectively between 2005 and 2019.

With the exception of passenger vessel movements to Grimsby and Immingham which more than doubled between 2005 and 2009, owing to the identification of Wind Cats into Grimsby as passenger vessels, there has been a declining trend in total estuary port tonnage, overall passenger vessel movements and total vessel movements. This analysis is consistent with consultation feedback received from the Statutory Harbour Authority (**Table 6**).

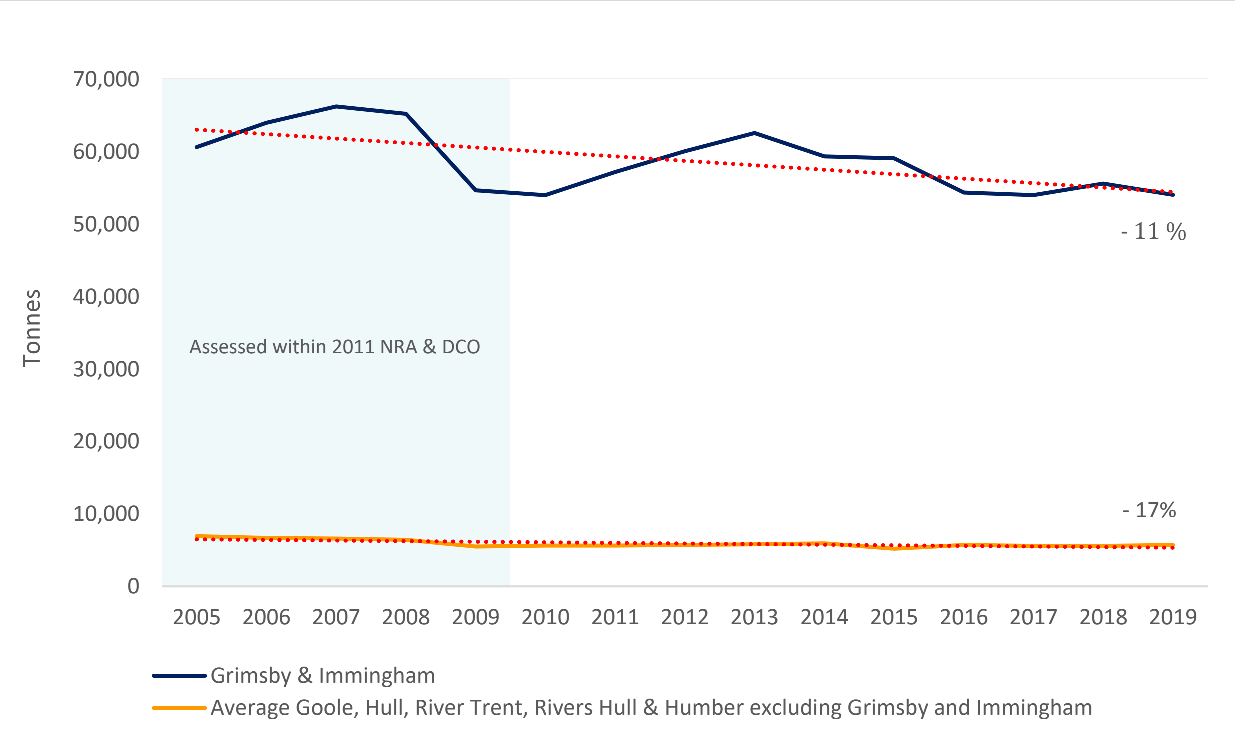


Figure 15: Humber Estuary Port Tonnage 2005 to 2019. Data source: Department for Transport (DfT)

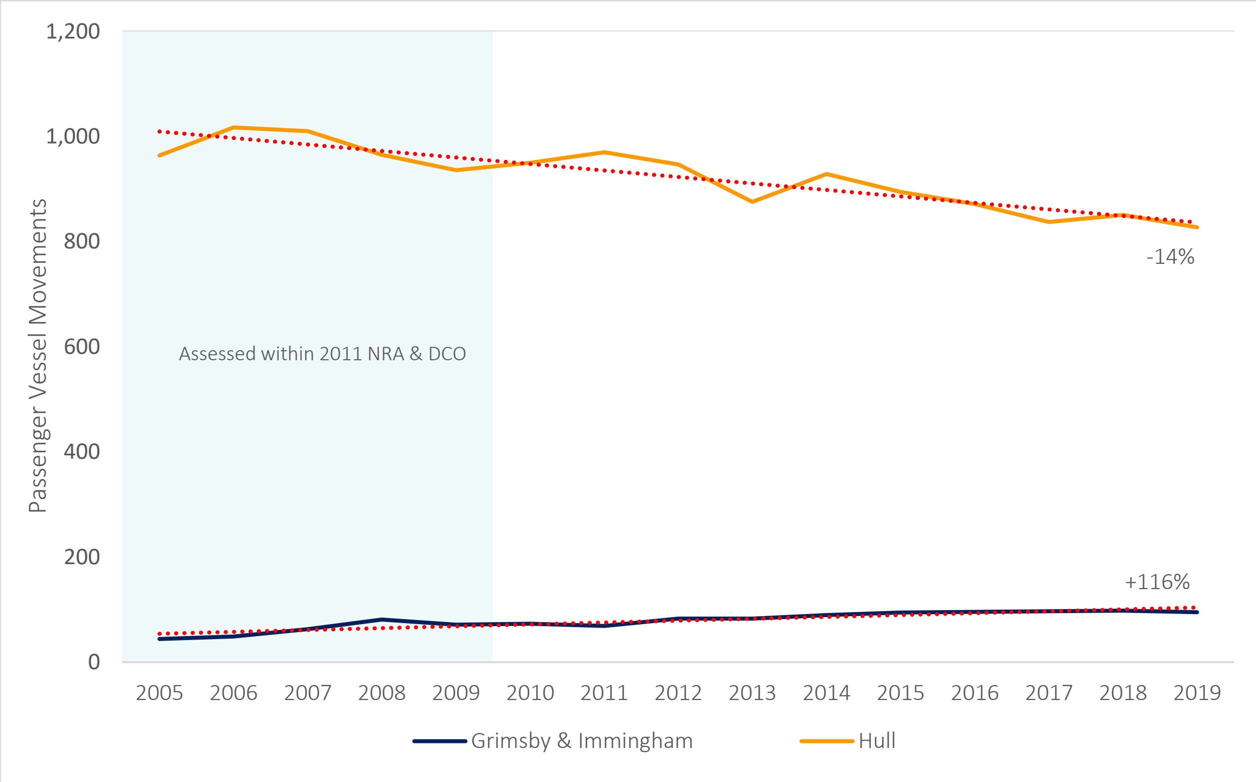


Figure 16: Humber international short sea, long sea and cruise passenger movements 2005 to 2019. Data source: DfT.

Figure 17: Humber vessel movements 2005 – 2019. Data source: DfT

3.3.2 Gate Analysis

Gate analysis is a tool used by Marico Marine to examine the frequency and direction of vessel traffic through a linear channel. A transect was created perpendicular to the AMEP development site across the channel, through which the frequency of intersecting vessel tracks was assessed.

Transits through the gate have been analysed in **Figure 18** to **Figure 20** to establish the traffic profile in the immediate vicinity of the Project. A total of 563 and 622 transits occurred through the gate during the assessed 2-week winter and summer periods respectively, equating to approximately 40 and 44 transits per day respectively past the Project.

Figure 18 indicates that during winter, peak movements past the Project appear to be driven by schedule, with tidal influence not determined to be a primary contributory factor (See **Table 5**). During summer, the hourly transit pattern is more sporadic reflecting the increase in movements of seasonal industries, primarily passenger vessels.

Over 70% of transits in winter and 55% in summer were by cargo vessels, as shown in **Figure 19,** with Workboat/ Other, accounting for 22% of transits in winter and 27% in summer (**Figure 14**). No recreational vessels were recorded passing the Project in winter with recreational vessels accounting for approximately 2% of all transits in summer.

Vessels have been assessed by Length Over-All (LOA) in **Figure 20.** The most common vessels transiting past the Project are between 10 – 30m LOA and 70 – 89m. These lengths are consistent with the dominant vessel types identified within **Figure 19**.

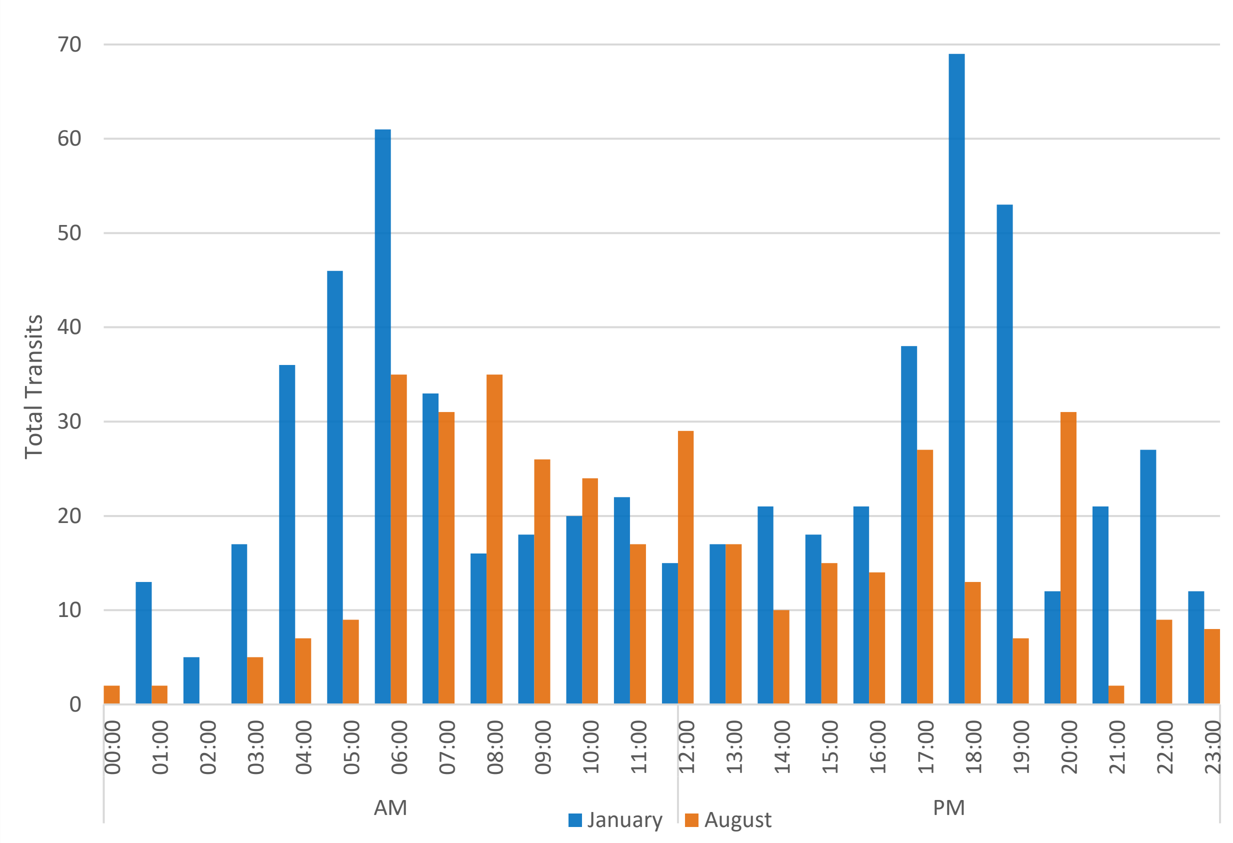


Figure 18: Transits by Time of Day – All Vessel Types – Summer and Winter.

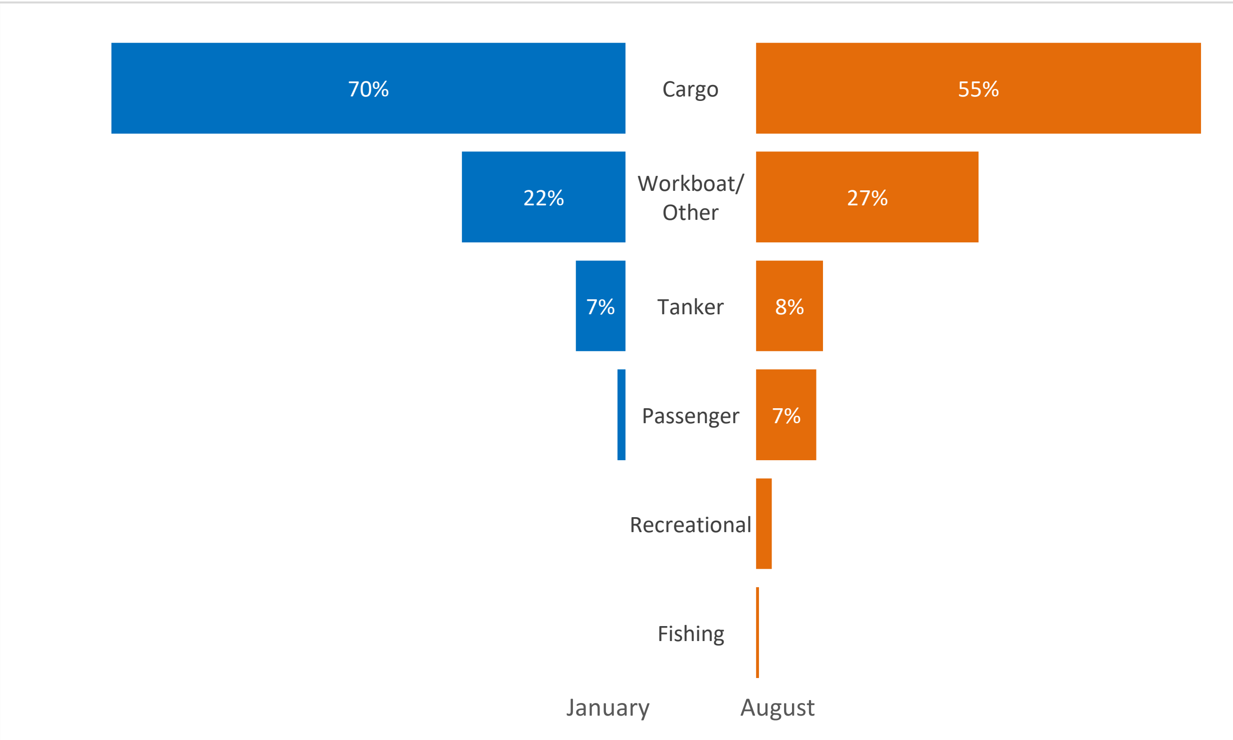


Figure 19:Transits by Vessel Type– Winter and Summer.

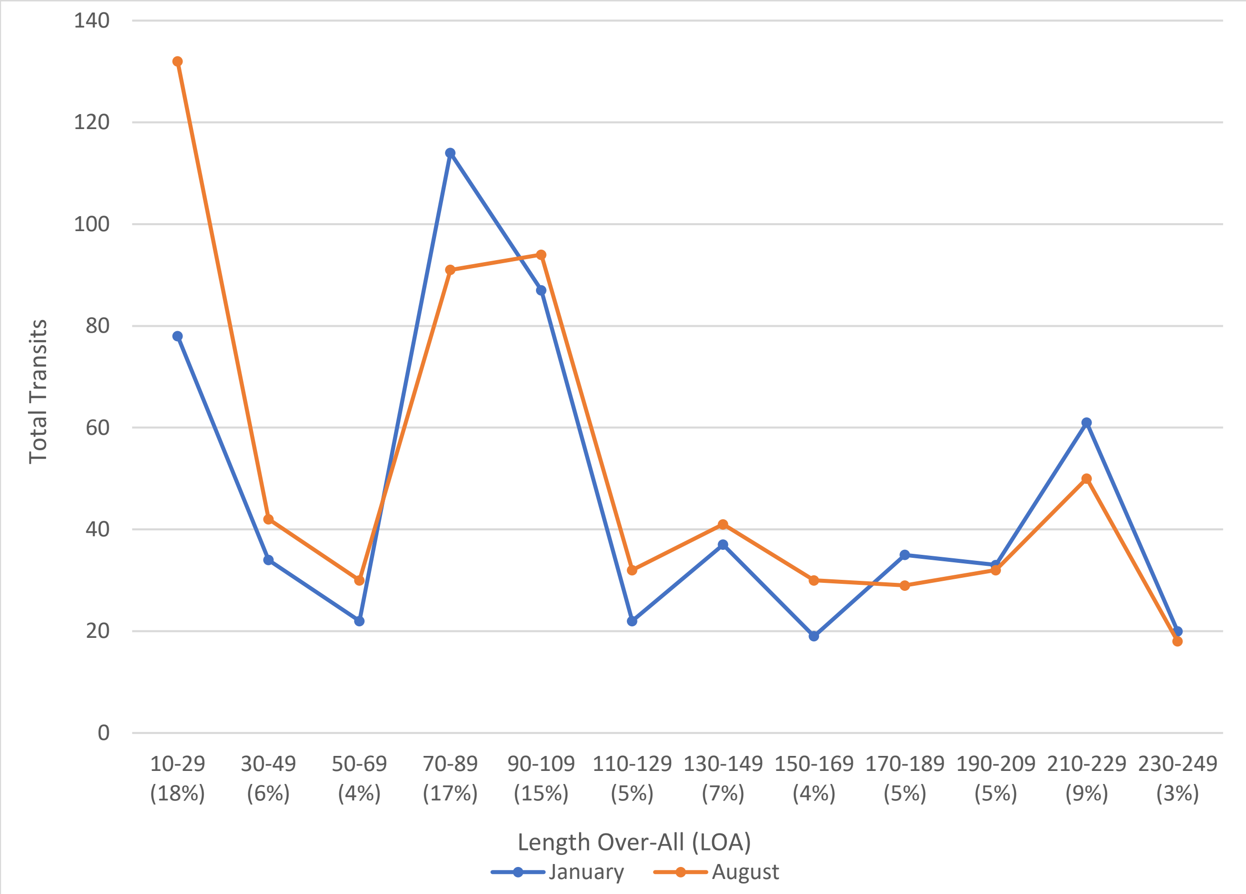


Figure 20:Transits by Length Over-All (LOA) (Summer and Winter)

3.4 HISTORIC INCIDENTS

Historic incident data has been provided by ABP Humber and is shown in **Table 9.** Navigationally significant incident data was filtered according to reported incident location to include incidents that occurred in vicinity of HST, IOH, HIT, and South Killingholme.

Table 9: Historic Incidents. HST, IOH HIT and South Killingholme.

	2016	2017	2018	2019	2020
Contact: Structure	1	7	1	2	1
Temporary Grounding	0	0	1	0	0
Grounding Over Tide	0	0	0	0	0
Collision	0	0	1	1	1
Contact: Floating Mark	0	1	1	2	0

The highest number of navigationally significant incidents occurred in 2017 totalling 8 consisting of seven contacts with structures and one contact with a floating mark (**Figure 21**). The most common incident type is Contact: Structure.

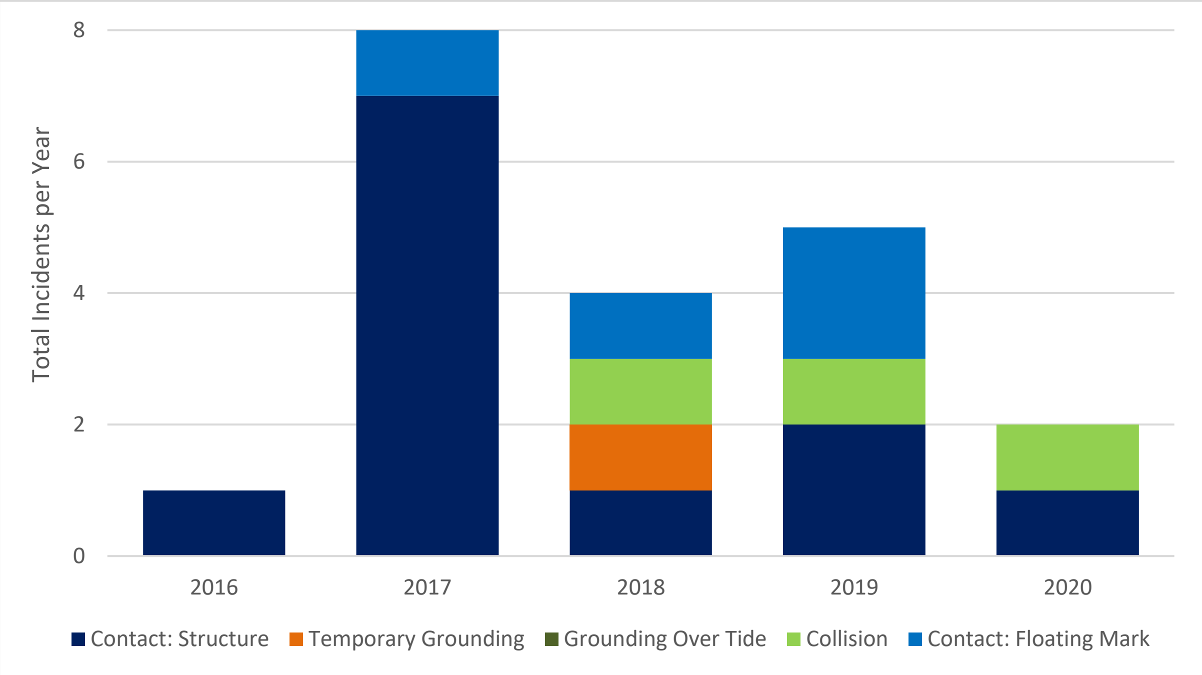


Figure 21: Navigational Incidents – 2016 - 2020

4 HAZARD IDENTIFICATION

IMO Guidelines define a hazard as 'something with the potential to cause harm, loss or injury', the realisation of which results in an accident. Hazards relating to navigation were identified through stakeholder consultation meetings and scoping and informed by vessel traffic and incident analysis (**Section 3**). A summary of the key impacts identified during stakeholder consultation are outlined in **Annex B.**

The hazard categories identified for assessment within the NRA are given in **Table 10**. Hazard categories were combined with the vessel categories identified in **Table 8** to establish a list of individual hazards for risk assessment. In total, 16 hazards were identified, as detailed in **Table 10**.

Table 10: Identified Hazard Categories.

Ref	Hazard Category	Hazard Detail	Comments	Individual Assessed Hazards
1	Collision	All Vessel Types	Two or more vessels impact each other whilst manoeuvring.	4
2	Contact	AMEP Infrastructure	One or more vessels makes contact with the AMEP quay or jack-up engaged in construction activities during the construction phase.	2
		Non-AMEP Infrastructure	One or more vessels makes contact with a berth, pier or jetty.	1
		Vessel Alongside Berth	One or more vessels makes contact with a stationary / berthed vessel. Also known as striking.	1
		Navigation Buoy	A project vessel makes contact with a navigation buoy (striking).	1
3	Grounding	All Vessel Types	A vessel unintentionally makes contact with the seabed.	2
4	Foundering / Swamping	Project Vessels	A vessel fills with water for any reason including capsize, and when overwhelmed, sinks.	1
5	Mooring Incident / Breakout	All Vessel Types	A vessel ranges (moves excessively) whilst alongside the berth or when one or more mooring lines fail resulting in the vessel unintentionally breaking away from its moored position.	2
6	Fire / Explosion	All Vessels	Interaction between a construction vessel and non-project vessel leads to a fire/explosion.	2

4.1 CUMULATIVE IMPACT IDENTIFICATION

Cumulative effects refer to the effects upon receptors arising from the AMEP project when considered alongside other proposed or in-construction projects.

In assessing the potential cumulative impacts, it is important to bear in mind that proposed projects may or may not actually be taken forward. For this reason, all identified relevant projects are considered to be operational for the purpose of risk assessment to represent worst case future development scenario.

Consultation did not establish any cumulative projects of significance to shipping and navigation for consideration within the NRA and, as such, no marine cumulative impacts have been identified.

It was, however, noted that Goole, Hull, Immingham and the AMEP development have been granted Free-Port status and therefore the Humber may see a general increase in overall capacity into the future; however, at this stage, modelling to ascertain any potential impact on river traffic has not been undertaken. It was additionally noted in consultation with C.Ro, that although not currently all in use, Humber Sea Terminals has 6 berths which may be utilised in the future.

It was additionally noted that some of the cumulative projects considered within the 2011 NRA were not taken forward, including the Hull Riverside Bulk Terminal, but the Grimsby Outer Harbour development and Green Port Hull are now in place and included in the current baseline traffic analysis.

5 EMBEDDED MITIGATION

Embedded mitigation measures describe those measures to which adherence is required by regulation / are already enforced by the local SHA. Embedded mitigation measures are assumed to be in place prior to assessment. **Table 11** lists embedded mitigation measures considered within this NRA. Following risk assessment, possible additional risk control measures may be identified with a view to further reducing residual risk (see **Section 9**).

Table 11: Embedded Mitigation measures

ID	Risk Control Measure	Phase	Description
1	VTS Traffic Organisation Service	C/O	Humber VTS is well established and covers the entire project area.
2	Adherence to International regulations	C/O	For example COLREGs, ISM, ISPS etc.
3	Adherence to local regulations/ procedures	C/O	For example byelaws, general directions, Humber Passage Plan etc.
4	Adherence to ABP Humber Emergency Plan	C/O	HESMEP.
5	Training and authorisation of pilots	C/O	Humber Estuary Services provides a pilotage service for the project area. Training and authorisation of Pilots and PEC holders is well documented and compliant with legislation and guidance.
6	Pilotage exemption certificates	C/O	HES issues PEC's to suitably qualified candidates.
4	Passage planning	C/O	Passage planning and scheduling should be undertaken to ensure that existing operations are not impacted by the AMEP arrival and departures. Passage Planning is a HES requirement for all authorised pilots and PEC holders
5	Guidance for small craft	C/O	HES provides and promulgates guidance for small craft [redacted] Pleasure_Craft_Navigation/).
6	Promulgation of Information including Notice to Mariners	C/O	Promulgation of information and warnings through notices to mariners and other appropriate maritime safety information (MSI) Is achieved by HES through [redacted], mailing lists and stakeholder engagement.
7	Update Navigation Charts	O	Final drawings should be submitted to the UKHO and HES, and navigation charts should be updated.
8	Protective Provisions	C/O	Adherence to terms of Protective Provisions, for example, maintaining existing depths of adjacent third-party berths.

6 ASSUMPTIONS

The following assumptions are applicable to this NRA:

- All international, national and local regulations and procedures are adhered to;
- When considering risk control measures, it is assumed that embedded risk controls are in place (see **Section 5**) and they are effective in meeting their intended goal (i.e. the NRA does not take into consideration failure to comply with regulations);
- This NRA is concerned with navigation related hazards and does not consider other non-navigational hazards including those related to a health and safety of marine operations such as slips, trips and falls, or those hazards which are not directly related to navigation, such as fire and explosion, except where they can be a consequence of a navigation hazard.

7 NAVIGATION RISK ASSESSMENT METHODOLOGY

The NRA process is based on Formal Safety Assessment (FSA) methodology as adopted by the International Maritime Organisation (IMO) and follows the guidance set out in International Best Practice. A detailed description of the methodology is provided in **Annex A**.

7.1 OVERVIEW

A standard 5x5 risk matrix is utilised and each hazard is assessed twice: firstly, to determine the risk associated with the most likely outcome of the hazard, and secondly, to determine the risk associated with the worst credible outcome for each hazard. The results were then combined to give a total risk score for each hazard, weighted towards the most-likely outcome to reflect the reality that comparatively few accidents result in the worst credible outcome.

7.1.1 Assessment of Frequency and Consequence

The assessment of frequency is combined with assessments of typical consequences to people, property, environment and business. The frequency and consequence bands used for this NRA are shown in **Annex A.**

The frequency and consequence assessments are largely based on the data/information collected during Stage 1 of this NRA, and in particular:

- Stakeholder consultation meetings;
- Quantitative vessel traffic analysis; and
- Review of the incident database.

This information is supplemented by expert judgement and specialist knowledge provided by the assessment team, who have considerable experience in undertaking NRAs of this type in ports/harbours all around the world.

7.1.2 Risk Scores

The frequency and consequence scores are then assessed to give two distinct risk scores;

- The average risk score of the categories in the most likely set;
- The average risk score of the categories in the worst credible set;
- The maximum risk score of the four categories in the most likely set; and
- The maximum risk score of the four categories in the worst credible set.

These scores were then combined using a weighted average to produce a single numeric value representing the final risk score for each hazard, between 0 (negligible) and 10 (high) (see **Annex A**), following which, the final risk scores are sorted into a ranked hazard list.

Hazard risk scores are categorised as either negligible, low, As Low as Reasonably Practicable (ALARP), significant or high, as per **Table 12**, where ALARP represents a level of risk that is neither acceptable nor unacceptable and for which further investment of resources for risk reduction may or may not be justifiable – i.e. risks which fall within the ALARP band should be reduced unless there is a disproportionate cost to the benefits obtained.

Navigation hazards with a risk score of significant or high are deemed unacceptable and, as such, additional risk control measures must be implemented to reduce the risk to an acceptable level (see **Section 9**).

Table 12: Risk Scoring.

Risk Score	Risk Definition	Action Taken
0 - 1.99	Negligible	The risk is acceptable and at level where operational safety is unaffected.
2 - 3.99	Low	The risk is acceptable and at level where operational safety is assumed.
4 - 6.99	ALARP	The risk is neither acceptable nor unacceptable. Risks in the ALARP band are to be managed to a level which is "As Low As Reasonably Practicable", based on the cost-effectiveness of implementing additional risk control measures. These hazards and associated risk control measures shall be regularly reviewed as part of the Safety Management System.
7 - 8.99	Significant	The risk is unacceptable and additional risk control measures shall be identified and implemented as soon as possible (or the activity / operation temporarily suspended). These hazards and associated risk control measures shall be regularly reviewed as part of the Safety Management System.
9 - 10	High	The risk is unacceptable and additional risk control measures shall be identified and implemented immediately (or the activity / operation permanently suspended). These hazards and associated risk control measures shall be regularly reviewed as part of the Safety Management System.

Each identified baseline hazard log is scored twice, once for the construction phase and again for the operational phase resulting in two separate risk assessments and hazard logs. Each log is then re-assessed applying proposed possible additional mitigation measures (**Section 9**) to assess the residual risk scores and their effectiveness should they be implemented.

8 NAVIGATION RISK ASSESSMENT RESULTS

8.1 CONSTRUCTION PHASE – BASELINE WITH EMBEDDED MITIGATION

A summary of the ranked hazard list for construction phase NRA is shown within **Table 13**. The full hazard log is provided in **Annex C.** The assessment assumes the implementation of all embedded risk control measures identified within **Section 5.**

All hazards were scored as ALARP or lower, with the highest scoring individual hazard assessed to be 'Construction Vessel ICW Construction Vessel' which scored 5.47: ALARP. **Figure 22** provides a summary of the average hazard category scores for the construction phase. The highest scoring overall hazard category was 'Collision' with an average risk score of 4.7: ALARP, closely followed by Fire / Explosion (4.6: ALARP). The lowest scoring overall hazard category in the construction phase was 'Grounding' which scored 2.1: Low driven by a low frequency of occurrence and a most likely outcome of temporary grounding and re-floating resulting in minor damage.

Average hazard category scores assessed within the 2011 NRA are additionally shown in **Figure 22.** A decrease in risk scores is noted across all hazard categories, with Contact and Swamping / Capsize jumping a risk band from ALARP to Low.

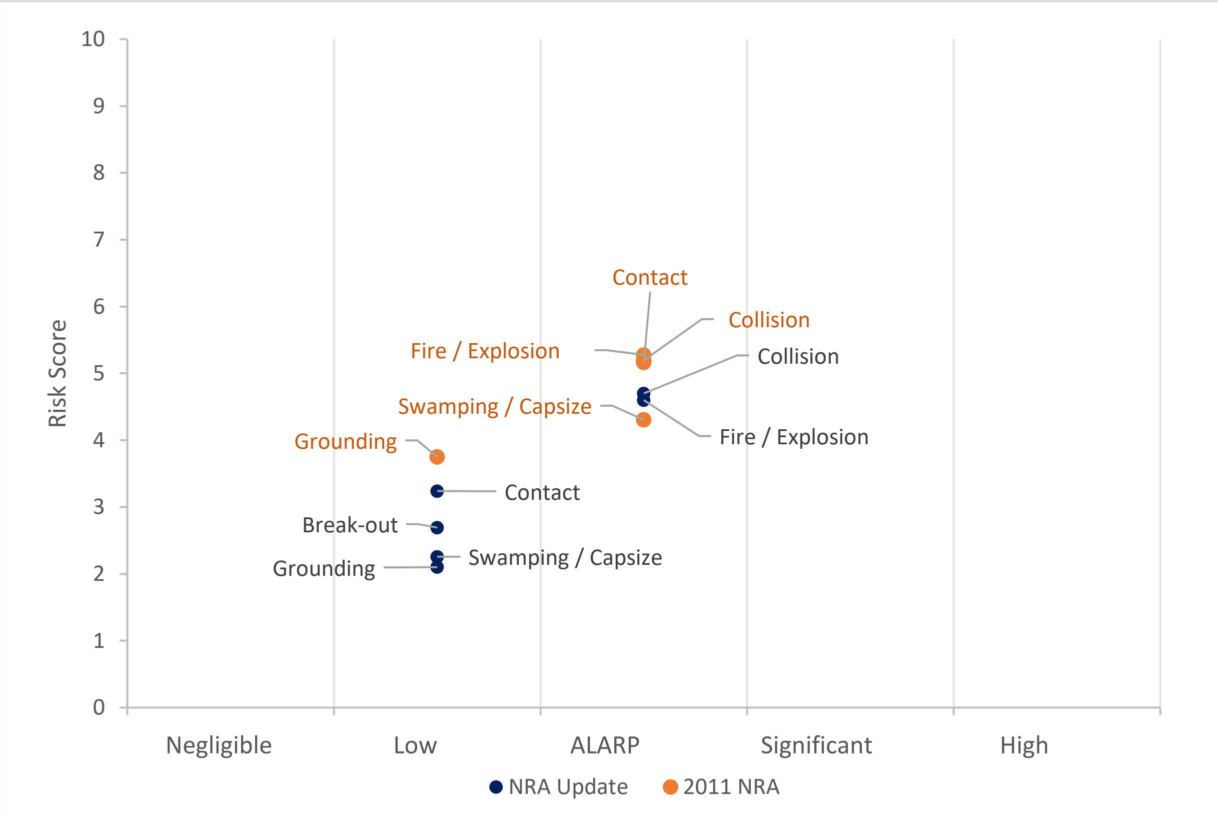


Figure 22: Average Risk Score by Hazard Category – Construction Phase

Table 13: Summary Ranked Hazard List – Construction Phase.

Rank	Hazard Type	Hazard Title	Score
1	Collision	Construction Vessel ICW Construction Vessel	5.47
2	Fire / Explosion	Fire / Explosion: Vessel alongside third party berth	4.72
3	Collision	Construction Vessel ICW Tanker	4.52
4	Fire / Explosion	Fire / Explosion: Construction Vessel alongside	4.45
5	Collision	Construction Vessel ICW Cargo	4.43
6	Collision	Construction Vessel ICW Workboat/Other	4.22
7	Contact	Construction vessel contacts AMEP project infrastructure	4.10
8	Contact	Non-project vessel contacts AMEP project infrastructure	4.10
9	Contact	Construction vessel contacts non-project infrastructure	3.70
10	Contact	Construction vessel contacts vessel alongside third party berth	3.10
11	Break-Out	Construction vessel breaks away from its moorings	2.85
12	Grounding	Non-project vessel runs aground due to construction activities	2.56
13	Break-Out	Third party vessel breaks away from its moorings due to project activities	2.54
14	Sinking / Capsize	Construction vessel sinks / capsizes	2.26
15	Grounding	Construction vessel runs aground	1.65
16	Contact	Construction vessel contacts navigation aid	1.21

8.1.1 Possible Variations During Construction Phase

Although the number and type of vessel movements associated with the construction phase of the project has been predicted based on best available information, it is recognised (**section 2.2.1**) that a number of factors (including contractor appointed, plant type and availability, real world ground conditions) may lead to a variation from predicted movements.

It is anticipated that such a variation is unlikely to be greater than +/- 25% from the description in **section 2.2.1**.

The effect of such variations has been considered in relation to the assessed navigation risks during the construction phase.

Peak vessel movements assessed during this phase are predicted to be 27 per day, therefore a variation of 25% would lead to new peaks of approximately 20 to 34 movements per day.

In the context of total traffic movements (excluding small vessels) on the Humber within the study area of approximately 60 per day **(section 3.3.1**) this is clearly significant and has been assessed within the NRA through consideration of frequency with which hazards may be realised.

However, hazard frequencies are assessed to be low overall due to effective existing mitigations (traffic management) a variation of 25% (7 vessels more or less per day) was not found to be sufficient to increase or reduce the frequency of occurrence of any assessed hazard. That is to say frequency would not move from the assessed band to the next higher or lower band – see frequency criteria in **Annex A.**

The risk assessment is therefore valid for the construction phase even if actual vessel numbers deviate within realistic margins.

8.2 OPERATION PHASE - BASELINE WITH EMBEDDED MITIGATION

A summary of the ranked hazard list for operational phase is shown within **Table 14**. The full ranked hazard list is provided in **Annex D.** The assessment assumes the implementation of all embedded risk control measures identified within **Section 5.**

All hazards were scored as ALARP or lower, with the highest scoring hazard assessed to be 'AMEP vessel contacts project infrastructure' which scored 4.93: ALARP.

Figure 23 provides a summary of the average hazard category scores for the operational phase. The highest scoring overall hazard category was 'Fire/Explosion with an average risk score of 4.4 driven by the potential for consequences to be high. This was closely followed by 'Collision' which scored 4.3. The lowest scoring overall hazard category in the operational phase was 'Swamping/Capsize' which scored: 2:0: Low, driven by its low likelihood of occurrence.

Average operational phase hazard category scores assessed within the 2011 NRA are additionally shown in **Figure 23.** A decrease in risk scores is noted across all hazard categories, with the exception of 'Fire/ Explosion' which jumped from Low to ALARP.

With the exception of 'Break-Out' and 'Grounding' all hazard categories were assessed to be higher during the construction phase.

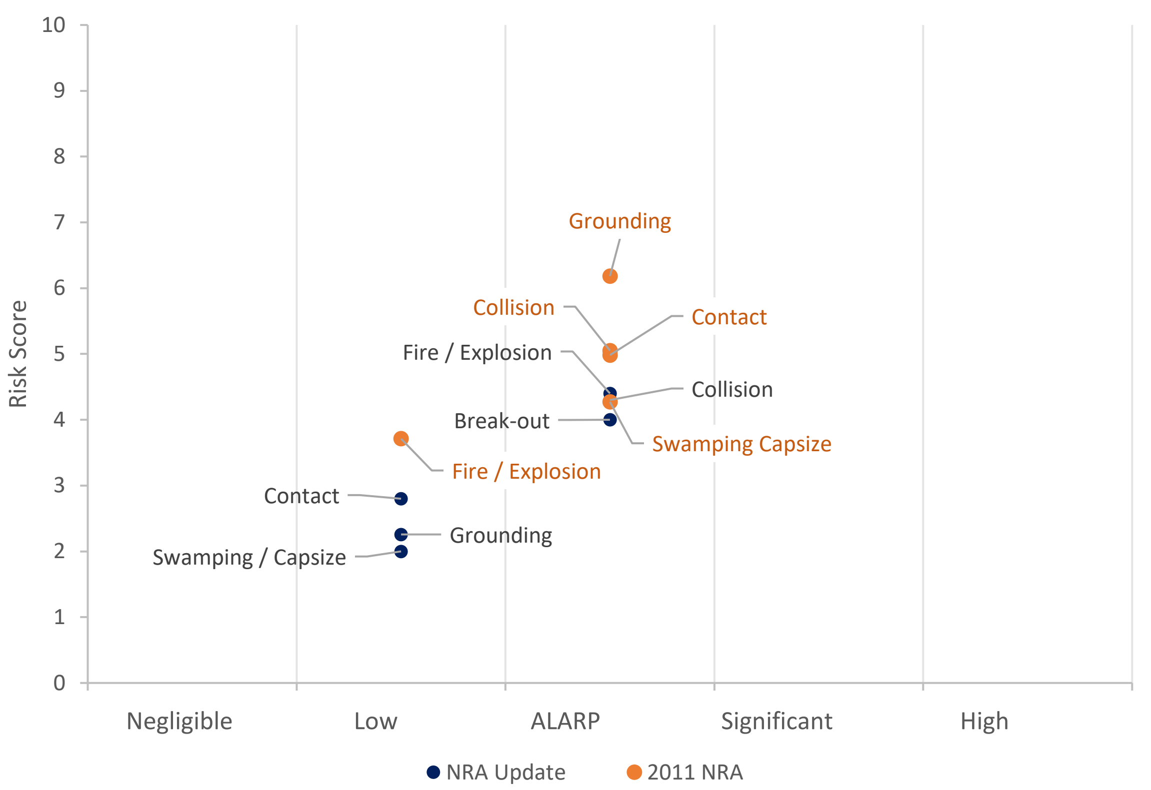


Figure 23: Average Risk Score by Hazard Category – Operation Phase

Table 14: Summary Ranked Hazard List – Operation Phase.

Rank	Hazard Type	Hazard Title	Score
1	Contact	AMEP vessel contacts project infrastructure	4.93
2	Fire / Explosion	Fire / explosion: non-project vessel alongside third party berth	4.72
3	Break-Out	AMEP vessel breaks away from its moorings	4.57
4	Collision	AMEP Vessel ICW tanker	4.52
5	Collision	AMEP Vessel ICW cargo	4.43
6	Collision	AMEP vessel ICW AMEP vessel	4.28
7	Fire / Explosion	Fire / explosion: AMEP vessel alongside	4.17
8	Collision	AMEP vessel ICW workboat / other	3.80
9	Contact	AMEP vessel contacts third party vessel alongside.	2.85
10	Contact	Non-project vessel contacts AMEP project infrastructure	2.74
11	Contact	AMEP vessel contacts non-project infrastructure	2.61
12	Break-Out	Third party vessel breaks away from its moorings due to project activities	2.54
13	Grounding	Non-project vessel runs aground	2.50
14	Grounding	AMEP vessel runs aground	2.04
15	Sinking/ Capsize	AMEP vessel sinks / capsizes	1.96
16	Contact	AMEP vessel contacts navigation aid	0.92

9 POSSIBLE ADDITIONAL RISK CONTROL MEASURES

A number of additional risk control measures have been identified, informed by stakeholder consultation and aimed at further reducing the residual risk during the construction and operation phases of the Project.

Table 15 provides a description of each of the proposed mitigation measures. The individual hazards to which they apply are indicated within the hazard logs in **Annex C** and **Annex D**. While all hazards have been assessed to be ALARP or lower, it is recommended that consideration is given to their implementation with a view to further reducing risk.

It is noted that many of the possible additional risk controls proposed within the 2011 NRA have now been embedded into the project design or HES procedures and as such, the proposed possible additional mitigation measures show a reduced effectiveness on the majority of hazards which are carefully managed and mitigated through the implementation of embedded risk control measures and procedures.

Following the implementation of possible additional risk control measures, the hazard showing the greatest risk reduction in the construction phase was 'Construction Vessel ICW Construction Vessel' with an effectiveness of 22% driven by risk control measures 2 and 4. The hazard showing the greatest risk reduction in the operation phase was 'AMEP vessel contacts project infrastructure' with a reduction of 22%.

Table 15: Possible Additional Risk Control Measures

ID	Risk Control Measure	Phase	Description
1	Suitably qualified marine personnel	C / O	Ensure marine personnel (vessel crew, marine managers) are suitably qualified with local knowledge.
2	Marine Safety Management System	C / O	As the Harbour Authority, AHPL will be required to develop and manage their own marine SMS. Ownership of responsibilities between ABP Humber and AHPL will need to be clear.
3	Emergency procedures	C / O	Development of emergency procedures for AMEP including: - Availability of pollution response equipment; - Availability of shoreside emergency services; - PPE.
4	Dedicated project marine manager	C / O	AHPL should appoint a dedicated marine manager to ensure liaison between project vessel movements and other traffic , both during construction and operational phases. (Liaison with Humber VTS, and neighbouring operators)
5	Mooring studies	O	A mooring study should be undertaken by AHPL as the Harbour Authority to ensure that adequate mooring arrangements and procedures are in place.
6	Additional surveys of study area	C / O	Additional surveys to monitor sedimentation within and in vicinity of the AMEP berths to ensure adequate water depth is maintained.
7	Standard Operation Procedures (SOP)	O	Able should develop standard operating procedures for the facility once operational.
8	Up-to date weather forecasting	C / O	The project marine manager should have access to up-to-date site-specific weather forecasts.
9	Marking and lighting	C / O	Temporary and permanent marking and lighting requirements should be reviewed in agreement with Trinity House.
10	Availability of towage.	O	Review Towage requirements, e.g: ▪ Use of additional towage for high-air draught vessels / vessels carrying large cargoes navigating to and from berthing pocket Guidance to be determined by the Harbour Authority(s).
11	Restrict simultaneous movements	C / O	Consider procedure to prevent simultaneous vessel movements with adjacent facilities.
12	Dredge disposal plan	C	Liaise with HES / Humber VTS to agreed dredge disposal plan and schedule.
13	Availability of pilots	C / O	Pilot allocation should be managed to ensure adequate capacity and avoid disruption to other river users during operational, and especially, construction phases.

10 CONCLUSIONS AND RECOMMENDATIONS

ABP Humber is experienced in the management of large and hazardous cargoes through its Marine Safety Management system (MSMS) and has effectively implemented a suite of embedded mitigation measures ensuring that the risk profile remains at acceptable levels.

The proposed activities associated with the Project have been assessed and it has been concluded that the Project should have a minimal effect on the existing risk profile which should be managed and contained assuming compliance with embedded mitigation and regulations governing; movements, pilotage, towage, VTS and procedures.

A general decrease in risk scores is noted across all hazard categories when compared to the NRA undertaken in 2011 in support of the original DCO application. Factors influencing this decrease in risk score include:

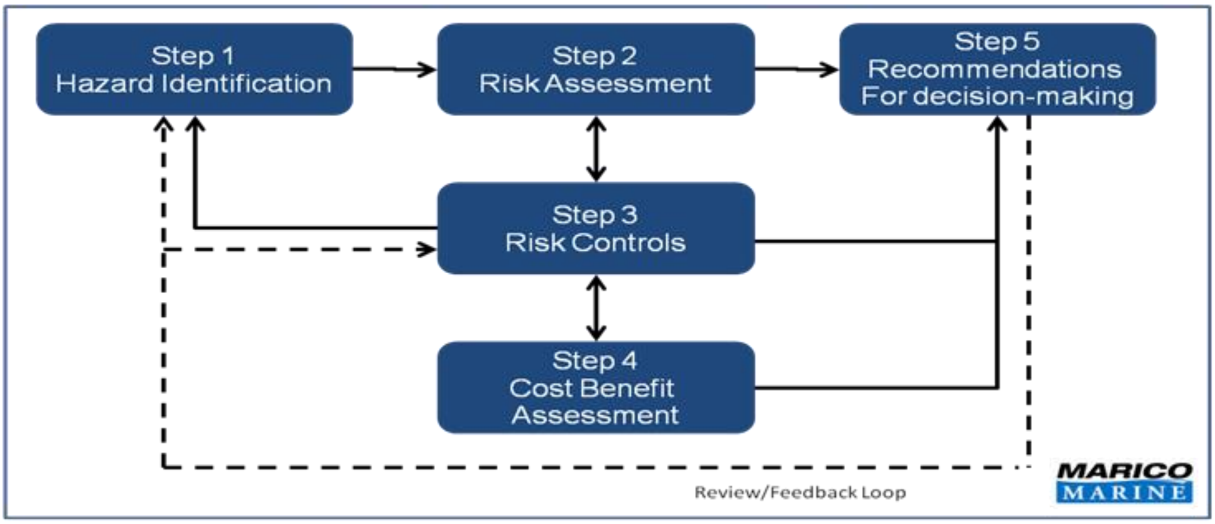
- An overall decline in Humber vessel transits past the Project (>50% reduction in passing transits from AIS) (**Section 3.3**);
- Improvement of the Humber-wide SMS and implementation of embedded mitigations over time;
- The embedding of many originally proposed additional mitigation measures into the project design (**Section 5**);
- The review and associated reduction in construction phase vessel movements associated with dredging activities identified within scoping;
- The simplification of the quay design via the removal of the specialist berth (**Section 2**)**;** and
- The reduction of cumulative projects considered within the 2011 NRA that were not taken forward (**Section 4.1**).

Although all hazards were scored as ALARP or lower, it is recommended that consideration is given to the implementation of the recommended possible additional risk control measures to further reduce the hazards to which they apply, particularly those within the ALARP band which should be reduced unless there is a disproportionate cost to the benefits obtained.

Annex A Navigation Risk Assessment Methodology

RISK ASSESSMENT METHODOLOGY

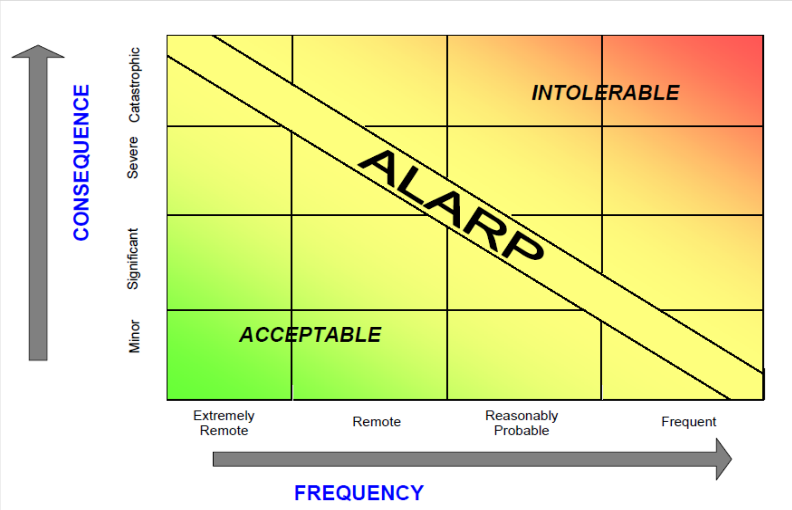
The Navigation risk assessment methodology is based on the Formal Safety Assessment methodology as adopted by IMO. It also follows the guidance set out within the Port Marine Safety Code. Marico Marine uses a form of risk assessment that has been specifically adapted for navigational use. It is unique to Marico and is fundamentally based on concepts of "Most Likely" and "Worst Credible", which reflect the range of outcomes arising from a shipping accident. This approach matches marine incident data that is customarily available. It is relevant that incident data often shows a high frequency of "Most Likely" events, separated from a much lower frequency of "Worst Credible" events.



Formal Safety Assessment Risk Assessment Process.

IMO Guidelines define a hazard as "*something with the potential to cause harm, loss or injury*", the realisation of which results in an accident. The potential for a hazard to be realised can be combined with an estimate or known consequence of outcome. This combination is termed "risk". Risk is therefore a measure of the frequency and consequence of a particular hazard. One way to compare risk levels is to use a matrix approach as illustrated below. At the lowest end of the scale, frequency is extremely remote and consequence insignificant such that a risk can be said to be negligible. At the high end, where hazards are defined as frequent and the consequence catastrophic, then risk is termed intolerable. Between the two lies an area known "As Low As Reasonably Practicable" (ALARP).

The IMO guidelines allow the selection of definitions of frequency and consequence to be made by the organisation carrying out the risk assessment. This is important, as it allows risk to be applied in a qualitative and comparative way. To identify high risk levels in a purely mathematically quantitative way would require a large volume of casualty data, which is rarely available in the maritime context. ALARP can be accepted as being "Tolerable", if the further reduction of the risk is impracticable, or if the cost of such reduction would obviously be highly disproportionate to the improvement. It can also be considered "Tolerable", if the cost of reducing the risk is greater than any improvement gained.



Frequency / Consequence Chart.

This NRA uses accident categories to organise hazards for assessment. The hazard categories identified as relevant to this study are as follows:

Hazard Categories

Ref	Hazard Category	Hazard Detail	Comments	Individual Assessed Hazards
1	Collision	All Vessel Types	Two or more vessels impact each other whilst manoeuvring.	4
2	Contact	AMEP Infrastructure	One or more vessels makes contact with the AMEP quay or jack-up engaged in construction activities during the construction phase.	2
		Non-AMEP Infrastructure	One or more vessels makes contact with a berth, pier or jetty.	1
		Vessel Alongside Berth	One or more vessels makes contact with a stationary / berthed vessel. Also known as striking.	1
		Navigation Buoy	A project vessel makes contact with a navigation buoy. Also known as striking.	1
3	Grounding	All Vessel Types	A vessel unintentionally makes contact with the seabed.	2
4	Foundering / Swamping	Project Vessels	A vessel fills with water for any reason including capsize, and when overwhelmed, sinks.	1

Ref	Hazard Category	Hazard Detail	Comments	Individual Assessed Hazards
5	Mooring Incident / Breakout	All Vessel Types	A vessel ranges (moves excessively) whilst alongside the berth or when one or more mooring lines fail resulting in the vessel unintentionally breaking away from its moored position.	2
6	Fire / Explosion	All Vessels	Interaction between a construction vessel and non-project vessel leads to a fire/explosion.	2

Each hazard is reviewed with respect to cause and effect. Frequencies are then derived for notional "Most Likely" and "Worst Credible" hazard events in each case, using the frequency bands defined below.

Frequency Criteria.

Scale	Description	Definition
F1	Remote	An event that could be expected to occur less than once > 1, 000 years.
F2	Unlikely	An event that could be expected to occur once in 1,000 years.
F3	Possible	An event that could be expected to occur once in 100 years.
F4	Likely	An event that could be expected to occur once in 10 years.
F5	Frequent	An event that could be expected to occur yearly.

Assessment of Consequence

Using the assessed notional frequency for the "*most likely*" and "*worst credible*" scenarios for each hazard, an assessment is made for the consequences to people, property, environment and business, using the criteria outlined below.

Consequence Criteria.

Cat	People	Property	Environment	Business
1	Negligible Possible very minor injury (e.g. bruising)	Negligible Costs <2k	Negligible No effect of note. Tier1 may be declared but criteria not necessarily met Costs <2k	Negligible Costs <2k
2	Minor (single minor injury)	Minor Minor damage Costs 2k –20k	Minor Tier 1 – Tier 2 criteria reached. Small operational (oil) spill with little effect on environmental amenity CEAS Site warning Costs 2K–20k	Minor Bad local publicity and/or short-term loss of revenue Costs 2k – 20k
3	Moderate Multiple minor or single major injury	Moderate Moderate damage Costs 20k – 200k	Moderate Tier 2 spill criteria reached but capable of being limited to immediate area within site COMAH site evacuation Costs 20k -200k	Moderate Bad widespread publicity Temporary suspension of operations or prolonged restrictions Costs 20k – 200k
4	Major Multiple major injuries or single fatality	Major Major damage Costs 200k -2M	Major Tier 3 criteria reached with pollution requiring national support. Chemical spillage or small gas release COMAH local evacuation Costs 200k - 2M	Major National publicity, Temporary closure Costs 200k - 2M
5	Catastrophic Multiple fatalities	Catastrophic Catastrophic damage Costs >2M	Catastrophic Tier 3 oil spill criteria reached. International support required. Widespread shoreline contamination. Serious chemical or gas release. Significant threat to environmental amenity. COMAH major area evacuation Costs >2M	Catastrophic International media publicity. Operations and revenue seriously disrupted for more than two days. Ensuing loss of revenue. Costs >2M

Note that the Oil Pollution Preparedness, Response Co-operation Convention[5] defines the following response levels for oil spills in the United Kingdom:

- Tier 1 Local (within the capability of the operator on site): A Tier 1 response is the lowest response level and requires resources to be available locally. Depending on the characteristics of the oil this may or may not include the use of dispersants. By definition these resources must be at or near the incident site. It is expected that these resources will be deployed as quickly as operational circumstances allow.
- Tier 2 Regional (beyond the in-house capability of the operator): For larger pollution incidents, local resources may be insufficient to deliver a proper response. In these cases it may be that resources from a regional centre will be required. A key component of UK offshore Tier 2 response is that operators are expected to have this capability mobilised and applied within 2 to 6 hours of an oil pollution incident.
- Tier 3 National (requiring national resources): For very large pollution incidents, resources supplied from national and international sources may be required. A key component of UK offshore Tier 3 response is that operators are expected to have this capability mobilised and applied within 6 to 18 hours of an oil pollution incident.

Using the assessed notional frequency for the "Most Likely" and "Worst Credible" scenarios for each hazard, the probable consequences associated with each are assessed in terms of damage to:

- People - Personal injury, fatality etc.;
- Property – including third party;
- Environment - Oil pollution etc.; and
- Business - Reputation, financial loss, public relations etc.

The magnitude of each is then assessed using the consequence categories as shown in the table below. These have been set such that the consequences in respect of property, environment and business have similar monetary equivalent outcomes.

It should be noted that, the approach and terminology of the 2011 NRA, conducted for the DCO ES and DCO application, was undertaken to be cognisant of the existing estuary-wide risk assessment that has been conducted by Associated British Ports (ABP) as the Statutory Harbour Authority. Since 2011, ABP has revised its risk assessment and vessel category bands and terminology. As such the NRA update will be updated accordingly and where possible, phraseology will be adopted that is consistent

[5] The Merchant Shipping (Oil Pollution Preparedness, Response Co-operation Convention) Regulations 1998, Statutory Instrument 1998 No. 1056

with that utilised by ABP. However, for consistency and to allow comparison to the 2011 NRA, the same risk assessment matrix and definitions of frequency and consequence have been utilised.

Project Risk Matrix.

Consequences	Cat 5	5.1	5.9	7.0	8.3	10.0
	Cat 4	4.1	4.9	5.9	7.4	9.4
	Cat 3	2.9	3.5	4.4	5.9	8.3
	Cat 2	1.5	1.8	2.4	3.5	5.9
	Cat 1	0	0	0	0	0
	Frequency	>1,000 years	<1,000 years	<100 years	<10 years	Yearly

Navigation hazards are identified by the project team and scored for "frequency" and "consequence" and in terms of a "Most Likely" and "Worst Credible" outcome, with results documented in a "Hazard Log".

Risk bands

Matrix Outcome	Risk Definition	Action Taken
0 – 1.99	Negligible Risk	A level where operational safety is unaffected.
2 -3.99	Low risk	A level where operational safety is assumed.
4 – 5.99	As Low As Reasonably Practicable (ALARP)	A level defined by study at which risk control in place is reviewed. It should be kept under review in the ensuing SMS.
6 – 7.99	Significant Risk	A level where existing risk control is automatically reviewed and suggestions made where additional risk control could be applied if appropriate. Significant risk can occur in the average case or in individual categories. New risk controls identified should be introduced in a timescale of two years.
8 - 10	High Risk	A level requiring immediate mitigation.

The frequency and consequence scores are assessed to give two distinct risk scores;

- The average risk score of the categories in the "most likely" set;
- The average risk score of the categories in the "worst credible" set;]

These scores are combined using a weighted average to produce a single numeric value representing the final risk score for each hazard, between 0 (negligible) and 10 (high) following which, the final risk scores are sorted into a ranked hazard list.

Hazard risk scores are categorised as either negligible, low, As Low as Reasonably Practicable (ALARP), significant or high, where ALARP represents a level of risk is neither acceptable nor unacceptable and for which further investment of resources for risk reduction may or may not be justifiable – i.e. risks which fall within the ALARP band should be reduced unless there is a disproportionate cost to the benefits obtained.

Navigation hazards with a risk score of significant or high are deemed unacceptable and, as such, additional risk control measures must be implemented to reduce the risk to an acceptable level.

Annex B Stakeholder Consultation Minutes

Minutes of Meeting held on 14 April 2021 – ABP Humber

Client:	Able UK	
Project:	Able Marine Energy Park (AMEP)	
Venue:	Teleconference	
Date of Meeting:	Tuesday 14 April 2021 , 14:00	
Present:	ABP Humber (ABP)	Andrew Firman (AF) Graham Cudbertson (GC) Ben Brown (BB)
	Marico Marine (MM)	Rebecca Worbey (RW) William Heaps (WH)

Item	Notes for the Record	Actions
1	**Introduction**	
	Introductions. RW introduced the project and proposed material changes.	
2	**Baseline Traffic Profile**	
	Vessel traffic plots and analysis reviewed: • Some vessels incorrectly identifying as passenger vessels, particularly the wind farm support vessels / wind cats going to Grimsby and accompanied RoRo vessels going to Humber Sea Terminal. • The wind cats transiting to and from Grimsby represent a new activity since the last NRA was undertaken. • Wind farm vessels transporting wind turbine equipment heading to Greenport Hull also represent a new activity since the last NRA was undertaken. • Passenger vessels passing the site are likely the Pride of Hull and Pride of Rotterdam, but one of the Hull passenger services has recently ceased (since the last NRA and AIS data obtained). • No significant change to the prevalence of the fishing industry since the last NRA. • No significant change in leisure movements since last NRA. • Overall, there has been approximately a 10% decline in vessel movements across the estuary which has been lower still during 2020 as a result of COVID-19. • Traffic largely passes well clear of the development. Vessels bound for Humber Sea Terminals will be most impacted.	
3	**Hazard Identification**	
	• Humber Sea Terminal will be the most impacted, however, impacts should not be dissimilar to that previously assessed. • COMAH sites are present in the study area. As far as ABP is aware there have not been any new COMAH developments since the 2011 NRA, however, ABP Immingham and APT will be able to comment on this.	

	• Barge Berth may cause local changes in sedimentation which may cause issues for vessels berthing and the project RoRo vessel if it needs to go port side to. • The removal of the specialist berth is considered a positive design change. • It is worth noting that the extension of Immingham frontage will result in another mile of five knot speed restrictions. This is not a result of the material change but rather the presence of the project. • Mooring breakout chief hazard, but similar to previous design.	
4	**Mitigation Measures**	
	• Mooring study should be undertaken by the berth operators / new HA to ensure adequate arrangements (Breakout Hazard mitigation). • Care should be undertaken when disposing of dredge deposits at HU082/HU081 to ensure that the deposits do not encroach the channel. • An agreed plan will need to be established in advance for the disposal of dredge materials. HES is particularly concerned to ensure pilot allocation to dredgers is fairly managed to avoid disruption to other customers. (Dredgers may need to have PEC holders on board, or wait for pilot availability). • As the Harbour Authority, ABLE will have to develop their own marine safety management system, and ownership of responsibilities will need to be clear (Able or HES).	
5	**Cumulative**	
	• North Killingholme Jetty was already present prior to the 2011 NRA and so will have been included within that assessment. • Greenport Hull has commenced operation since the previous NRA. • Hull Riverside Bulk Terminal was not built however was in planning at the time of the last NRA and so may have been considered within the cumulative assessment. • Sunk dredge deepening was in the planning during the last NRA assessment but has not been undertaken. • Immingham Outer Harbour was already constructed during the last NRA. • There are no planned future developments within the study area.	
6	**Actions**	
	ABP requested a copy of the original NRA. ABP requested an updated construction phase vessel movement / dredge programme.	MM MM

Minutes of Meeting held on 15 April 2021 – ABP Immingham

Client:	Able UK	
Project:	Able Marine Energy Park (AMEP)	
Venue:	Teleconference	
Date of Meeting:	Tuesday 15 April 2021 , 11:30	
Present:	ABP Immingham (ABP)	Mark Collier (MC)
	Marico Marine (MM)	Rebecca Worbey (RW) William Heaps (WH)

Item	Notes for the Record	Actions
1	**Introduction**	
	Introductions RW introduced the project and proposed material changes.	
2	**Baseline Traffic Profile**	
	Vessel traffic plots and analysis reviewed: • Traffic profile appears as expected. • About 75 Crew Transfer Vessels (CTVs) per week into Grimsby. CTVs will not pass the Able site. Incidents • No recent incidents within the study area. • Most significant incident in recent years out of study area.	
3	**Hazard Identification**	
	• Tug availability may be an issue. • Likely to be sedimentation issues with the new recessed barge berth becoming a sediment trap and increasing grounding risk of project vessels. Dredge levels will need to be maintained through regular maintenance dredging. • Dredging to these levels will return hard clay which is very heavy and does not erode.	
4	**Mitigation Measures**	
	• Hazards should be adequately managed / mitigated by HES and passage planning. • Mooring study should be undertaken by the berth operators / new HA to ensure adequate arrangements (Breakout Hazard mitigation) • Can’t see a need for additional simulation.	
5	**Cumulative**	
	• No future developments for consideration within the cumulative assessment as far as MC is aware. • COMAH sites are present in the study area. As far as MC is aware there have not been any new COMAH developments since the 2011 NRA.	

	• There has been some interest in the potential of bringing LNG into the Humber in the future. There is no formal plan at this stage. • MC noted that Goole, Hull and Immingham including the Able development have been granted free-port status and therefore the traffic levels may increase in the future. If available, volume modelling of anticipated future traffic levels in light of freeport designation would be useful.	MM
6	**Other**	
	Will stone beds be installed for jack-ups? MC noted that maintenance costs for stone-beds can be high. MC questioned who has been appointed to undertake the dredging.	MM

Minutes of Meeting held on 21 April 2021 – CLdN / C.Ro Ports

Client:	Able UK	
Project:	Able Marine Energy Park (AMEP)	
Venue:	Teleconference	
Date of Meeting:	Tuesday 21 April 2021, 13:00	
Present:	CLdN	Benjamin Dove-Seymour (BD)
		Phil Pannett (PP)
	C.Ro Ports	Hugh Gates (HG)
	Marico Marine (MM)	Rebecca Worbey (RW)
		William Heaps (WH)

Item	Notes for the Record	Actions
1	**Introduction**	
	Introductions RW introduced the project and proposed material changes.	
2	**C.Ro Operations / Baseline**	
	• Activities (RoRo operations) remain unchanged since previous NRA was undertaken. • However, larger vessels (including the "next generation" G9 class vessels at 234m LOA) are now being utilised and therefore they require a larger swinging area when turning to berth. • There are six berths at Humber Sea Terminals. Although they are not all currently in use at one time, they may be utilised in the future. • It was clearly stressed that this is a significant and busy port with time critical operations.	
3	**Hazard Identification**	
	<u>Alignment</u> • It was clarified that while changes are proposed to the quay line, the alignment of the quay remains unchanged. • It was noted that any changes to the quay alignment may have an impact upon flow and sedimentation dynamics. <u>Construction Phase Vessel Traffic</u> • The prolonged duration of vessel movements depositing material to the HU082 and / or HU081 site was discussed in relation to risk. It was noted that while the risk presented by the vessels themselves would remain similar, the increased duration of the activity may have an impact on assessed risk. <u>Dredge Disposal</u> • CLdN expressed concern that the increased demand for pilotage from dredging vessels may impact on other customers and their own operations if the dredgers did not have sufficient PEC holders available. CLdN would expect the Pilotage	

<table>
<tr><td></td><td>Authority to manage pilot allocation to ensure existing customers and time critical services were not adversely impacted.</td><td></td></tr>
<tr><td>4</td><td>Mitigation Measures</td><td></td></tr>
<tr><td></td><td><u>Communication</u>
Communication will be essential at all project stages including between AMEP, the Dredging Contractor, C.Ro and other river users.
Communication must particularly be maintained during dredging operations. Delays caused by inability to swing to the berth due to obstruction will have considerable commercial and operational impact.
Contact details of all relevant Able personnel would be required.
A dedicated project marine movement co-ordinator was suggested as an effective mitigation measure during both construction and operational phases.
<u>Dredge Licences</u>
ABP should be fully consulted with regard to dredge licences. C.Ro would expect to be included in these discussions to ensure that their activities will not be disrupted or endangered by the dredge disposal operations.
<u>Scheduling</u>
There is a pinch point at Immingham Oil Terminal. It was suggested that project dredging vessels (especially less manoeuvrable towed barges, should (if possible) use the ‘Foul Holme Channel’ to keep clear of larger / scheduled river traffic.
It was suggested that priority should be given to C.Ro and other large vessels berthing at Immingham which operate according to strict timetables and which would be more impacted by delays than AMEP operational or / construction vessels.
<u>Protective Provisions</u>
Protective provisions originally negotiated with Able remain in place. It was noted that the proposed changes may have a bearing on risk factors and operations and the negotiated protective provisions.
<u>Mooring Planning</u>
Mooring planning was discussed, although it was noted that this will be required within Able’s SMS, and WH stated that this has already been identified as a potential mitigation factor.</td><td></td></tr>
<tr><td>5</td><td>Actions</td><td></td></tr>
<tr><td></td><td>CLdN considers that some of the necessary information required to form a view on navigation risk is missing and requested the following additional information:
A discrepancy was noted between the information presented within the scoping report and information provided by Able with regard to construction methodology. Please confirm whether the construction methodology remains the same as that presented within the DCO.
Additional information required with regards to the types of vessels to utilise the new barge berth. How long will they be there? How manoeuvrable will they be?</td><td>MM / Able

MM / Able
MM / Able</td></tr>
</table>

	• Detailed construction phase vessel movement schedule including dredger movements required. • CLdN to send MM vessel movements schedule for HST	CLdN

Minutes of Meeting held on 15 April 2021 – Exolum / APT

Client:	Able UK
Project:	Able Marine Energy Park (AMEP)
Venue:	Teleconference
Date of Meeting:	Tuesday 15 April 2021 , 10:00

Present:	Exolum (EX)	Kevin Redmile (KR) Steve Howard (SH) Simone Ingram (SI) Lee Wilson (LW) Tim Barrow (TB)
	Associated Petroleum Terminals (APT)	Neal Keena (NK)
	Marico Marine (MM)	Rebecca Worbey (RW) William Heaps (WH)

Item	Notes for the Record	Actions
1	**Introduction**	
	Introductions RW introduced the project and proposed material changes.	
2	**Description of Activities**	
	Jetty is owned by Exolum who utilize the jetty for their own vessels. Usage is additionally shared by the two adjacent refineries to load / discharge LPG and white oil products. No heavy fuel oils go through the jetty.	
3	**Baseline Traffic Profile**	
	Vessel traffic plots and analysis reviewed: • The development is in a very busy part of the Humber. • RoRo traffic into HST will be passing very close to the DCO area. • Overall, there has been a reduction in vessel traffic in the Humber. ○ SKJ – received 173 ships last year, 178 in 2019, 214 in 2018 and 243 in 2017. First quarter berth occupancy figures for 2021 show an increase on 2020. Incidents • Spring line parted on a ship berthed on SKJ in 2019 due to interaction with vessel going up to HST.	
4	**Hazard Identification**	
	Sedimentation • Sedimentation levels and the impact that they may have on the dredge pocket off SKJ, and the areas behind the jetties used by mooring boats, is a concern.	

	• Currently there is little maintenance dredging required around SKJ which needs to be maintained to -11m. • Extra siltation would negatively impact access to the mooring dolphins at SKJ. If siltation was such that it prevented access by boat then jetties would need to be fitted. • Sedimentation of approach channels may also be an issue. Vessel Traffic • The proposed frequency of vessel movements in the operational phase (approximately 1 per day) look to be reasonable. Proximity to SKJ • The development is very close to SKJ • Interactions with SKJ, for example, simultaneous berthing, will need to be considered. Tugs • APT suffers cancellations due to lack of tug availability and tug availability will be a concern if AMEP is reliant on tugs.	
5	**Mitigation Measures**	
	• Will ABP place any restrictions on simultaneous movements on SKJ and the downstream end of the new berth? • Will ABP impose tidal restrictions on berthing and sailing? • Mooring study should be undertaken by the berth operators / new HA to ensure adequate arrangements (Breakout Hazard mitigation) • Mitigation measures proposed within 2011 NRA look reasonable.	MM MM
6	**Other**	
	• Is a RoRo ramp part of the design? • It was noted that there is also an additional land-based (no marine component) development adjacent to the project. • It was questioned whether or not materials will be brought in by road or by river during the construction phase. If by road, there are concerns about the level of congestion of the main nearby access road.	MM MM
7	**Actions**	
	• SI requested a copy of the DCO.	MM

Additional Comments Received via Email - APT

Client:	Able UK	
Project:	Able Marine Energy Park (AMEP)	
Date of Meeting:	10 May 2021	
From	Associated Petroleum Terminals (APT)	Neal Keena (NK)
To	Marico Marine (MM)	Rebecca Worbey (RW)

1	Notes for the record	
	• The dredging company to be fully aware of all SKJ and IGJ shipping movements. • Slow speed required when passing moored vessels at both SKJ and IGJ. This is in line with the Humber bylaws. • There is a concern that waste material from dredging operations would find its way into the dredged pocket on SKJ and behind the berth, reducing access to the mooring dolphins. This would be an additional concern on top of the general concern we have about the effect of the new jetty of siltation. We currently have very little siltation in the SKJ dredged pocket. Will Able be offering any additional monitoring of water depths off the jetty, to understand if any waste material is being deposited there?	

Minutes of Meeting held on 20 April 2021 – MCA

Client:	Able UK	
Project:	Able Marine Energy Park (AMEP)	
Venue:	Teleconference	
Date of Meeting:	Tuesday 20 April 2021, 10:00	
Present:	Maritime and Coastguard Agency (MCA)	Helen Croxson (HC)
	Marico Marine (MM)	Rebecca Worbey (RW) William Heaps (WH)

Item	Notes for the Record	Actions
1	**Introduction**	
	Introductions RW introduced the project and proposed material changes.	
2	**Hazard Identification**	
	• The development is fully within ABP Humber harbour limits. • The MCA expects the proposed assessment methodology for 'Commercial and Recreational Navigation' to be updated for the revised Environmental Statement, and on the understanding Associated British Ports Ltd (ABP) as the Statutory Harbour Authority for the Humber Estuary remains fully consulted, is content with the NRA and that the NRA complies with PMSC requirements, the MCA is unlikely to have any concerns at this time.	
3	**Mitigation Measures**	
	• To address the ongoing safe operation of the marine interface for this project, MCA would point developers in the direction of the Port Marine Safety Code (PMSC) and its Guide to Good Practice. They will need to liaise and consult with the Statutory Harbour Authority and develop a robust Safety Management System (SMS) for the project under this code. • Charts should be updated. • Appropriate information should be circulated to interested parties. • Final drawings should be submitted to the UKHO. • Trinity House should be consulted regarding changes to Aids to Navigation and any other aspects of relevance identified within the NRA.	
4	**Other**	

	• HC questioned whether there would be any change to harbour powers and whether there would be a Harbour Revision Order.
	    o WH confirmed that Able will be the Statutory Harbour Authority for the development area, however, ABP Humber will remain the Conservancy Authority. HC questioned when this would come into effect?
	    o HC noted that the MCA, through the Ports Team, would expect to be consulted on this and review the Harbour Revision Order.
		MM

	• The NRA process was discussed.
	  ○ MM confirmed that ABP Humber has been consulted and will continue to be consulted throughout the NRA /EIA process.
	  ○ MM clarified that a PEIR has already been undertaken and that the NRA will inform the final ES chapter.	

Annex C Construction Phase Risk Assessment Hazard Log – Baseline with Embedded Mitigation

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
					People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency		
1	Collision	Construction Vessel ICW Tanker	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	3	3	3.0	4	4	4	4	2.0	4.52	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots
2	Collision	Construction Vessel ICW Cargo	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	3	2	3	3.0	4	4	3	4	2.0	4.43	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Frequency	Risk Score	Possible Additional Risk Controls
3	Collision	Construction Vessel ICW Construction Vessel	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	2	2	4.0	4	4	4	4	3.0	5.47	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots
4	Collision	Construction Vessel ICW Workboat/Other	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	3	2	2	3.0	4	4	3	3	2.0	4.22	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Frequency	Risk Score	Possible Additional Risk Controls
5	Contact	Construction vessel contacts AMEP project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	2	2	3.0	4	4	3	3	2.0	4.10	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots
6	Contact	Non-project vessel contacts AMEP project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	2	2	3.0	4	4	3	3	2.0	4.10	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score	Possible Additional Risk Controls
7	Contact	Construction vessel contacts non-project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	2	2	2.0	4	4	3	3	2.0	3.70	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots
8	Contact	Construction vessel contacts vessel alongside third party berth	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	2	2	2	2.0	4	3	3	3	2.0	3.10	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
					People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency		
9	Contact	Construction vessel contacts navigation aid	Adverse weather conditions; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	5.0	2	2	2	2	3.0	1.21	Marine Safety Management System Emergency procedures Marking and lighting Availability of pilots
10	Grounding	Construction vessel runs aground	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	4.0	3	3	2	3	2.0	1.65	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
					People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency		
11	Grounding	Non-project vessel runs aground due to construction activities	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	4.0	3	3	2	4	3.0	2.56	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots Protective Provisions
12	Sinking / Capsize	Construction vessel sinks / capsizes	Incorrect assessment of height of tide Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures in place onboard vessel; Loss of vessel stability (due to other than watertight integrity) Loss of water tight integrity; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	3.0	4	3	3	4	2.0	2.26	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score	Possible Additional Risk Controls
13	Break Out	Construction vessel breaks away from its moorings	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	2	1	1	3.0	4	4	1	2	2.0	2.85	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting
14	Break Out	Third party vessel breaks away from its moorings due to project activities	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	1	1	1	2.0	4	4	4	3	1.0	2.54	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Frequency	Risk Score	Possible Additional Risk Controls
15	Fire / Explosion	Fire / Explosion: Vessel alongside third party berth	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	3	4	3	2.0	5	5	5	5	1.0	4.72	Marine Safety Management System Emergency procedures Dedicated project marine manager
16	Fire / Explosion	Fire / Explosion: Construction Vessel alongside	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	1	2	3.0	5	4	4	4	2.0	4.45	Marine Safety Management System Emergency procedures Dedicated project marine manager

Annex D Operation Phase Risk Assessment Hazard Log – Baseline with Embedded Mitigation

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
					People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency		
1	Collision	AMEP Vessel ICW Tanker	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	3	3	3.0	4	4	4	4	2.0	4.52	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots
2	Collision	AMEP Vessel ICW Cargo	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	3	2	3	3.0	4	4	3	4	2.0	4.43	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score	Possible Additional Risk Controls
3	Collision	AMEP Vessel ICW AMEP Vessel	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	1	1	1	5.0	4	4	4	4	2.0	4.28	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots
4	Collision	AMEP Vessel ICW Workboat / Other	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	3	2	2	2.0	4	4	3	3	2.0	3.80	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Frequency	Risk Score	Possible Additional Risk Controls
5	Contact	AMEP vessel contacts project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	2	1	2	5.0	4	4	4	3	2.0	4.93	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Standard Operating Procedures Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots
6	Contact	AMEP vessel contacts non-project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	2	1	2	2.0	4	4	2	3	1.0	2.61	Suitably qualified marine personnel Marine Safety Management System Standard Operation Procedures (SOP) Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environmen t	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environmen t	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score	Possible Additional Risk Controls
7	Contact	Non-project vessel contacts AMEP project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	2	2	2	2.0	3	4	3	3	1.0	2.74	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Availability of pilots
8	Contact	AMEP vessel contacts third party vessel alongside.	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	2	1	2	2.0	4	4	4	4	1.0	2.85	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score	Possible Additional Risk Controls
9	Contact	AMEP vessel contacts navigation aid	Adverse weather conditions; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	3.0	2	2	2	2	2.0	0.92	Marine Safety Management System Emergency procedures Marking and lighting Availability of pilots
10	Grounding	AMEP vessel runs aground	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	3.0	3	4	1	4	2.0	2.04	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score	Possible Additional Risk Controls
11	Grounding	Non-project vessel runs aground	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	4.0	3	4	1	4	3.0	2.50	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots Protective Provisions
12	Sinking / Capsize	AMEP vessel sinks / capsizes	Incorrect assessment of height of tide Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures in place onboard vessel; Loss of vessel stability (due to other than watertight integrity) Loss of water tight integrity; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	1	1	1	1	3.0	4	4	3	4	1.0	1.96	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence: People	Property	Environment	Business	Frequency	Worst Credible Consequence: People	Property	Environment	Business	Frequency	Risk Score	Possible Additional Risk Controls
13	Break Out	AMEP vessel breaks away from its moorings	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	1	1	4.0	4	4	1	3	3.0	4.57	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Mooring Studies
14	Break Out	Third party vessel breaks away from its moorings due to project activities	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	2	1	1	1	2.0	4	4	4	3	1.0	2.54	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting
15	Fire / Explosion	Fire / Explosion: Non-project vessel alongside third party berth	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	3	4	3	2.0	5	5	5	5	1.0	4.72	Marine Safety Management System Emergency procedures Dedicated project marine manager

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Most Likely Consequence					Worst Credible Consequence					Risk Score	Possible Additional Risk Controls
					People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency		
16	Fire / Explosion	Fire / Explosion: AMEP Vessel alongside	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	3	2	1	2	3.0	5	5	4	5	1.0	4.17	Marine Safety Management System Emergency procedures Dedicated project marine manager

Annex E Construction Phase Risk Assessment Hazard Log – Residual with Possible Additional Mitigation

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
1	Collision	Construction Vessel ICW Tanker	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	3	2	3	3	2.0	4	4	4	4	2.0	4.07
2	Collision	Construction Vessel ICW Cargo	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	3	3	2	3	2.0	4	4	3	4	2.0	4.00

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
3	Collision	Construction Vessel ICW Construction Vessel	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots	3	2	2	2	3.0	4	4	4	4	2.0	4.27
4	Collision	Construction Vessel ICW Workboat/Other	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	3	3	2	2	2.0	4	4	3	3	2.0	3.80

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
5	Contact	Construction vessel contacts AMEP project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	3	2	2	2	3.0	4	4	3	3	2.0	4.10
6	Contact	Non-project vessel contacts AMEP project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	3	2	2	2	3.0	4	4	3	3	2.0	4.10

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
7	Contact	Construction vessel contacts non-project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	3	2	2	2	2.0	4	4	3	3	2.0	3.70
8	Contact	Construction vessel contacts vessel alongside third party berth	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	2	2	2	2	2.0	4	3	3	3	1.0	2.74

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
9	Contact	Construction vessel contacts navigation aid	Adverse weather conditions; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Marine Safety Management System Emergency procedures Marking and lighting Availability of pilots	1	1	1	1	4.0	2	2	2	2	3.0	1.21
10	Grounding	Construction vessel runs aground	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots	1	1	1	1	3.0	3	3	2	3	2.0	1.65

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
11	Grounding	Non-project vessel runs aground due to construction activities	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots Protective Provisions	1	1	1	1	4.0	3	3	2	4	2.0	2.07
12	Sinking / Capsize	Construction vessel sinks / capsizes	Incorrect assessment of height of tide Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures in place onboard vessel; Loss of vessel stability (due to other than watertight integrity) Loss of water tight integrity; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting	1	1	1	1	3.0	4	3	3	4	2.0	2.26

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score
13	Break Out	Construction vessel breaks away from its moorings	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting	2	1	1	1	2.0	4	4	1	2	2.0	2.51
14	Break Out	Third party vessel breaks away from its moorings due to project activities	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting	2	1	1	1	2.0	4	4	4	3	1.0	2.54

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
15	Fire / Explosion	Fire / Explosion: Vessel alongside third party berth	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Marine Safety Management System Emergency procedures Dedicated project marine manager	3	3	4	3	2.0	5	5	5	5	1.0	4.72
16	Fire / Explosion	Fire / Explosion: Construction Vessel alongside	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Marine Safety Management System Emergency procedures Dedicated project marine manager	3	2	1	2	2.0	4	4	4	4	2.0	3.75

Annex F Operation Phase Risk Assessment Hazard Log – Residual with Possible Additional Mitigation

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
1	Collision	AMEP Vessel ICW Tanker	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots	3	2	3	3	2.0	4	4	4	4	2.0	4.07
2	Collision	AMEP Vessel ICW Cargo	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots	3	3	2	3	2.0	4	4	3	4	2.0	4.00

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
3	Collision	AMEP Vessel ICW AMEP Vessel	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of towage Restrict simultaneous movements Availability of pilots	2	1	1	1	5.0	4	4	4	4	1.0	3.89
4	Collision	AMEP Vessel ICW Workboat / Other	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - Tug Personnel; Human error/competence/fatigue - VTS Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Standard Operating Procedures Up-to date weather forecasting Marking and lighting Availability of pilots	3	3	2	2	2.0	4	4	3	3	2.0	3.80

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence: People	Most Likely Consequence: Property	Most Likely Consequence: Environment	Most Likely Consequence: Business	Most Likely Consequence: Frequency	Worst Credible Consequence: People	Worst Credible Consequence: Property	Worst Credible Consequence: Environment	Worst Credible Consequence: Business	Worst Credible Consequence: Frequency	Risk Score
5	Contact	AMEP vessel contacts project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Standard Operating Procedures Marking and lighting Availability of towage. Restrict simultaneous movements Availability of pilots	2	2	1	2	4.0	4	4	4	3	2.0	3.87
6	Contact	AMEP vessel contacts non-project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Standard Operation Procedures (SOP) Availability of pilots	2	2	1	2	2.0	4	4	2	3	1.0	2.61

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
7	Contact	Non-project vessel contacts AMEP project infrastructure	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Availability of pilots	2	2	2	2	2.0	3	4	3	3	1.0	2.74
8	Contact	AMEP vessel contacts third party vessel alongside.	Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Availability of pilots	2	2	1	2	2.0	4	4	4	3	1.0	2.77

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
9	Contact	AMEP vessel contacts navigation aid	Adverse weather conditions; Equipment failure; Failure of navigation aid; Failure to comply with International COLREGS; Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Marine Safety Management System Emergency procedures Marking and lighting Availability of pilots	1	1	1	1	3.0	2	2	2	2	2.0	0.92
10	Grounding	AMEP vessel runs aground	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots	1	1	1	1	3.0	3	4	1	4	1.0	1.71

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
11	Grounding	Non-project vessel runs aground	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - equipment; Communication failure - operational/ procedural; Equipment failure; Failure of navigation aid; Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Human error/competence/fatigue - Pilot/PEC holder; Human error/competence/fatigue - VTS Personnel; Inadequate procedures in place onboard vessel; Loss of water tight integrity; Malicious action by third party Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Additional surveys of study area Up-to date weather forecasting Marking and lighting Restrict simultaneous movements Dredge disposal plan Availability of pilots Protective Provisions	1	1	1	1	4.0	3	4	1	4	2.0	2.04
12	Sinking / Capsize	AMEP vessel sinks / capsizes	Incorrect assessment of height of tide Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures in place onboard vessel; Loss of vessel stability (due to other than watertight integrity) Loss of watertight integrity; Malicious action by third party Restricted visibility. Result of avoiding action with 3rd party vessel / dredging operations Unexpected shoaling/ inadequate survey	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting	1	1	1	1	3.0	4	4	3	4	1.0	1.96

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
13	Break Out	AMEP vessel breaks away from its moorings	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting Mooring Studies	3	2	1	1	3.0	4	4	1	3	2.0	3.58
14	Break Out	Third party vessel breaks away from its moorings due to project activities	Incorrect assessment of height of tide Adverse weather conditions; Communication failure - operational/ procedural; Communication failure - personnel; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Fire and explosion. Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Suitably qualified marine personnel Marine Safety Management System Emergency procedures Dedicated project marine manager Up-to date weather forecasting	2	1	1	1	2.0	4	4	4	3	1.0	2.54

ID	Category	Hazard Title	Possible Causes	Embedded Mitigations	Possible Additional Risk Controls	Most Likely Consequence					Worst Credible Consequence					Risk Score
						People	Property	Environment	Business	Frequency	People	Property	Environment	Business	Frequency	
15	Fire / Explosion	Fire / Explosion: Non-project vessel alongside third party berth	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Marine Safety Management System Emergency procedures Dedicated project marine manager	3	3	4	3	2.0	5	5	5	5	1.0	4.72
16	Fire / Explosion	Fire / Explosion: AMEP Vessel alongside	Adverse weather conditions; Equipment failure; Excessive wash or draw-off. Failure of ship's mooring gear. Failure to observe Byelaws/local regulations; Human error/ competence/fatigue - Ship Personnel; Inadequate procedures ashore; Inadequate procedures in place onboard vessel; Malicious action by third party Restricted visibility.	VTS Traffic Organisation Service; Adherence to International regulations; Adherence to local regulations/ procedures; Adherence to ABP Humber Emergency Plan; Training and authorisation of pilots; Pilotage exemption certificates; Passage planning; Guidance for small craft; Promulgation of Information including Notice to Mariners; Update Navigation Charts.	Marine Safety Management System Emergency procedures Dedicated project marine manager	3	2	1	2	3.0	4	4	3	4	1.0	3.65

DFDS COMMENTS ON D3 SUBMISSION

APPENDIX 3

SOLENT NRA

MARCHWOOD PORT DEVELOPMENT: NAVIGATION RISK ASSESSMENT

05-MAY-2021 SOLENT GATEWAY LTD

Assessment to determine the navigation risk in Southampton Water as a result of increased vessel movements associated with the Marchwood Port Development Project.

Project No.: 20-NASH-0116

Issue: R02-00

REPORT TITLE:	MARCHWOOD PORT: NAVIGATION RISK ASSESSMENT
CLIENT:	SOLENT GATEWAY LIMITED
CLIENT ADDRESS:	CRACKNORE HARD, MARCHWOOD, SO40 4UT

Document Control					
Document Number		20-NASH-0116_200_R02-00			
Document Title		MARCHWOOD PORT: NAVIGATION RISK ASSESSMENT			
Revision	Date of Issue	Description	Prepared	Checked	Approved
R01-00	23-Mar-21	Draft	SAB, CH, EJR	CH	EJR
R02-00	05-May-21	Final issue with update SGL vessel numbers.	EJR	EJR	EJR

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CONTENTS

FIGURES

TABLES

ANNEXES

1. INTRODUCTION

1.1 OVERVIEW

NASH Maritime Ltd have been contracted by Solent Gateway Ltd (SGL) to deliver a Navigational Risk Assessment (NRA) for the Marchwood Port Development (the project) to support ARUP (as lead EIA consultant) as they prepare an Environmental Statement report for the land-based development of the Marchwood Port site. **Figure 1** shows the location of Marchwood Port and other navigational points of interest within the Port of Southampton study area.

The proposed development will comprise the phased intensification of Marchwood Port to make effective and efficient use of the site for port and port related uses, including additional hardstanding for open storage, buildings for warehousing, industrial, office, security and staff welfare purposes, along with access improvements, circulation routes, servicing and parking, as well as landscaping, ecological areas, secure boundary fencing and other works[1]. The proposed development does not include any plans for further development of the existing Marchwood port marine infrastructure (e.g. wharfs, quay walls, dredged depths, etc.).

1.2 REQUIREMENTS FOR ASSESSMENT

An initial Environmental Scoping report was submitted by ARUP to New Forest District Council in July 2020 and the requirement to consider Shipping and Navigation has arisen from a consultee response from ABP Southampton as Statutory and Competent Harbour Authority for the Port of Southampton. The response relates specifically to the requirement for a detailed NRA to be included as part of the EIA submission. A detailed NRA has been requested in order to address concerns regarding the increase in vessel numbers projected to visit Marchwood Port, as a result of the land-based development.

1.3 ASSESSMENT APPORACH

The assessment methodology was developed in conjunction with Solent Gateway Ltd and ABP Southampton as the Statutory Harbour Authority and included the following process:

- **Step 1:** Review of proposed development as it relates to additional vessel traffic movement numbers and early engagement with ABP Southampton to define key issues to be addressed as part of the assessment – see **Section 1**.

[1]https://planning.newforest.gov.uk/onlineapplications/files/22396EACF2446FC40670282BAAE40CB5/pdf/20_10795-EIA_SCOPING_REPORT-5535829.pdf

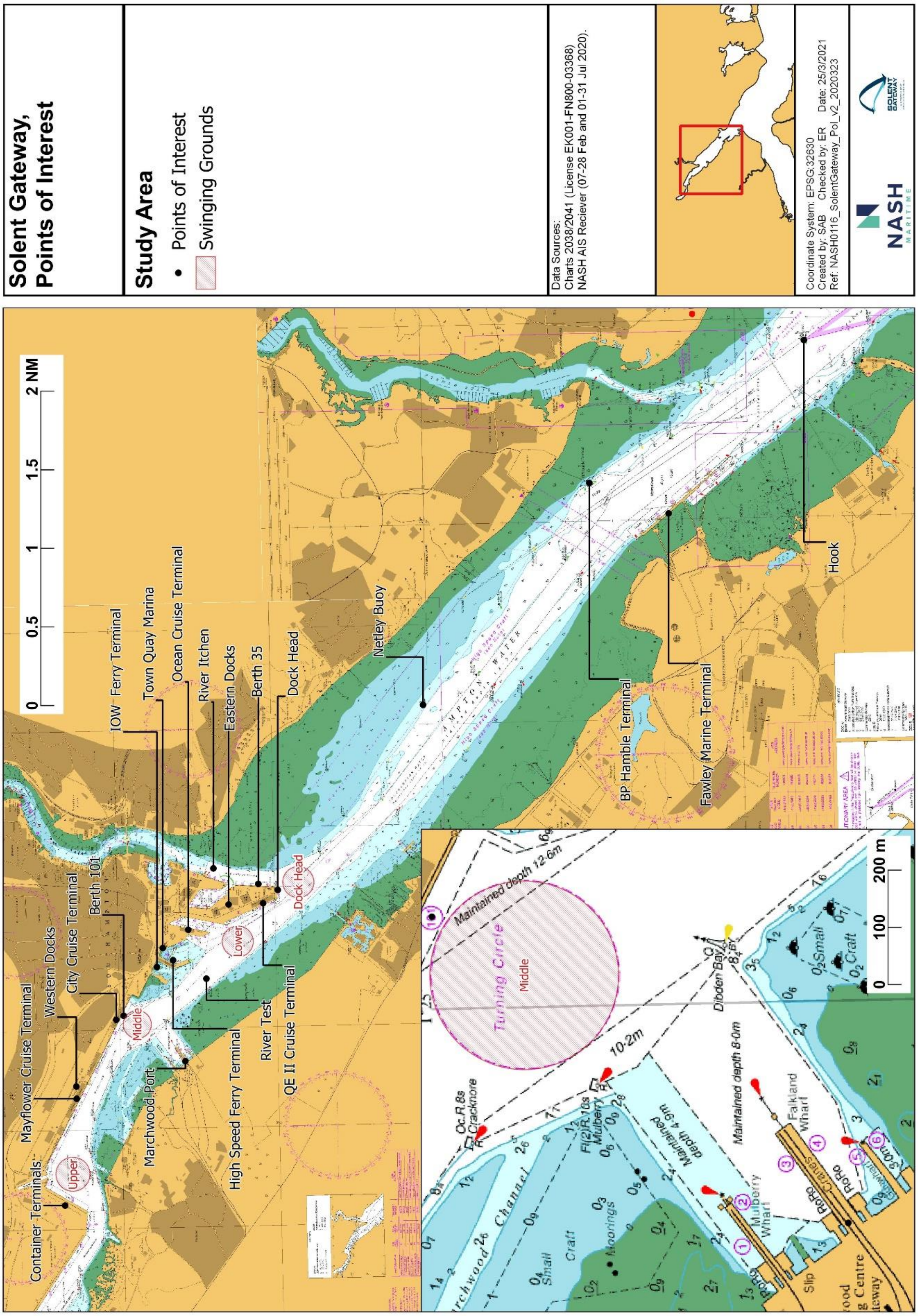

Figure 1: Marchwood Port and Navigational Points of Interest.

- **Step 2:** Vessel traffic analysis to characterise baseline vessel traffic activity within the project study area – see **Section 2**.
- **Step 3:** Future vessel traffic risk modelling to understand the magnitude of vessel collision, grounding, or alision occurrence as a result of the project – see **Section 3**.
- **Step 4:** Consultation with statutory regulators (ABP Southampton) and interested navigation parities – see **Section 4.**
- **Step 5:** Review of navigation impacts brought about by the project – see **Section 5**.
- **Step 6:** Review and update ABP Southampton's port wide risk assessment to consider changes (in terms of navigation hazard likelihood and consequence) brought about by the project, based on the analysis, modelling, and consultation undertaken – see **Section 6**.
- **Step 7:** Present conclusions and recommendation of the assessment see **Section 7**.

1.4 RELEVANT GUIDANCE

The following sections provide details on the legislation and guidance, procedures and practices required to be taken into account when conducting a NRA within a port area, such as is required for the project.

1.4.1. LEGISLATION

The following list provides a summary of the relevant legislation identified as part of this NRA outline review:

- Southampton Harbour Byelaws
- Southampton Harbour Act 1939
- Harbours, Docks & Piers Clauses Act 1847
- Transport Docks Act 1964
- British Transport Docks Act 1972
- Transport Act 1981
- Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs, as amended)[2]

[2] Implemented in the UK through the Merchant Shipping (Distress Signals and Prevention of Collisions) Regulations 1996

- International Ship and Port Facility Security Code 2004[3]

1.4.2. GUIDANCE, PROCEDURES, PRACTICES

The following list provides a summary of the relevant guidance, procedures and practices identified as part of this NRA outline review:

- Port Marine Safety Code [4]
- Port Marine Safety Code – "Guide to Good Practice" [5]
- Port of Southampton Port Users Information & Navigation Guidelines (PUNG)[6]
- SOLFIRE - SOLFIRE is a contingency plan developed to deal with any Marine Emergency occurring within the Ports of Portsmouth or Southampton, Southampton Water, Spithead, and The Solent.
- Port of Southampton Pilotage Directions [7]
- Port of Southampton Marine Safety Management System
- The Yachtsman's Guide to Southampton Water and it's Approaches[8]

1.5 MARCHWOOD PORT

Marchwood Port, also known as Marchwood Sea Mounting Centre / Marchwood Military Port, is operated by SGL and has several wharves and berths, with the Falkland Wharf providing the largest berths. The site is owned by the Ministry of Defence (MoD) who have entered into a 35-year concession agreement with SGL (which commenced in 2016) to grow the commercial use of Marchwood Port. The concession agreement serves to meet future aspirations for the port whilst maintaining certain contractual obligations to the MoD. Marchwood Port is located immediately to the south and east of Marchwood village, which is located on the opposite side of the River Test and to the south-west of the city of Southampton.

There are three double berth jetties (from north to south – see **Figure 1**):

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[3] International Convention for the Safety of Life at Sea (SOLAS) chapter XI-2 Implemented in the UK through the Ship and Port Facility (Security) Regulations 2004
[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/918935/port-marine-safety-code.pdf
[5] https://www.gov.uk/government/publications/a-guide-to-good-practice-on-port-marine-operations
[redacted]

- Mulberry Jetty which is only used by the Ministry of Defence;
- Falklands Jetty, used by vessels operated by the Ministry of Defence and commercial operators (using the port to load / discharge commercial cargo); and
- Gunwharf jetty which is only used by the Ministry of Defence.

The majority of vessel traffic currently visiting Marchwood Port is Ministry of Defence vessels, most notably the Point Class vessels, which are roll-on / roll-off sea lift ships used as naval auxiliaries to the British Armed Forces.

Marchwood Port is located within the Statutory Harbour Authority (SHA) area (navigation authority for safe management of navigation) and Competent Harbour Authority (CHA) area (provision of marine pilots) of ABP Southampton.

A review of historical vessel traffic arrivals to Marchwood Port is presented in **Figure 2**, which shows since 2018 the majority of vessel calls have been related to Ministry of Defence vessels and that on average around 12 vessels visit Marchwood Port per quarter. Of the vessels visiting Marchwood Port between 2018 and 2020 the:

- MoD vessels made up 136 arrivals (of which 121 were the Point Class vessels); and
- SGL vessels made up 19 arrivals.

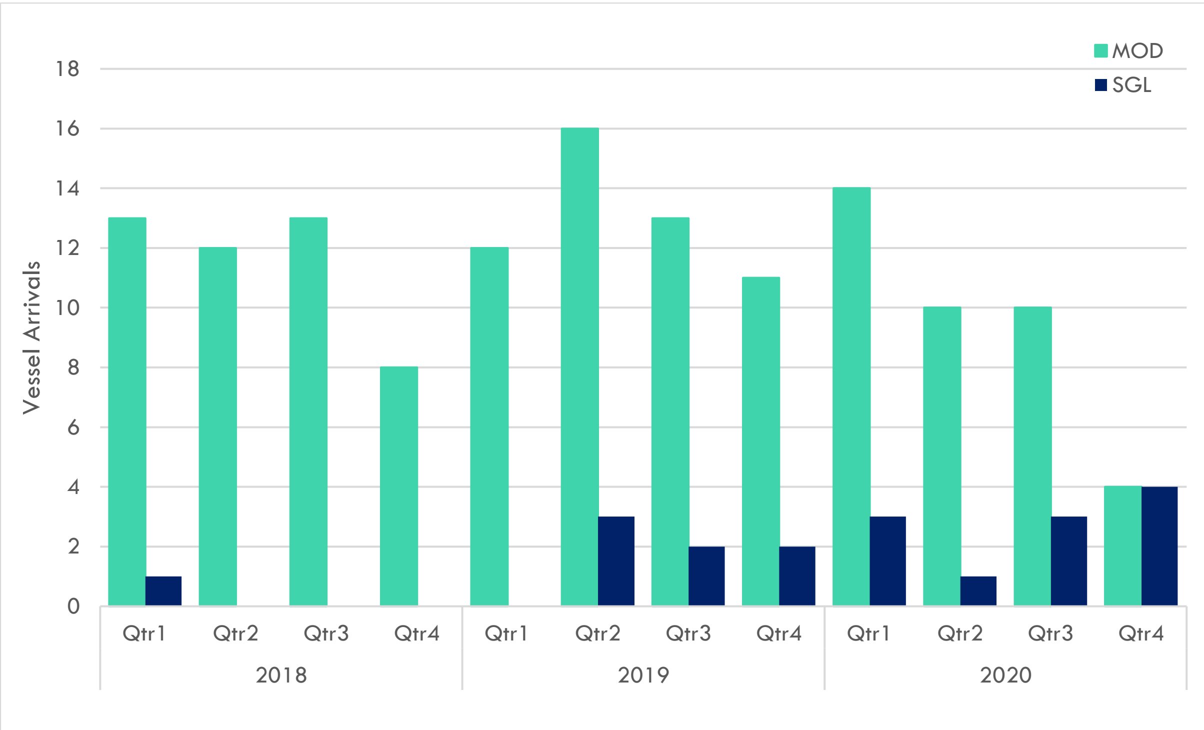


Figure 2: Historical vessel arrivals at Marchwood Port (MOD – Ministry of Defence vessels, SGL – Solent Gateway Vessels).

1.6 SOLENT GATEWAY FUTURE VESSEL TRAFFIC

SGL have provided anticipated vessel arrivals based on the Marchwood Port Development project (see **Table 1**) which provides a summary of the number of future vessel movements[9] (future baseline) at Marchwood Port in relation to the ports current use in 2019. The future numbers account for additional vessel arrivals to Marchwood Port (these relate to additional vessel movements through ABP Southampton waters rather than relocated existing vessel movements from other facilities within ABP Southampton).

Table 1: Summary of potential increase in Vessel Movements (Annual).

Cargo Types	2019	Future
	Arrivals	Arrivals
Automotive	1	22
Aggregates		
Specialist Aggregates		25
Bulk Aggregates		15 or 6 [10]
Steel	3	19
Project cargo / Other	6	72
Other (Barge/Support vessel)	0	5
MOD (Non Commercial)	36	40
Totals	46	189 or 198

SGL have identified a number of exemplar vessels that have similar dimensions and capabilities to vessels that will utilise Marchwood Port in the future, see **Table 1**, which have been used for this assessment to determine the future vessel traffic profile for the Marchwood Port Development.

For the purpose of this assessment, it is assumed there will be no material change to 2019 vessel traffic volume and type at the Port of Southampton, other than that related to the Marchwood Port Development. The port had expected an increase in cruise vessel traffic in 2020 and beyond, however, the impact of COVID-19 has been significant on this sector and it may take some time to recover to 2019

[9] Note that original forecasts included approximately 200 aggregate dredger vistis per year.
[10] Dependant on vessel utilised.

levels. This is considered a conservative assumption on the basis that the port traffic remains static or increases.

Table 2: Summary of Exemplar Vessels.

Vessel Type	Name	Dimensions
Automotive	Autopremier	LOA: 125m
		Beam: 18.8m
		Draught: 7.3
	City of Oslo	LOA: 140m
		Beam: 22m
		Draught: 7.3m
Quarried Aggregates - Specialist	Arklow Ranger	LOA: 89.95m
		Beam: 14.45
		Draught: 5.79m
Quarried Aggregates - Bulk General	Thamesborg	LOA: 172
		Beam: 21.5
		Draught: 9.5
	or	
	Yeoman Bank	LOA: 205m
		Beam: 27m
		Draught: approx. 10.5
Steel	Rolldock	LOA: 151m
		Beam: 26m
		Draught: 8.1m
Project cargo / Other	Morgenstrond II	LOA: 140m
		Beam: 19m
		Draught: 6.1m
MOD (Non Commercial)	Point Class	LOA: 193m
		Beam: 26m
		Draught: 6m

The largest vessels utilised as part of the future operation will be the bulk carrier vessels. It is envisaged that vessels similar to the *Yeoman Bank* and *Thamesborg* (see **Figure 3**) will be deployed to transport bulk aggregate cargos to and from Marchwood Port. Due to the size of these vessels, arrivals and departures from the port will need to be carefully planned to ensure minimal impact on other port operations.

Figure 3: Left- Yeoman Bank, Right – Thamesborg.

1.7 KEY ISSUES TO BE ADDRESSED

In early consultation with ABP Southampton Harbour Master, the following key issues to be addressed as part of the NRA were discussed and identified:

- The impact on existing navigation;
- Impact on the passage of draught restricted vessels (e.g. container vessels);
- Impact on the passage of time critical vessels (e.g. cruise ships);
- Impact on vessel traffic procedures – (e.g. passing points for vessels ≥180m LOA above the Hook Buoy);
- Possible impacts to ferry movements;
- Take into consideration the increased number of cruise ships using the turning circle off berth 102; and
- Consideration to leisure traffic transiting to and from Town Quay marina.

2. VESSEL TRAFFIC CHARACTERISATION

To establish baseline traffic levels and disposition of vessel traffic activity in the vicinity of Marchwood Port, AIS data was collated from NASH Maritime's AIS receiver located at Ocean Village. The data for the months of February 2020 and July 2020 were analysed to understand the general / representative disposition of vessel movements in and around the study area. For the purpose of the NRA the study area (which was agreed with ABP Southampton) is as illustrated in **Figure 4**.

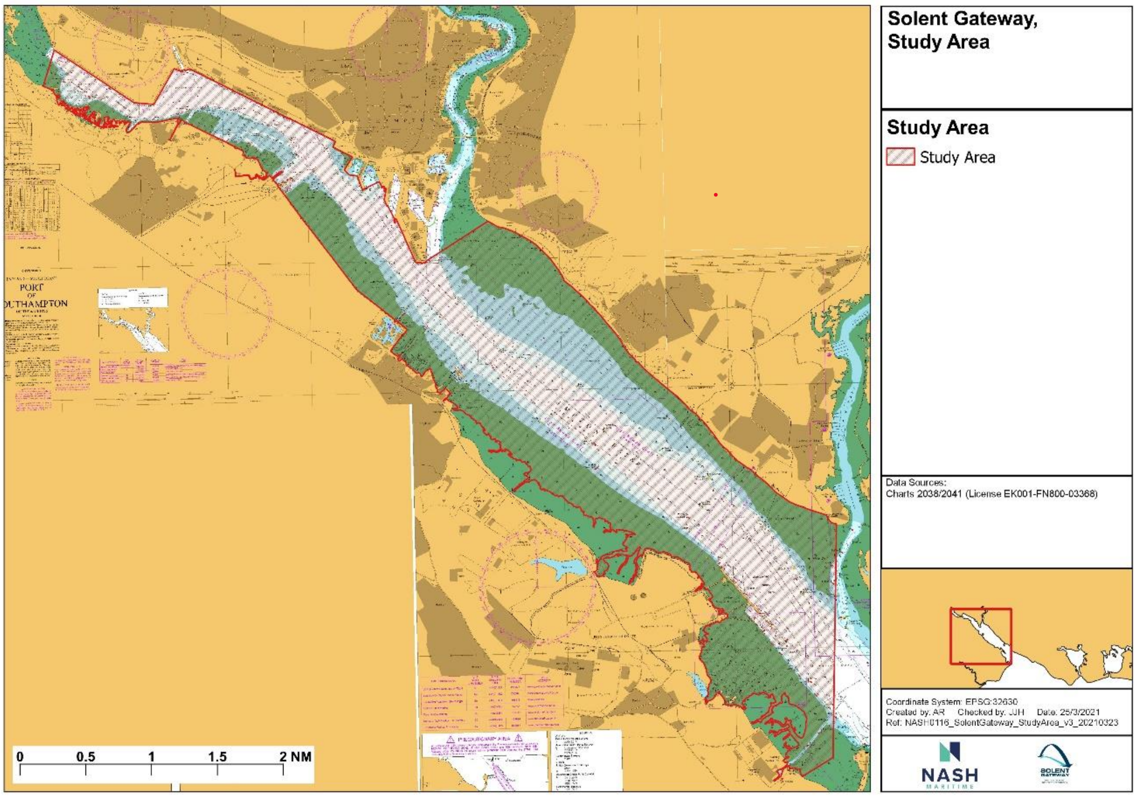


Figure 4: Study Area.

To establish a baseline understanding of vessel movement and passage through the study area the following analysis was conducted:

- Vessel track analysis by vessel type (see **Section 2.2**);
- Vessel density analysis (see **Section 2.2**);
- Swept path analysis of vessels berthing / unberthing at Marchwood Port (and of vessels similar to those using the port arriving / departing a berth in the vicinity of the project location) (see **Section2.3**); and
- Gate analysis near the proposed site (see **Section 2.4**

Note that considerations of Covid-19 impacts on vessel traffic movements are made in **Section 2.5**.

A review of ABP Southampton incident data was also undertaken to inform likelihood / consequence of hazard occurrence (see **Section 2.6**).

Together these data and analyses provide the baseline evidence behind the understanding and characterisation of vessel traffic that informs the identification and assessment of navigation risk.

2.1 ABP SOUTHAMPTON

2.1.1. BACKGROUND AND REGULATION

ABP Southampton is the Statutory Harbour Authority (SHA) for the Port of Southampton, which covers Southampton Port, Southampton Water and areas of the Solent. It is a busy commercial harbour with a diverse mixture of commercial vessel traffic from deep draught and tidally constrained vessels (e.g. Ultra Large Container Carriers bound for Southampton Container Terminal) to smaller cargo vessels. The port also has a number of dedicated terminals including oil terminals, car terminals and cruise ship terminals. The port is also home to a number of ferry terminals servicing Cowes on the Isle of Wight and Hythe in the New Forest. Recreational craft activity in the area is significant and it is amongst the busiest in the UK in this respect.

ABP Southampton is also the Competent Harbour Authority (CHA) providing pilotage and pilot boat services to vessels visiting the port, including Marchwood Port.

2.1.2. PORT MARINE SAFETY

In line with UK Department for Transport (DfT) Port Marine Safety Code (PMSC) requirements, ABP Southampton has a port wide NRA which covers the day-to-day and routine operations, including all vessel types currently visiting, the port (see **Section 6** for more details). This NRA is made up of:

- Navigation Hazards – 37 in total
- Risk Control Measures – 83 in total (termed "embedded" risk control measures in this report).

It is important to note that this assessment, for the Marchwood Port Development, does not seek to supersede ABP Southampton's own port wide NRA, which is the basis of the Safety Management System (SMS) for the port, but to supplement it by considering those aspects of the proposed Marchwood Port Development, which are not adequately covered already, or are related to increased traffic volume, and to ensure that hazards are appropriately assessed, and increased navigation risk is mitigated (if necessary) through implementation of fit for purpose risk control measures.

2.1.3. SOUTHAMPTON TIDAL CHARACTERISATION

The tidal characteristics in Southampton are unique with a "double" high water occurring each high tide, a "young flood stand" evident both in spring and neap tides, and a short duration of ebb tide relative to the flood (see **Figure 5** for details).

Spring and Neap tide characteristics are distinctly different with mean tidal ranges of 4.0m and 1.9m respectively.

Therefore, for Falkland Wharf:

- Mean High Water Springs (e.g. 4.5m) the depth of water based on the advertised depth at Falkland Wharf (berths 3 and 4) would be 12.5m;
- Mean High Water Neap (e.g. 3.7m) the depth of water based on the advertised depth at Falkland Wharf (berths 3 and 4) would be 11.7m;
- Mean Low Water Springs (e.g. 0.5m) the depth of water based on the advertised depth at Falkland Wharf (berths 3 and 4) would be 8.5m; and
- Mean Lower Water Neap (e.g.1.8m) the depth of water based on the advertised depth at Falkland Wharf (berths 3 and 4) would be 9.8m.

As noted above the ebb tide has a short duration following the double high waters, and as such the rate of water level change is greater on the ebb tide that the flood tide, particularly during the last 2.5 hours of the ebb.

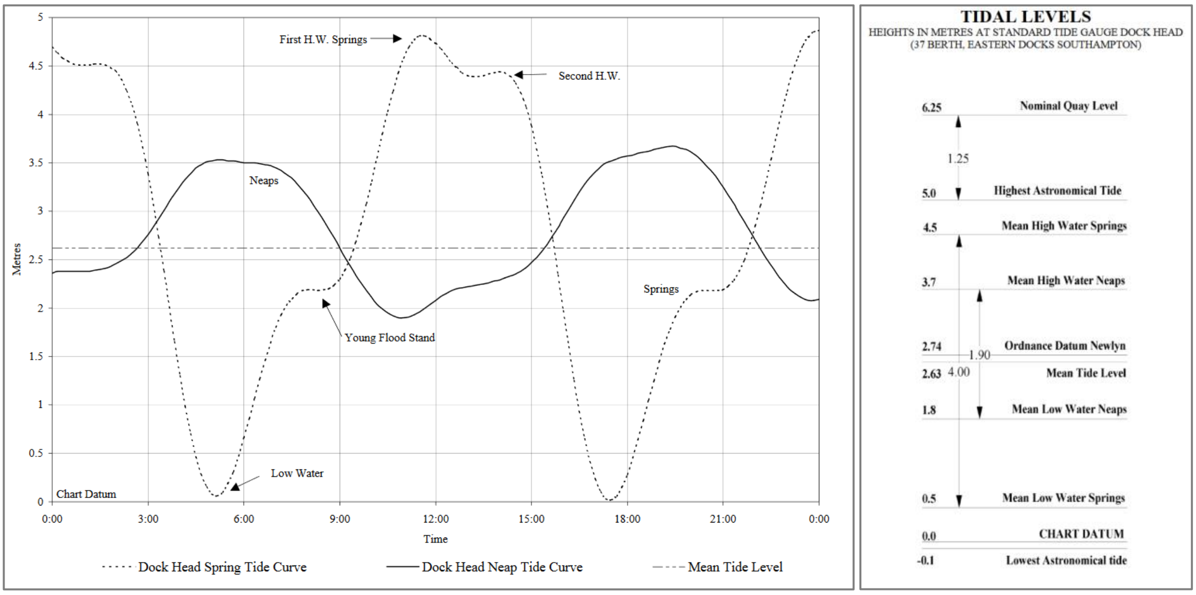


Figure 5: Left - Typical Southampton Tidal Curve for Spring and Neap tides[11].Right - Typical Tidal Levels for Southampton[12].

[redacted]

2.2 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;
- (Dry) Bulk Carriers;
- Bulk Liquid Tankers;
- Container Vessels (>200m LOA);
- Cruise Ships;
- General Cargo Vessels;
- Passenger Ferries;
    - Red Funnel – Vehicle / Passenger Service – Southampton to Cowes, Isle of Wight;
    - Red Jet – Fast Passenger Service – Southampton to Cowes Isle, of Wight; and
    - Hythe Ferries – Passenger Service – Southampton to Hythe, New Forrest;
- Vehicle Carriers; and
- Vessels calling at Marchwood Port.

2.2.1. ALL AIS EQUIPPED VESSELS

The vessel traffic density (as average number of vessels per year within the sample data) within the study area for all AIS equipped vessels is presented in **Figure 6**. The analysis shows a concentration in the main shipping channel within around Dock Head (location illustrated in **Figure 1**). Similar high traffic density areas extend north towards the ferry terminal at Town Quay, into Empress Dock and up the Hamble Estuary. Within the main channel adjacent to Marchwood Port, the shipping densities are lower (see Section 2.4 for more details).

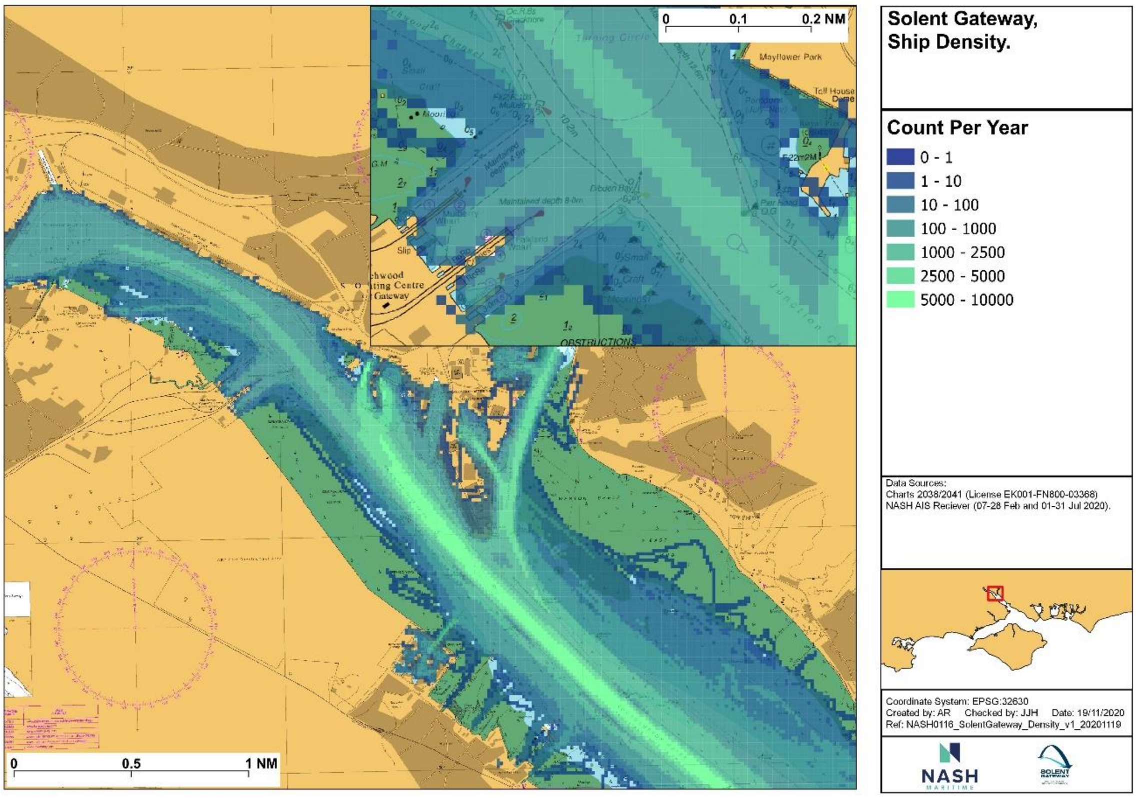


Figure 6: Focused density analysis of AIS enabled vessels transiting in the vicinity of Solent Gateway.

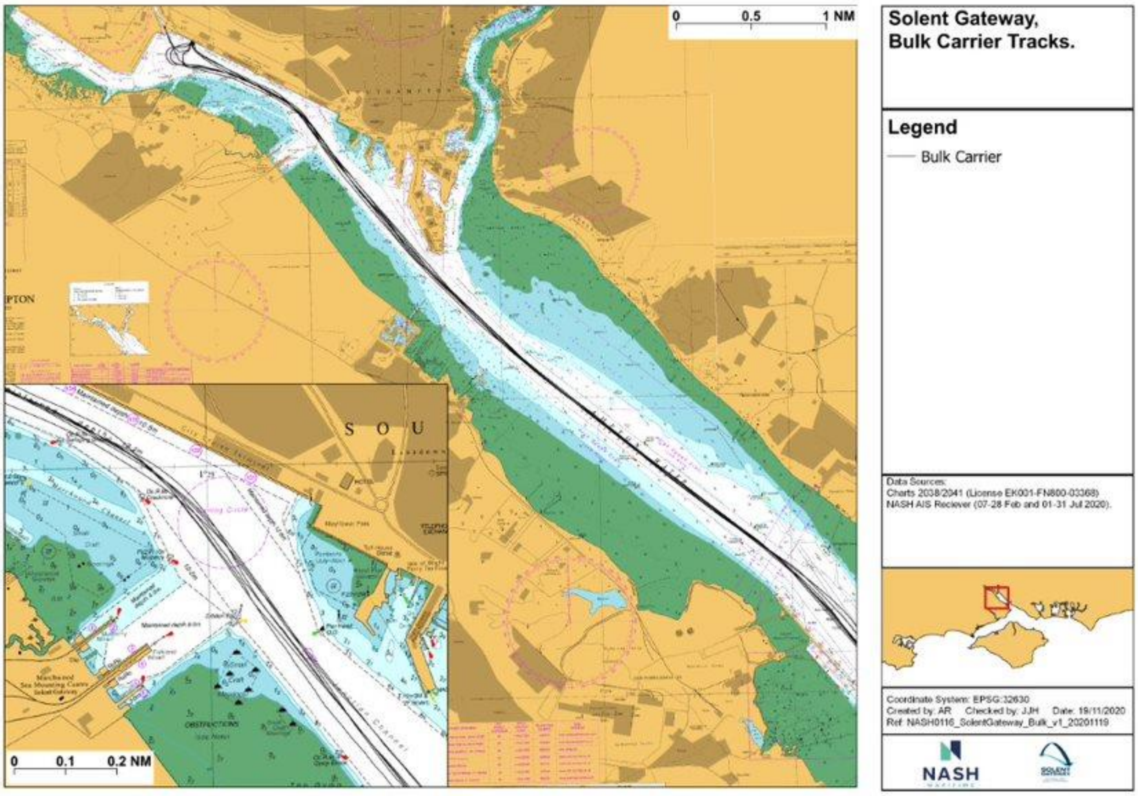


Figure 7: Dry Bulk Carrier Vessel Tracks (Feb and Jul 2020).

2.2.2. DRY BULK CARRIERS

The dry bulk carrier data show a very limited number of vessel tracks (**Figure 7**). All vessels visit the the Western Docks (Berths 107, 108 and King George V). The vessel tracks remain in the dredged channel and indicate that the upper swinging ground is used to turn onto/off the berth.

Dry bulk cargoes handled in the Western Dock include animal feed, fertiliser, scrap, aggregates, salt and biomass products. An export grain silo is located in the Eastern Docks, but there are no vessel tracks in the data showing its use during the relevant period.

2.2.3. BULK LIQUID (TANKERS)

A large number of vessel tracks (**Figure 8**) relate to bulk liquid carriers (tankers) which account for amongst the largest vessels - very large crude carriers (VLCC's) – visiting ABP Southampton. These vessels, up to 330m LOA, 60m beam and +15m draught are used for importing and exporting crude oil and hydrocarbon products through the Esso Fawley refinery terminal and BP Hamble Terminal, both towards the south east corner of our study area.

Smaller tankers are used for distributing hydrocarbon products to/from these terminals. Fawley has five ocean and four coastal berths in the south east corner of the study area and handles approximately 2,000 vessels annually[13].

The BP Hamble terminal is used for import of jet fuel for onshore distribution and export of crude oil from Wytch Fam oil field in Dorset. It typically handles less than 100 vessel calls per year.

Large liquid bulk carriers (destined for Fawley and BP Hamble) will have tug assistance during their transit through the study area.

None of the large bulk liquid carriers' approach Marchwood Port, but clearly the traffic using Marchwood Port will pass Fawley Refinery and the BP Terminal.

Bulk liquid vessel tracks further north extend throughout Southampton Water (within the shipping channel) to the Western Docks and the Itchen. A significant number of vessel tracks are seen in Ocean Dock and Empress Dock. These are related to bunkering operations involving smaller bunker vessels servicing the vessels in these locations. The tracks to the Western Dock and the Itchen relate to similar vessels and purposes. The tracks to/from Marchwood Port are also bunker vessels serving other vessels berthed at Marchwood Port.

[13] Fawley Marine Terminal Oil Spill Contingency Plan (Issue 3, Nov 2011)

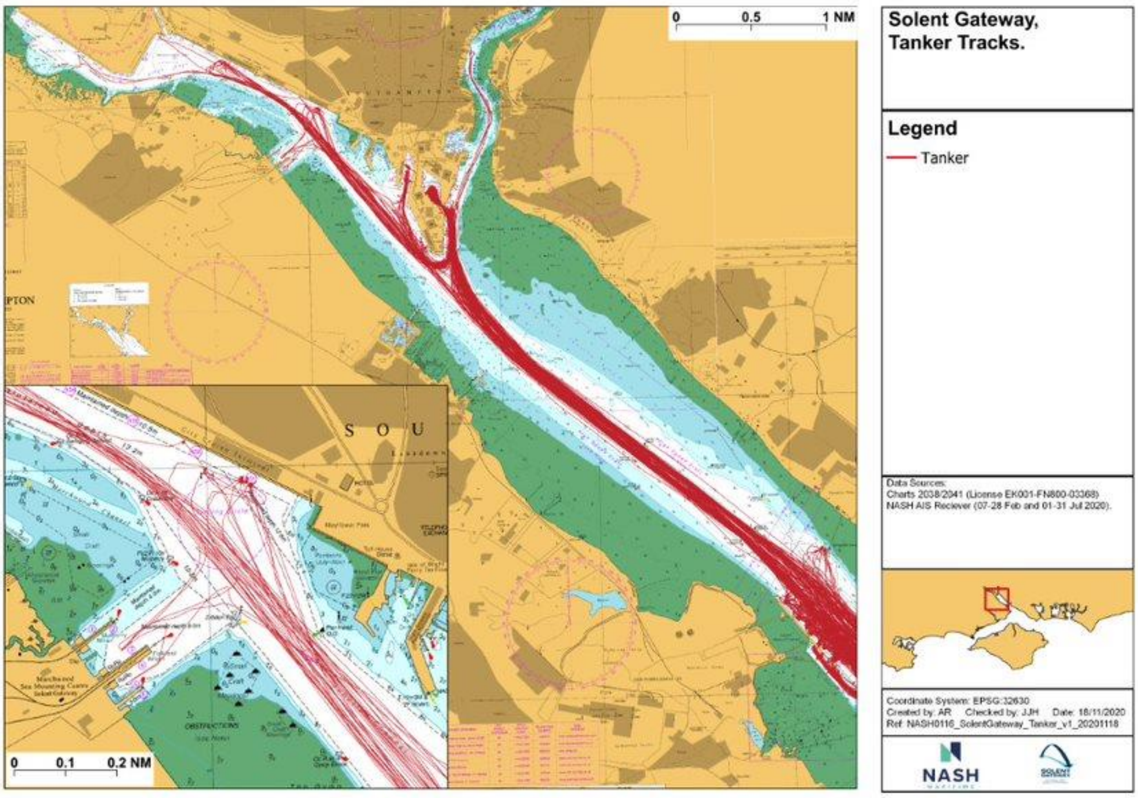


Figure 8: Bulk Liquid (Tanker) Vessel Tracks (Feb and Jul 2020).

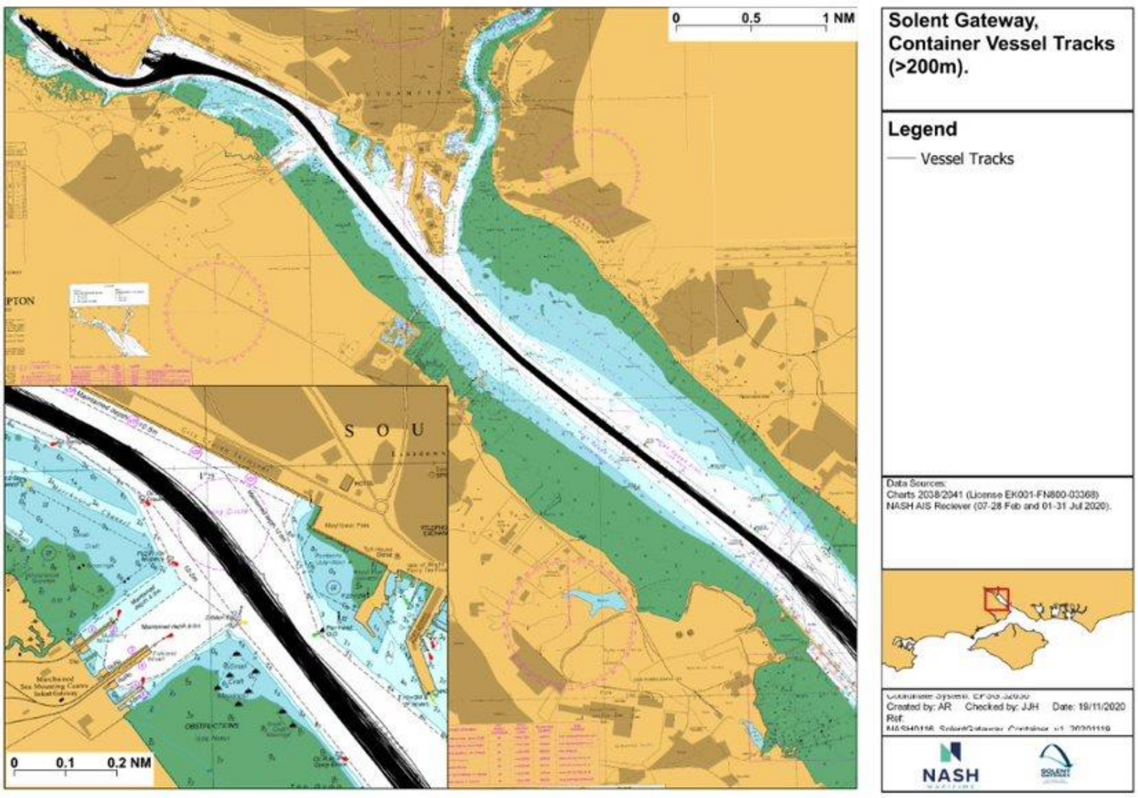


Figure 9: Container Vessel Tracks (Feb and Jul 2020).

2.2.4. CONTAINER VESSELS

The DP World container terminal upstream of the Western Docks in Southampton can accommodate container vessels up to an including the world's largest Alphaliner Megamax-24 class, *CSCL Globe* (and sister ships) and Maersk Triple-E class vessels. The largest of these vessels can be up to 402m in length, 61.4m beam, with a container capacity up to 23,500 TEU. These and similar vessels have visited the port of Southampton in recent years. Some, but not all the container ship visiting Southampton are tidally constrained both inward and outward.

Vessels track analysis (see **Figure 9**) show container vessels remain within the dredged channel throughout their transit through Southampton Water on their way to/from the container terminal. The vessels all pass the Marchwood Port entrance.

The container vessels will all have tug support during their approach to the berth.

2.2.5. CRUISE SHIPS

Cruise ship track analysis (**Figure 10**) shows all the vessels navigating within the dredged channel to and from their berthing points at the Queen Elizabeth II, Ocean, City and Mayflower Cruise Terminals. The largest cruise ships in the world including the *Symphony of the Seas* (362m LOA, 47m beam) can be accommodated at and have visited Southampton. Cruise vessels calling at Southampton include many in excess of 300m in length. The cruise vessels are not tidally constrained at the port and rarely require tug assistance.

Vessels using the City Cruise Terminal manoeuvre onto/off the berth opposite the entrance to Marchwood Port (see inset in **Figure 10**). All the vessel tracks shown indicate that these vessels remain to the northern side of the dredged channel throughout their passage and manoeuvring, thus not encroaching any closer the Marchwood Port than cruise ships using berths further north west.

2.2.6. GENERAL CARGO

General cargo vessel tracks are shown in **Figure 11**, showing all vessels remaining within the dredged channel en-route to/from the berths within the port of Southampton. A few vessel tracks show vessels using berths close to the City Cruise Terminal location and their tracks are similar to those of the cruise ships using this area, as they remain to the north of the dredged channel.

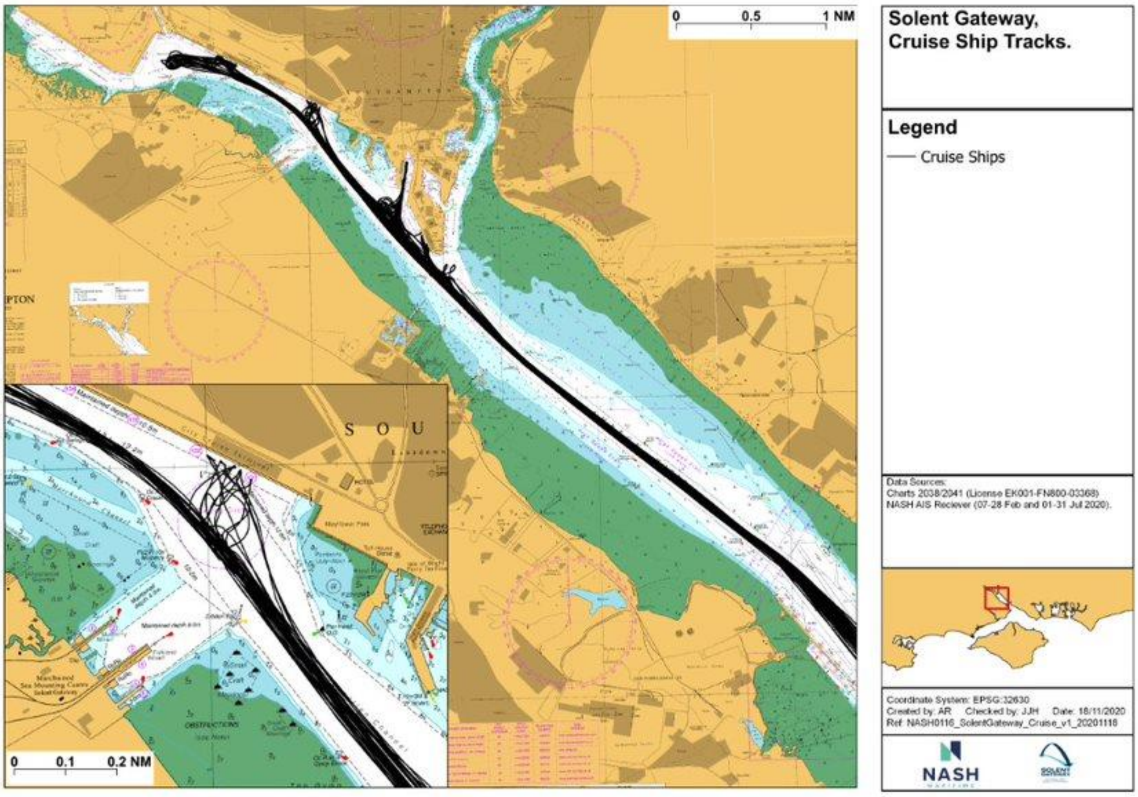


Figure 10: Cruise Ship Vessel Tracks (Feb and Jul 2020).

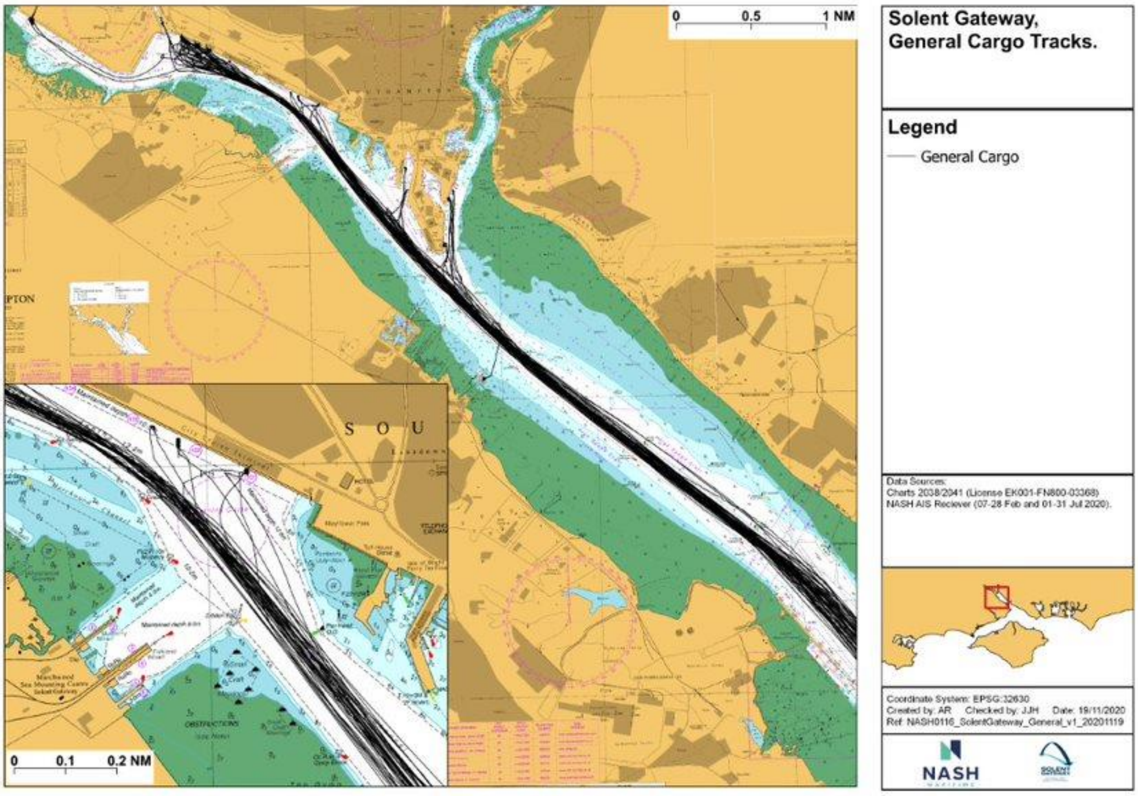


Figure 11: General Cargo Vessel Tracks (Feb and Jul 2020).

2.2.7. PASSENGER FERRIES

Three primary ferry services operate within the study area (for track analysis see **Figure 12**):

- Red Funnel passenger/vehicle/freight services running from Town Quay Red Funnel Terminal 1 in Southampton to East Cowes on the Isle of Wight. The fleet comprises four Raptor Class ro-pax / ro-ro ferries up to 93.22m in length with a beam of 17.5m and maximum draught of 2.74m. The services run year-round with a 60–90-minute frequency during the day and reduced sailings at night and additional sailings in the summer.
- Red Jet hi-speed passenger ferries running services from Town Quay Red Funnel Terminal 2 in Southampton to West Cowes on the Isle of Wight. The fleet comprise four hi-speed catamarans up to 41.12m in length overall, 10.87m in beam and have a maximum service speed of 38 knots. They operate services year-round with a 30–60-minute frequency during the day and limited night services.
- Hythe passenger only ferry running from Town Quay in Southampton to Hythe Pier. The services run approximately hourly from 0640-1810 on weekdays, 0940-1840 on Saturdays and 1010-1710 on Sundays.

These regular services produce a high density of vessel tracks between the ferry terminals as illustrated **Figure 12**. The larger Red Funnel ferries generally remain within the dredged channel, while shallower draught Red Jet hi-speed ferries and the Hythe Ferry regularly track outside the dredged channel.

All of the regular ferry routes and tracks remain south of Marchwood port and thus will not impact on vessels entering/leaving the port, but may impact vessels as they navigate beyond the immediate vicinity of the port and through Southampton Water.

2.2.8. VEHICLE CARRIERS

Southampton is the UK's number one vehicle handling port and has seen the world's largest car carrier vessels with lengths of up to 265m and beam of up to 41m. The track plots (**Figure 13**) show the vessels use the Eastern Docks, Ocean Terminal and various berths in the Western Docks. They remain within the dredged channel during approaches and departures and some of the larger vessels maybe draught restricted. Vessels using the Western Dock pass the entrance to Marchwood Port but tend to stay toward the north of the dredged area.

2.2.9. VESSELS CALLING AT MARCHWOOD PORT

The vessel tracks for vessels using Marchwood port in February and July 2020 are shown in **Figure 14,** with details listed in **Table 3.** They comprise four Point Class vessels, one load-on load-off (Lo-Lo) vessel and bunker barges.

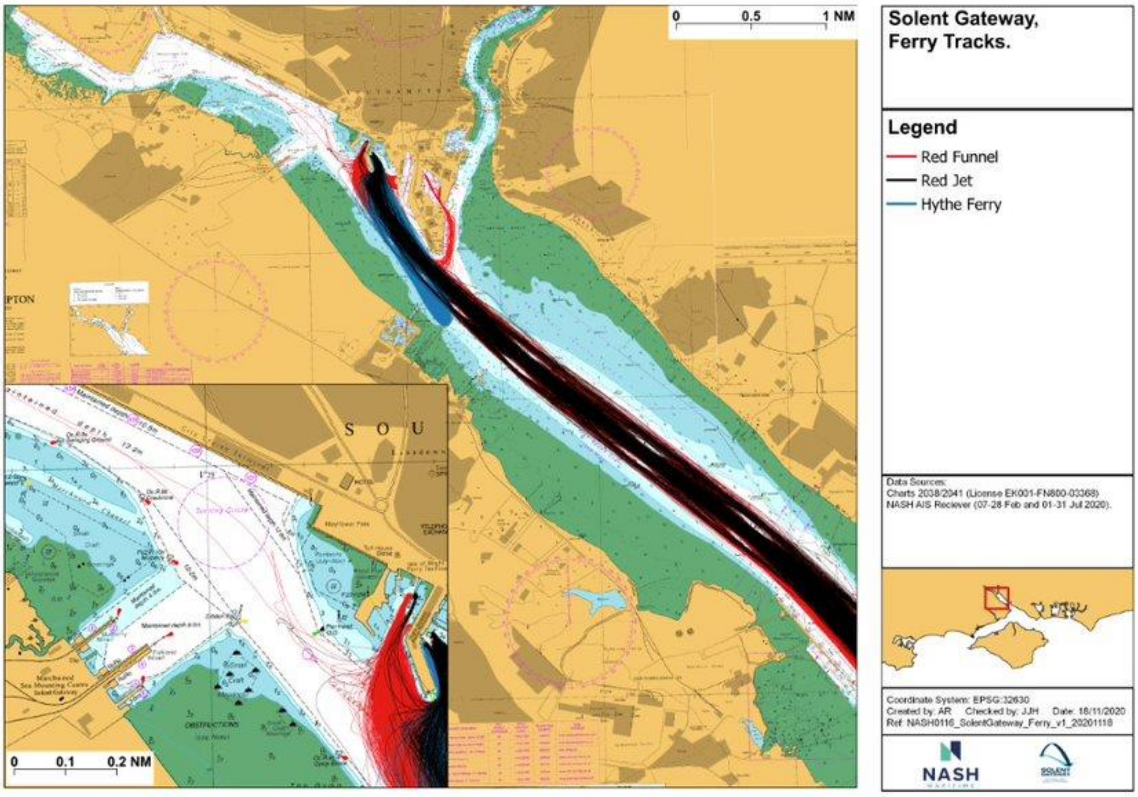


Figure 12: Passenger Ferry Vessel Tracks (Feb and Jul 2020).

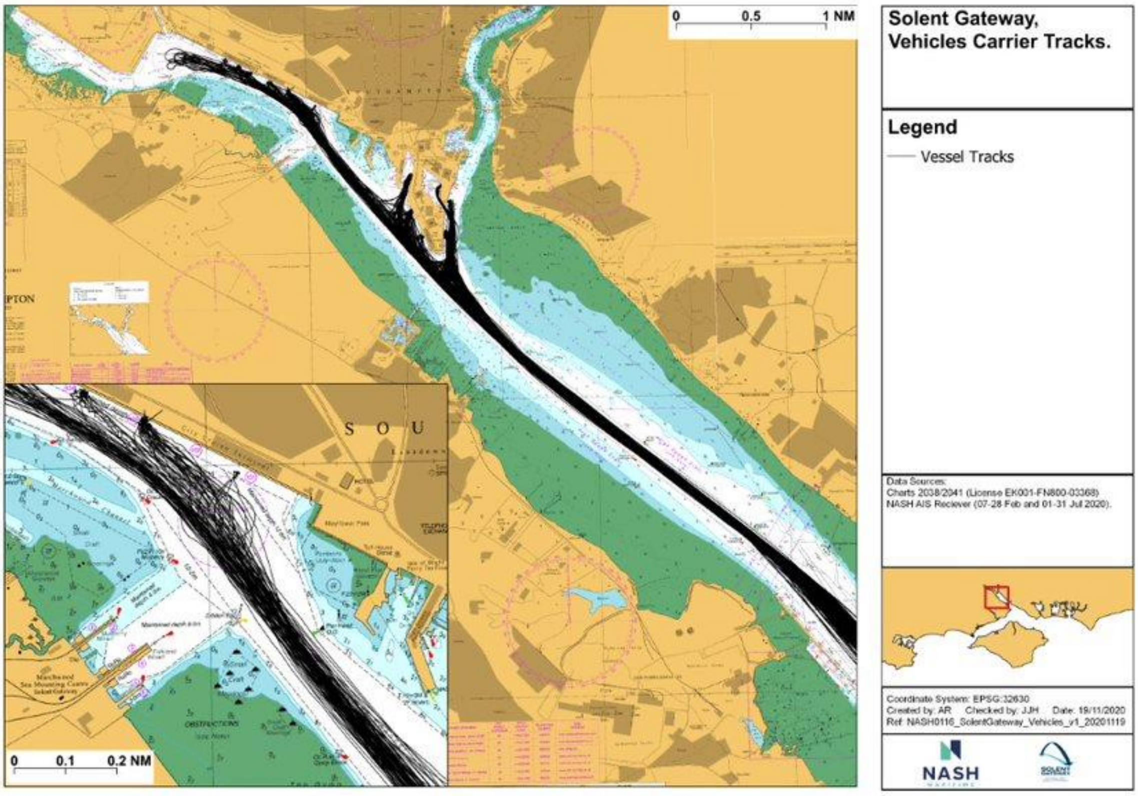


Figure 13: Vehicle Carrier Vessel Tracks (Feb and Jul 2020).

The Point Class and Lo-Lo vessels use berths 3 and 4 on the Falklands Wharf. They arrive and depart from Southampton Water to the south of Marchwood Port remaining within the dredged channel on arrival and departure. The vessels arrival and departure is relatively straight forward with little/no use of the turning circle off the cruise terminal.

The bunker barges provide bunker fuel to the Ro-Ro and Lo-Lo vessels while they are alongside the Falklands Wharf. The tankers also cross the shipping channel to service other vessels in the eastern dock.

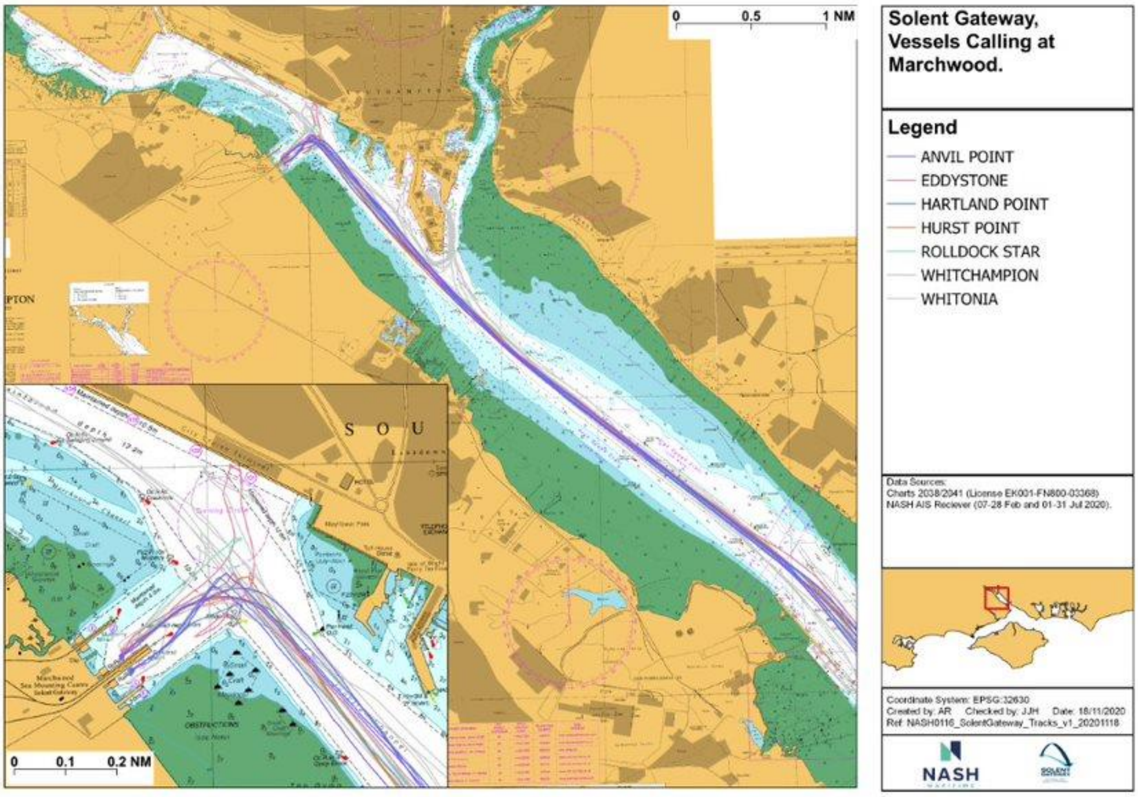


Figure 14: Vessel Tracks for vessels calling at Marchwood (Feb and Jul 2020).

Table 3: Vessels calling at Marchwood Port (Ministry of Defence vessel) (Feb and Jul 2020).*

Vessel Name	Type	DWT (t)	LOA (m)	Beam (m)	Draught (m)
*Anvil Point**	Ro-Ro cargo	23,235	193	26	5.8
*Eddystone Point**	Ro-Ro cargo	23,235	193	26	5.8
*Hartland Point**	Ro-Ro cargo	23,235	193	26	5.8
*Hurst Point**	Ro-Ro cargo	23,235	193	26	5.8
Rolldock Star	Lo-Lo cargo	15,382	151	26	4.8
Whitchampion (Bunker Vessels)	Oil products carrier	2,965	85	15	5.4
Whitonia (Bunker Vessels)	Oil products carrier	4,292	101	18	4.9

2.3 SWEPT PATH ANALYSIS

To illustrate vessel manoeuvres into and out of Marchwood Port, swept path analysis key vessels was undertaken – an example analysis is presented for the *Anvil Point* (Point Class Ministry of Defence vessel) as an example of the most frequent class of vessel visiting the port during the AIS data period (Feb and Jul 2020).

The analysis demonstrates that vessels frequently swing (turn) on arrival (as per **Figure 15**), such that the stern roll-on/roll-off door is presented to the floating link span. The vessels typically swing off Marchwood Port, which would be the case for all vessels visiting the port, and therefore the need to swing in the defined swinging ground (Middle Swinging Ground) is not required. In terms of transit speed, then when vessels pass Dock Head it is evident that speeds are around 5-10knts.

On departure the *Anvil Point* performed a simple 90 degree turn to starboard on exiting the Marchwood Port area and entering Southampton Water before continuing south-east within the dredged navigation channel (**Figure 16**).

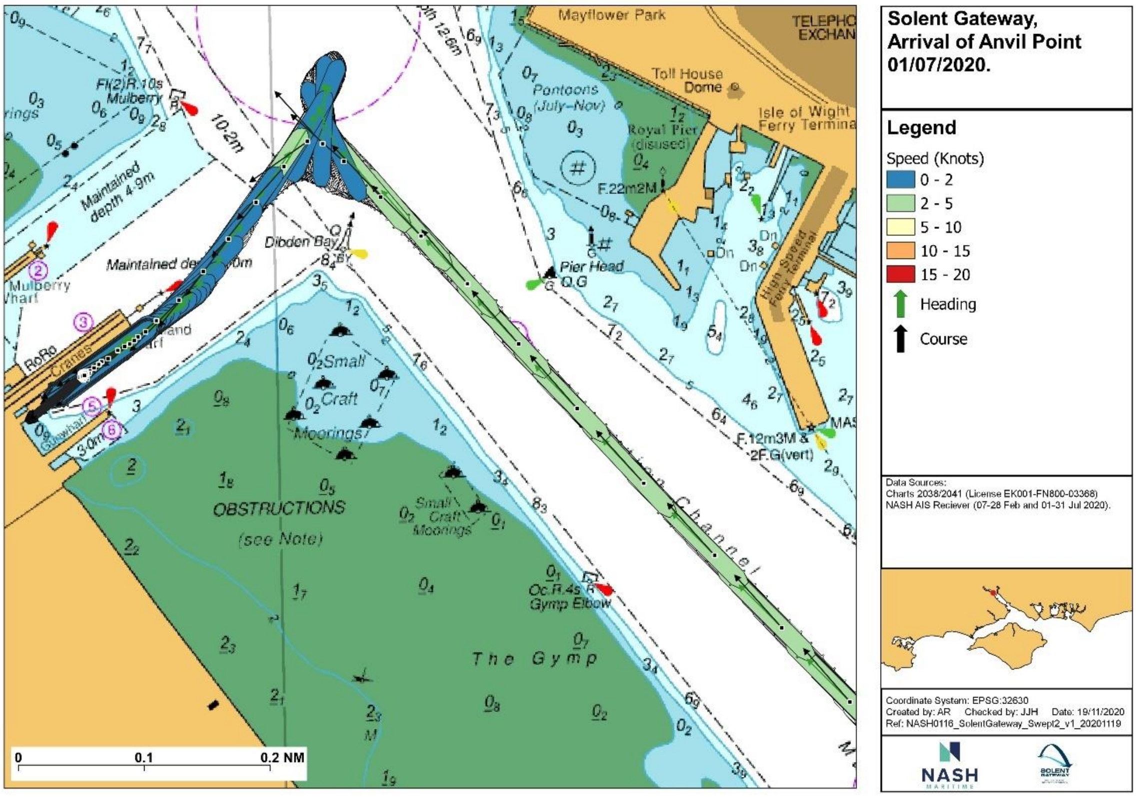


Figure 15: Anvil Point Swept Path Arriving at Marchwood Port

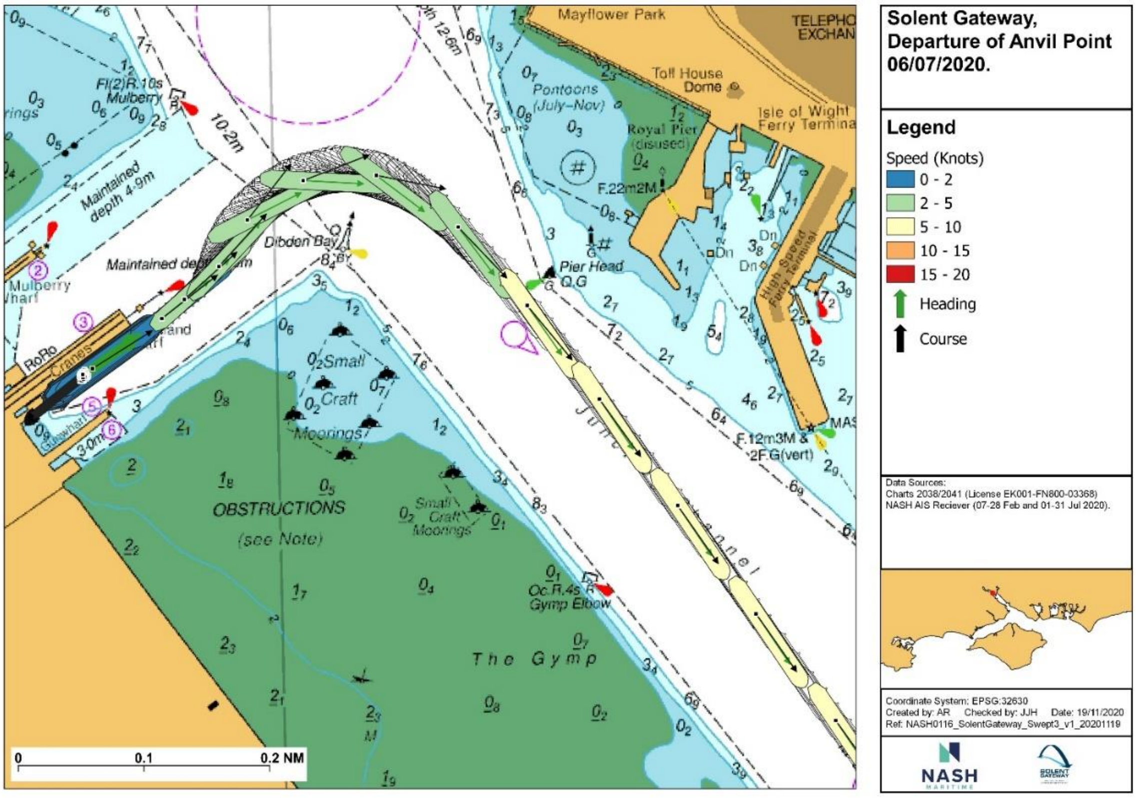


Figure 16: Anvil Point Swept Path Departing Marchwood Port

2.4 GATE ANALYSIS

To better understand the existing vessel traffic flows approaching and in the vicinity of Marchwood Port, a gate analysis was carried out. Four vessel transit gates were established as illustrated in **Figure 17** to analyse the frequency of vessel use in the approaches to Marchwood Port.

All gates show a similar pattern of vessel passage, with the majority of vessels using the dredged navigation channel and (as expected) favouring the starboard side of the channel. The most southerly gate shows this strong preference clearly with the centre of the dredged channel recording 3000-5000 counts per year (CPY). This gate also shows a clear trend for other vessels also using the high-speed craft area and the moored craft area either side of the main channel with records of up to 1000 CPY. These are most likely the high-speed ferries, shallower draught vessels and AIS-carrying recreational craft.

Off Dock Head the navigation is more constrained and though the peak counts remain at 3000-500 CPY in the dredged channel following the starboard navigation rule, the plot also shows up to 3000 CPY close to Dock Head itself but transiting to the south. This is likely attributable to vessels leaving the berths in and around Dock Head and smaller vessels avoiding crossing the navigation channel before heading up the Hamble or proceeding further south.

At the most northerly gates, closer the Marchwood Port, peak vessel counts in the channel are in the 500-1000 CPY range and out of the channel do not exceed the 10-100 CPY range. There is evidence of 10-100 vessels per year using the Marchwood Channel and areas outside the dredged channel just north of Marchwood Port which were smaller shallower draught vessels.

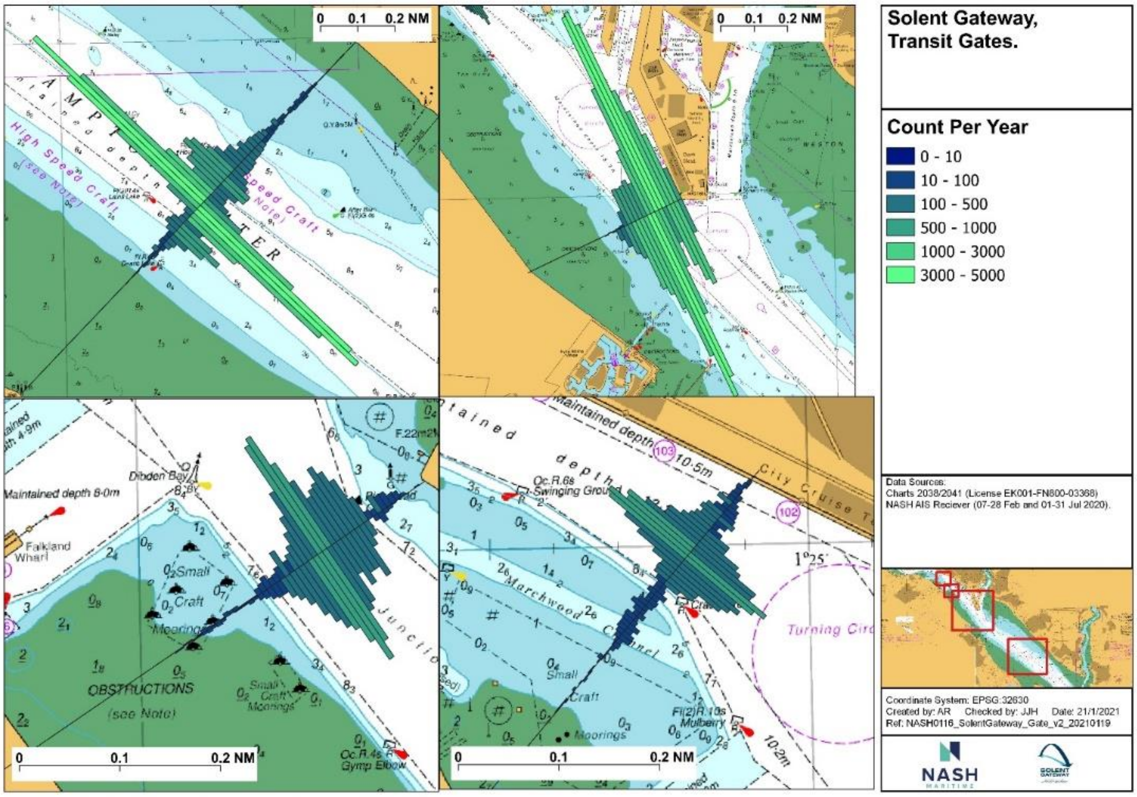


Figure 17: Transit Gates on the approaches to Marchwood Port.

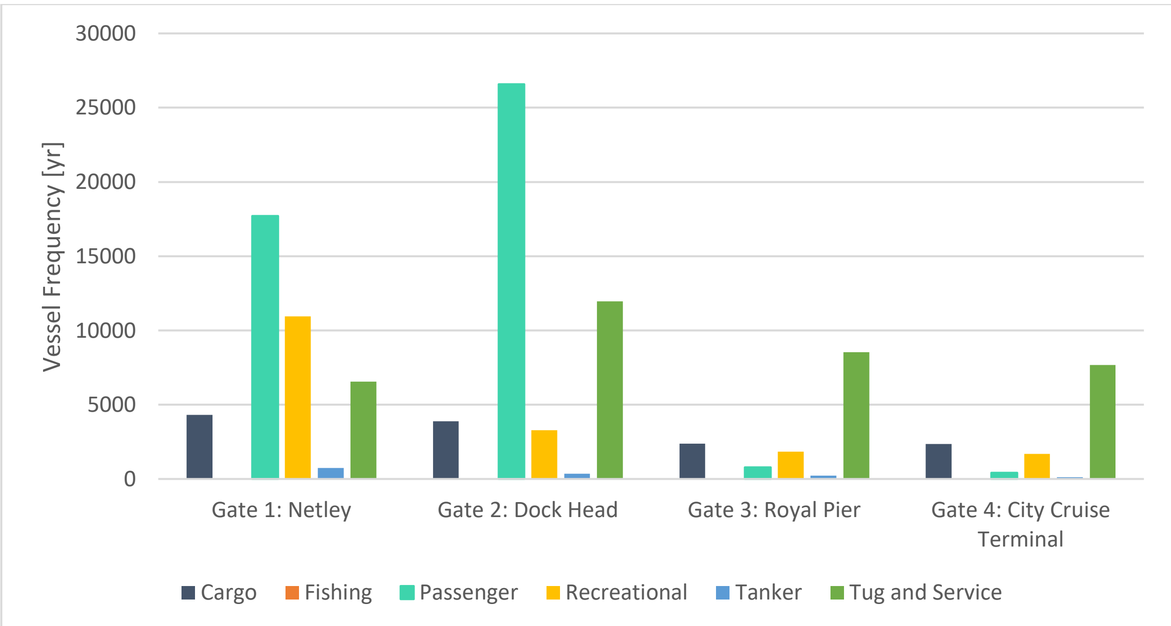


Figure 18: Gate Analysis by vessel type.

Analysis of vessel type and vessel type / length frequency for each gate are presented in **Figure 18** and **Table 4**. The distribution by vessel type over the 4 gates is as expected, with a reduction in most vessel numbers with distance into the port – the exception to this are tugboats, which are generally stationed at dock head and predominantly work in the and around the docks, as such the highest distribution for them is around Dock Head itself.

Table 4: Gate vessel frequency by type and length (annualised based on February and July AIS data).

Gate Location	Vessel Type	Vessel Length[m]									Sub-Total	Total
		<50	50-99	100-149	150-199	200-249	250-299	300-349	350-399	400-450		
Gate 1: Netley	Cargo	101	1,953	581	1,203	804	243	142	270	88	5,385	45,406
	Fishing	68	0	0	0	0	0	0	0	0	68	
	Passenger	9,645	9,747	0	0	101	365	81	0	0	19,939	
	Recreational	12,282	27	0	14	0	0	0	0	0	12,323	
	Tanker	0	520	324	0	0	0	0	0	0	844	
	Tug and Service	6,773	20	54	0	0	0	0	0	0	6,847	
Gate 2: Dock Head	Cargo	68	1,467	561	973	608	216	142	270	88	4,393	51,884
	Passenger	19,257	10,051	0	0	128	419	81	0	0	29,936	
	Recreational	3,691	0	0	14	0	0	0	0	0	3,705	
	Tanker	0	210	196	0	0	0	0	0	0	406	
	Tug and Service	13,397	20	27	0	0	0	0	0	0	13,444	
Gate 3: Royal Pier	Cargo	162	223	534	771	291	216	142	270	88	2,697	28,903
	Passenger	257	14	0	0	54	520	27	0	0	872	
	Recreational	2,062	0	0	0	0	0	0	0	0	2,062	
	Tanker	0	122	128	0	0	0	0	0	0	250	
	Tug and Service	9,537	14	27	0	0	0	0	0	0	9,578	
Gate 4: City Cruise Terminal	Cargo	324	223	493	622	291	216	142	270	88	2,669	23,368
	Passenger	203	0	0	0	0	237	27	0	0	467	
	Recreational	1,906	0	0	0	0	0	0	0	0	1,906	
	Tanker	0	68	68	0	0	0	0	0	0	136	
	Tug and Service	8,584	14	14	0	0	0	0	0	0	8,612	

Passenger vessel numbers are seen to dramatically reduce between Gate 2: Dock Head and Gate 3: Royal Pier – this is due to the ferries making up the vast majority of passenger vessel moments in the port and all three ferry services departing from Town Quay – located between Gates 2 and 3. The remaining passenger vessel movements seen in Gates 3 and 4 are cruise vessels bound to and from the Western Docks.

Total vessel movements past Marchwood Port should be referenced to Gate 3 totals, which are 28,903 movements per year (in both directions). In contrast the increase in vessel movements from the Marchwood

Port Development is up to around 200 vessel per year, this means that the increase represents approximately a 1.37% increase.

2.5 IMPACT OF COVID-19

From April 2020 onwards, vessel movements in Southampton Water were significantly lower than an equivalent period in 2019 due to the impact of COVID-19 on vessel transits. **Figure 19** shows the number of transits in Southampton Water provided by Southampton VTS, excluding the Hythe ferry. July 2020 was 48% of July 2019's movement numbers for all vessel traffic but only 36% if non ferry vessels are coutned, and this will be accounted for in the modelling undertaken in **Section 3**.

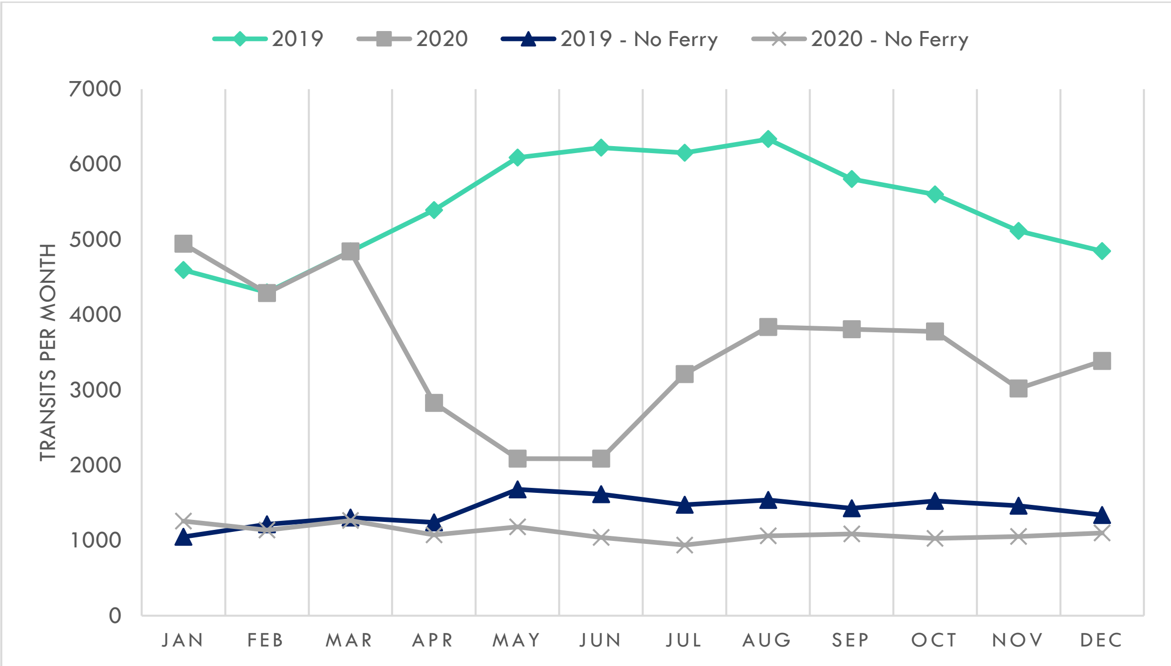


Figure 19: Impact of COVID-19 on transit numbers at Southampton (showing all traffic and all traffic excluding ferry traffic).

2.6 INCIDENT ANALYSIS

Analysis of incident data provided by ABP Southampton is presented in **Figure 20**, showing incidents of any magnitude from minor to major consequence:

- Collisions Ship-Ship;
- Grounding;
- Impact with Structure (also known as allision or contact); and
- Striking with ship (also known as contact / impact of a vessel under way with a moored vessel).

The analysis shows that Impacts with Structures and Striking with ship is the most common incident type (pertinent to this assessment) and is common in ports and harbours where vessels are frequently arriving and departing berths. There appears to be no incident hot spots in the vicinity of Marchwood Port.

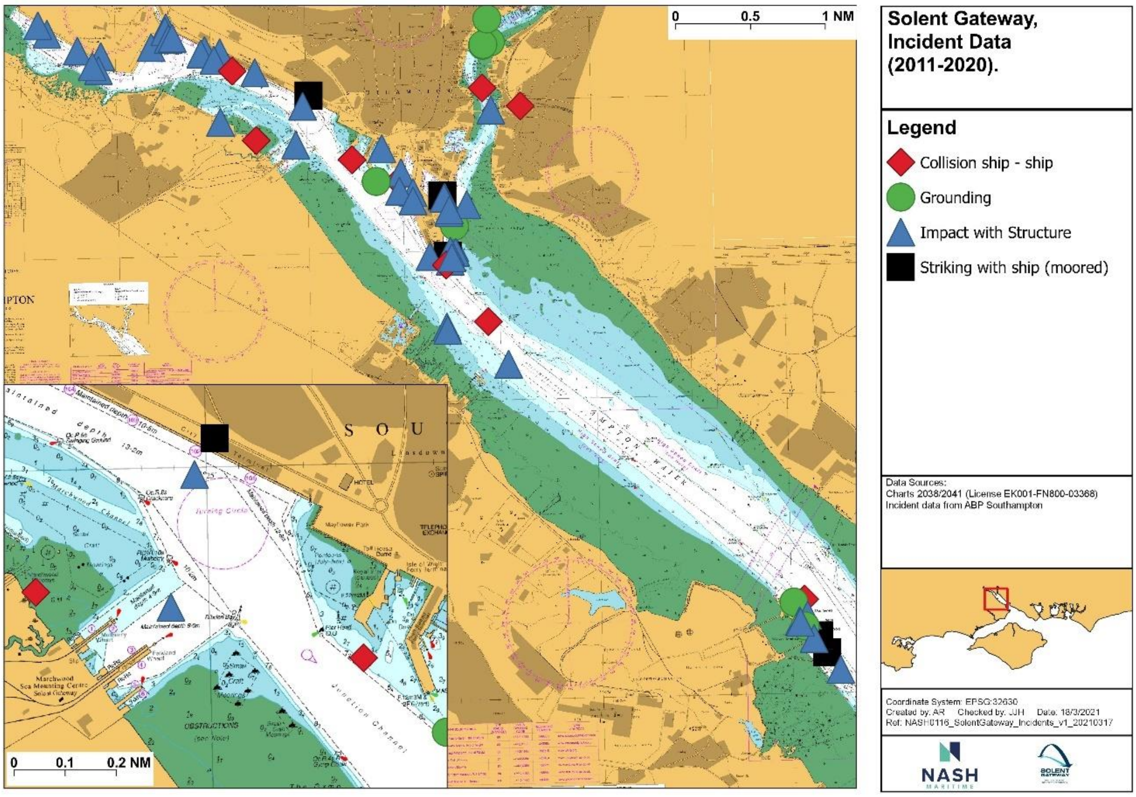


Figure 20: Spatial analysis of ABP Southampton provided incident data for Collisions Ship-Ship, Grounding, Impact with Structure and Striking with ship (moored) (2011-2020).

Significant collision and grounding incidents reports have been extracted from the ABP Southampton incident database (from 2011-2020) and are presented in **Table 5** – note this table covers the whole of ABP Southampton SHA waters (not just this assessment study area).

Table 5: Significant collision and grounding incidents in whole of ABP Southampton SHA waters.

Incident	Vessels	Incident Date	Description
Collision	Recreational - Commercial	06/08/2011	*Collision between inbound tanker Hanne Knutsen and racing yacht Atalanta of Chester on day 1 of Cowes Week.*
Collision	Commercial / Commercial	23/08/2012	*The inbound Arklow Viking proceeding upstream and approx. 100m upstream of the Itchen Bridge was struck by a Griffon Hovercraft. The Hovercraft was returning from trials in Southampton Water. She followed the Arklow Viking under the bridge and started to overtake her on the starboard side on route to Merlin Quay. The trainee Captain of the 12m long Hovercraft misjudged the clearance from the Arklow Viking and made contact (speed 5 knots) on her starboard quarter before moving away. No damage.*

Incident	Vessels	Incident Date	Description
Collision	Recreational-Commercial	17/10/2013	*Wyepull reports a rowing boat with 4 people in has just hit him off American wharf. 1 person fell into the water from the rowing boat but was quickly recovered by the rowing boat. All persons ok and there was no damage to the rowing boat or tug/tow. The tug followed the rowing boat back to the rowing club (Imperial Rowing Club). On the Southampton side of the river Itchen north of the Itchen Bridge. Tug skipper was asked to submit a report to the Harbour Master*
Collision	Recreational-Commercial	27/12/2016	*Baltic Freedom made contact with the Joseph J (angling vessel) whilst Pilot boarding in the NAB EAST boarding grounds.*
Collision	Recreational-Commercial	27/05/2018	*City Of Chichester reported physical contact with an unknown white day boat off Dock Head. Day boat continued passage without stopping.*
Collision	Ferry-Recreational	29/09/2018	*Red Falcon in collision with motorboat Phoenix in the Thorn Channel.*
Collision	Recreational-Commercial	26/05/2019	*Collision between Tanker Mona Swan & Sailing Yacht Island Surf.*
Collision	Recreational-Commercial	19/06/2020	*Yacht Bedowin lost control in gusting wind and collided with tug Oryx who was at the time attending to inbound tanker PAUL E (9268277) to FMT berth # 9. SP attended yacht and minor damage to vessel and no injuries.*
Grounding	Commercial	28/06/2011	*Pilot Vessel Hampshire reported touching the bottom whilst approaching Ryde pier, approximately 8 cables NE of Ryde Pier. The chart plotter showed them to be in 2.0m of water and there should have been over 2m on top of that - LW Southampton being 1513 at 1.7m and the launches draft being 1.4m. No damage caused to the launch as manoeuvring at slow speed.*
Grounding	Commercial	10/11/2013	*Tug Apex reports Terramare 1 has parted their tow line and will standby to assist. Not reported to VTS. On investigating with Terramare 1 it appears Barge TF 301 drifted aground on Hamble Spit after the wire parted. Wind WNW 17-23kn, Flood tide, HW 1629 4.1m Calshot tide gauge 2.24m 1140 Barge TF 301 afloat. Terramare 1 confirms no damage and continued to the Nab Spoil. PEC Holder and his superintendent subsequently met with HM and PM 11/11/13. NFA*
Grounding	Commercial	03/01/2015	*Hoegh Osaka was observed listing heavily to starboard as she rounded the West Bramble Buoy Outward . Moments later the ship blacked out and had an estimated 40 degree list to starboard. At 2120 hrs lights came back on the ship and the ships propeller was out of the water (observation by 'SP'). The ship drifted towards the West Knoll Buoy area and as the list increased it came to rest on the west side of the Bramble Bank. VTS and Solent Coastguard scrambled Tugs and Lifeboats.*
Grounding	Tug	23/06/2015	*Svitzer Eston touched bottom off TQ (LL50-53.473N 001-24.278W). Had moved over for Cat-4 Corte Real - Autopride pass in vicinity Pier Head. Barely moving - no injury, pollution or water ingress - PDS to follow. Eston has hull form in shape of ˜elephants foot sits on this in DD. Master believes this touched bottom - no damage.*
Grounding	Commercial	22/08/2016	*Vessel ran aground in the vicinity of NE Gurnard/ Bourne Gap when transiting inward. Solent Towage Tugs assisted in re-floating vessel.*
Grounding	Recreational	09/10/2018	*Cabin cruiser Living The Dream ran aground on the Bramble Bank at 20+ kts,1 hour before LW Springs.*

Incident	Vessels	Incident Date	Description
Grounding	Launch	28/11/2018	*Launch Willfetch grounded over LW close inshore Calshot Turn.*
Grounding	Commercial	02/01/2019	*Seashark tanker IMO 9298193 reported as touching bottom over LW period by FMT.*

2.7 SUMMARY

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

- There are significant vessel movements in Southampton Water for a range of vessel types and the proposed increase in vessel movements associated with Marchwood Port Development represent only a small number (approximately 2.5%).
- Many of the vessels navigate within the maintained (dredged) navigation channel and adhere to starboard side rules of navigation.
- Despite this there are also large numbers of (shallower draught) vessels also transiting outside the dredged channel.
- Vessels passing the entrance to Marchwood Port are mainly container vessels, cruise vessels, vehicle carriers and general cargo vessels.
- Ferry traffic makes up a significant proportion of vessel traffic movements in Southampton Water.
- COVID-19 had a big impact on reducing vessel traffic in 2020.

3. FUTURE VESSEL TRAFFIC CHARACTERISATION

3.1 INTRODUCTION

Vessel traffic risk modelling has been undertaken to ascertain the magnitude of navigation risk change because of the increases in vessel traffic activity in Southampton Water as a result of the Marchwood Port Development. The risk modelling enables a quantitative estimation of navigation risk spatially and by vessel type within the study area. The future vessel traffic risk characterisation is undertaken using two types of vessel traffic risk models:

- Grounding and Allision Risk Modelling using Geometric Risk Modelling Theory; and
- Collision Risk Model using Domain Theory.

The general model workflow is shown in **Figure 21** and the methodology is described in **Sections 3.2** and **3.3**. The modelling was undertaken using future vessel movements as identified in **Table 1**, and also included a provision for 200 dredger movements per year, which were subsequently removed from the assessment scenario, so results have be adjusted to take this into account.

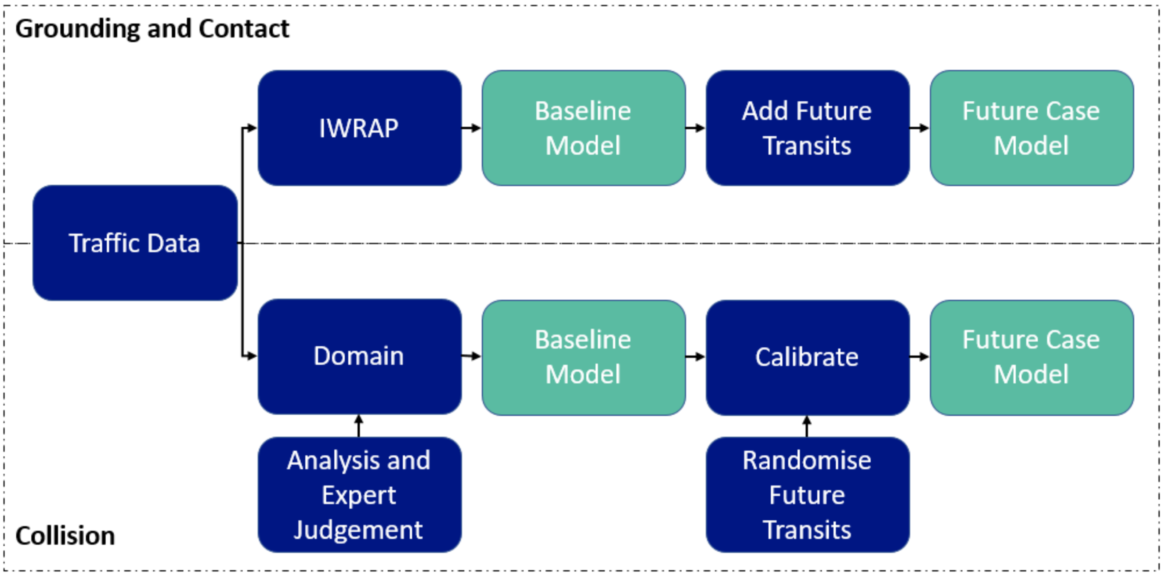


Figure 21: Model workflow (Blue – process, Green Model).

3.2 GROUNDING AND ALLISION (CONTACT) RISK

3.2.1. IWRAP RISK ANALYSIS MODELLING

The IALA IWRAP Mk2 risk analysis modelling tool (IWRAP) was used to provide a quantitative analysis of grounding and contact (allision/impact) risk for the future vessel traffic profile for the Marchwood Port Development within the study area of Southampton Water. IWRAP uses a geometric mathematical model of vessel traffic flow to calculate the likelihood of Grounding and Allision (contact/impact) risk based on inputted vessel traffic data (AIS) which can be uplifted to account for projected increases in vessel traffic.

IWRAP generates geometric distributions for vessel routes based on a known number of transits and distributions. In the case of contacts, if some obstacle or obstruction such as new pier overlaps with that traffic route, then the proportion of vessels at risk is calculated to give the geometric probability of contact (see **Figure 22**).

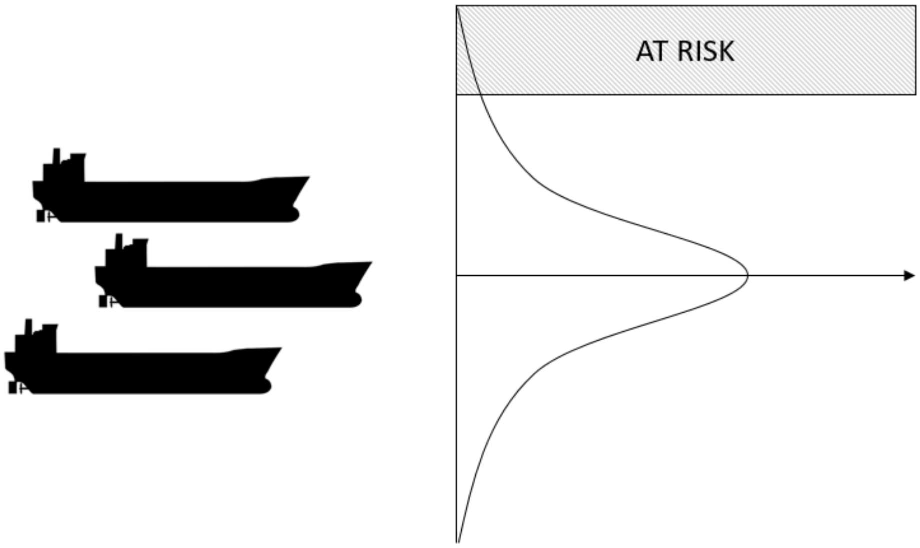


Figure 22: IWRAP Methodology for Contact/Grounding (see Gate Analysis plots at Figure 18 showing lateral distribution of vessel traffic).

IWRAP is a high-level mathematical tool for which the following assumptions and limitations should be noted:

- IWRAP assigns all traffic to a geometric distribution;
- Analysis was limited to legs within Southampton Water;
- IWRAP cannot take into account tidal height variations; and
- IWRAP uses average vessel transits on each route – therefore the seasonal, hourly and tidal variability in transit times by vessels is smoothed over 24 hours, which is a generalisation of actual practice.

The IWRAP contact / grounding modelling considers the probability that vessels are unable to avoid the hazard (e.g. Dock Head), due to 1) human error or 2) mechanical failure 3) or environmental factors, which are known as causation probabilities. The number of expected contacts/grounding is then mathematically modelled by taking the product of these two probabilities based on the geometric distribution of traffic (see **Figure 22**).

3.2.2. INPUT DATA

The AIS data collect and analysed as part of the project, was inputted into IWRAP and a vessel route modelled based on the vessel traffic and the navigation channel (**Figure 23**). IWRAP extracts traffic numbers and distribution of this route based on the vessel traffic. In addition, the bathymetry and key infrastructure such as jetties and quays were extracted from the navigation charts for Southampton Water. As IWRAP is unable to account for variation in tidal heights, the model was run twice, once at Mean Low Water Springs (LW), and once at Mean High Water Springs (HW), using vessel transits for the 6 hours of LW and 6 hours of HW respectively from the AIS data collected.

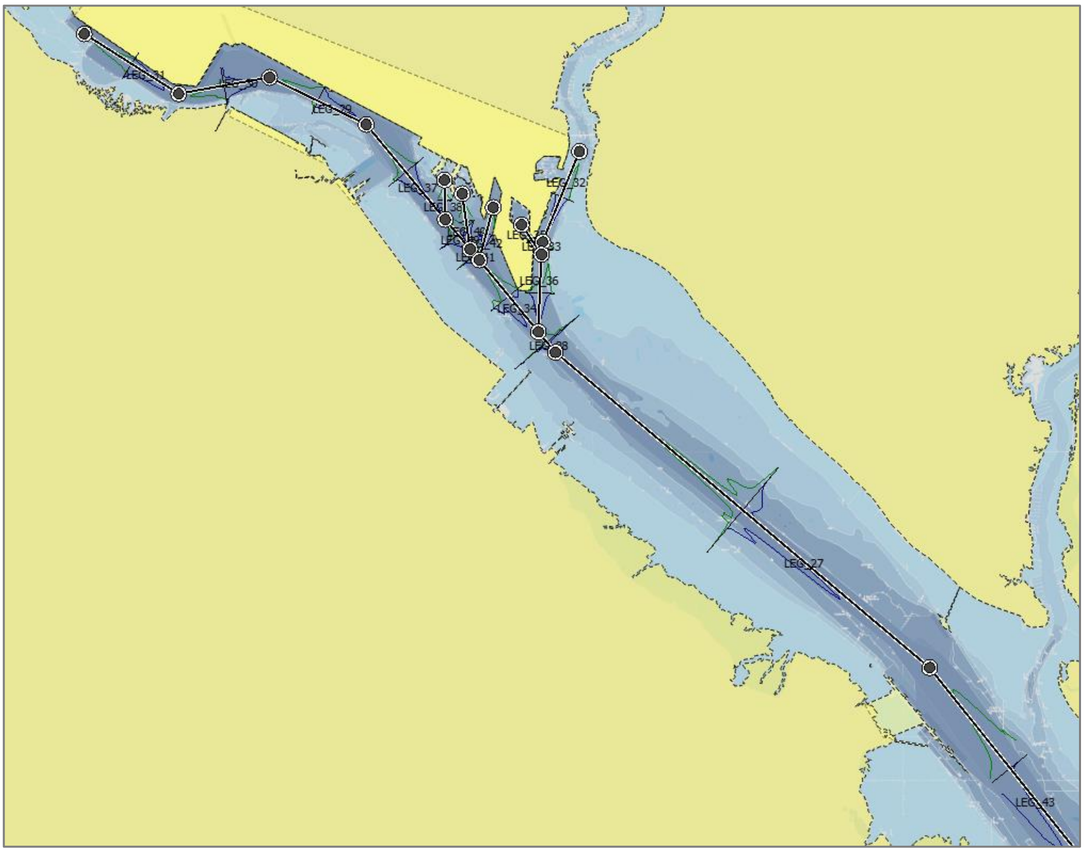


Figure 23: IWRAP model for Southampton water (contact hazards – beige, bathymetry – blue, traffic legs – black).

3.2.3. MODEL SCENARIOS

Two scenarios were created and are described below:

1. Baseline Model – "current day scenario" using baseline dataset:
    a. Assessed at LW;
    b. Assessed at HW; and
    c. Adjusted for COVID-19.
2. Future scenario including additional vessels from the Marchwood Port Development "Future Vessel Specifications" – see **Section 1.6.**

a. Assessed at LW;
b. Assessed at HW; and
c. Adjusted for COVID-19.

Where results are shown as adjusted for COVID-19, the 2020 baseline figures have been increased to reflect relevant 2019 values and it is these adjusted values that are represented in the modelled results.

3.2.4. GROUNDING AND ALLISION (CONTACT) MODELLING RESULTS

Figure 24 shows the predicted contact and grounding incidents for the modelled scenarios. For each hazard type, the LW scores are shown filled and the HW scores are shown dotted, with the adjusted scores the updated baseline with COVID-19's impact taken into account. Due to the limitations described in **Section 3.2.1**, the number of incidents per year is relatively high compared to the historical incident record, however, the proportional increase as a result of Solent Gateway activity can be quantitatively assessed.

The results show that groundings are modelled to increase by 3.3%, mostly the result of powered groundings. This disproportionate increase compared to the approximate 1.37% increase in transits is due to the relative size of Marchwood Port bound vessels compared to the average vessel, the shallow waters adjacent to the berth, and the conservative nature of the IWRAP modelling which does not take into account the significant number of risk controls measures put in place by ABP Southampton.

The risk of allision is far less, with an increase of 0.6%.

The distribution of relative risk grounding and allision risk throughout the study area is presented in **Figure 25** and **Figure 26**.

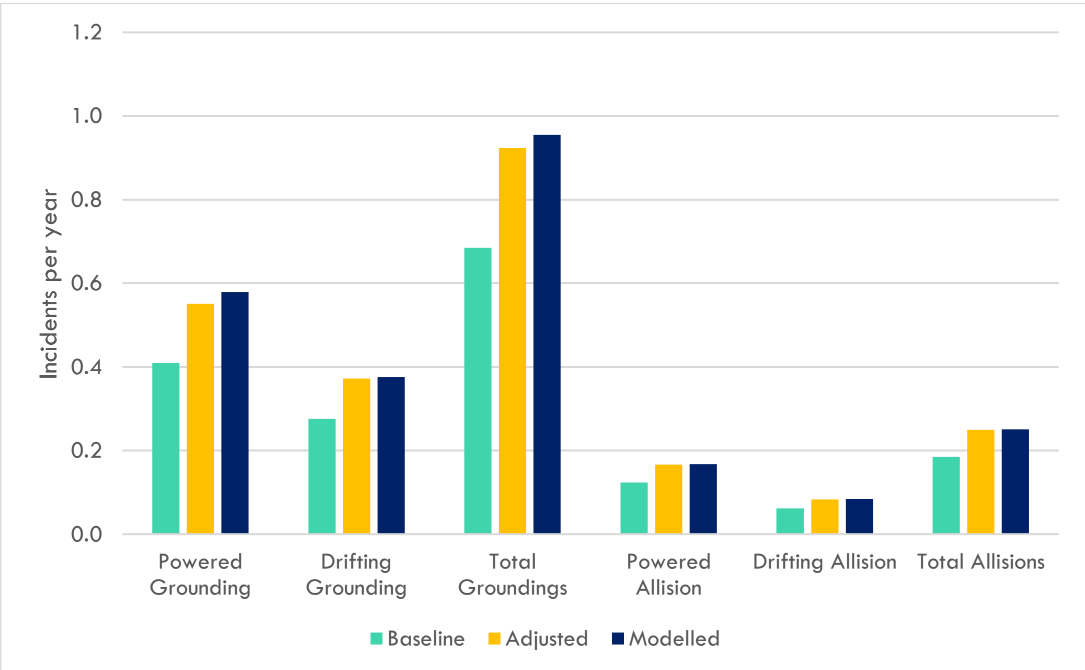


Figure 24: IWRAP Model Results.

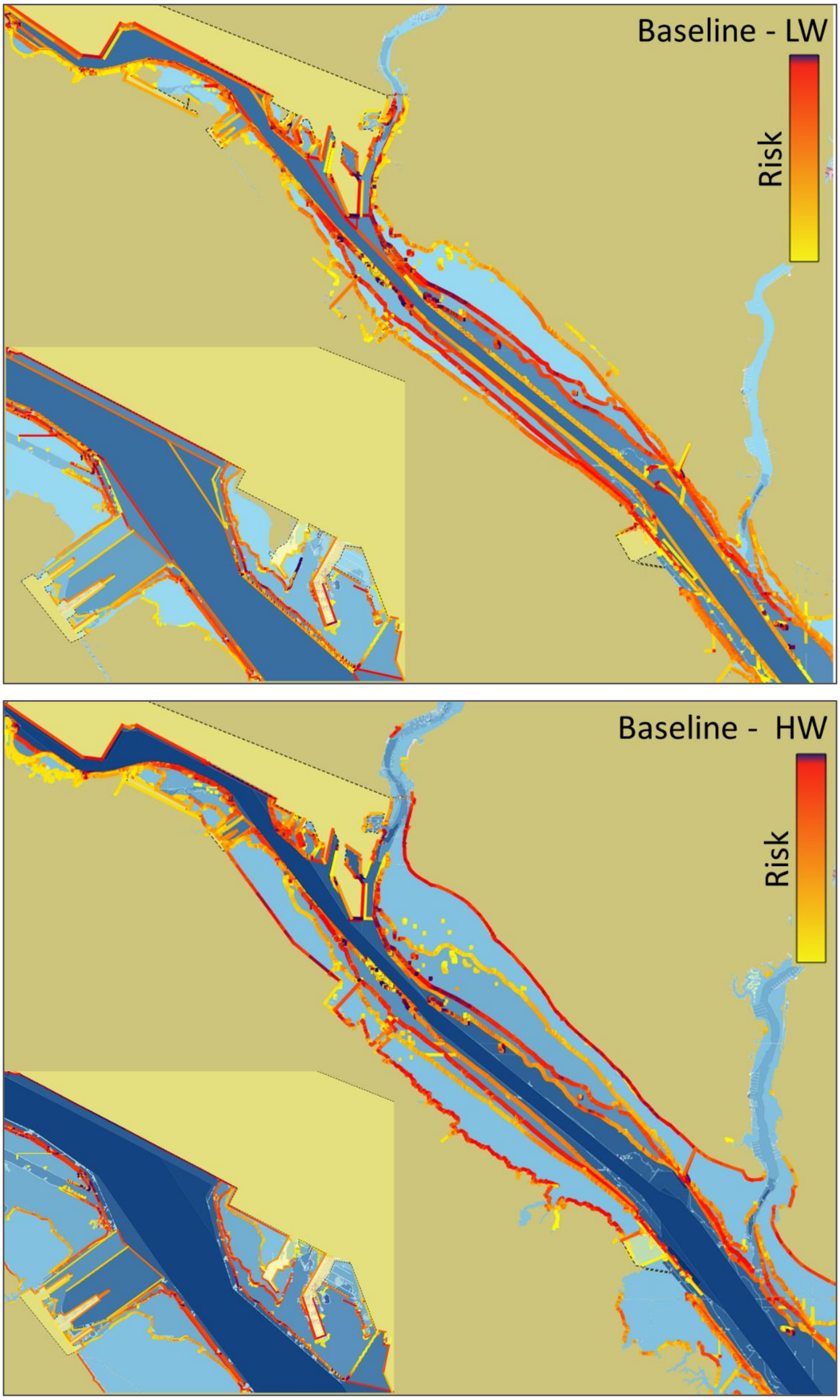


Figure 25: Baseline Grounding Risk Model Results: Top - Low Water, Bottom – HW (risk grading is relative to the study area).

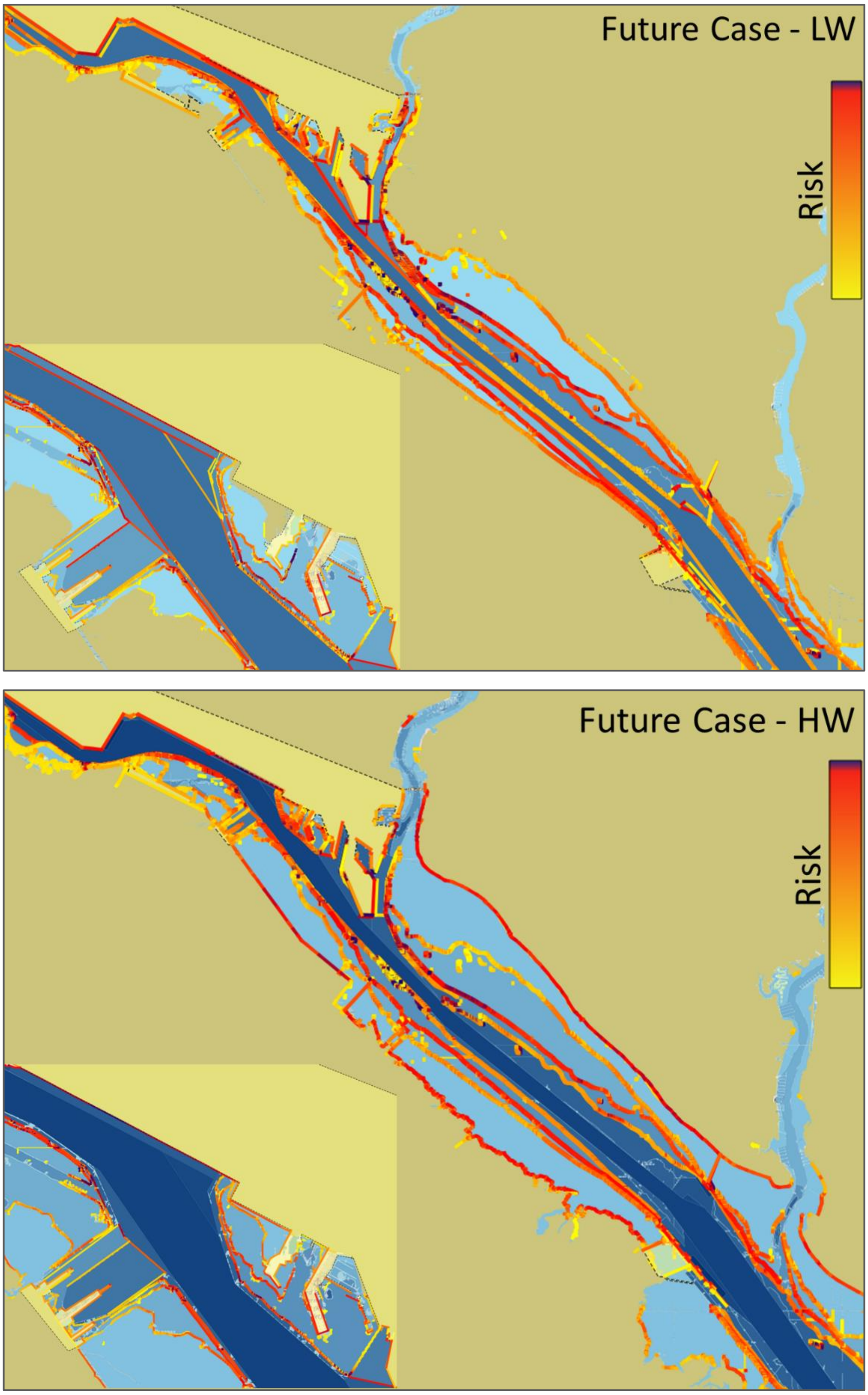


Figure 26: Future Case Grounding Risk Model Results: Top - Low Water, Bottom - HW (risk grading is relative to the study area).

3.3 COLLISION RISK MODELLING

The Collision Risk Modelling empirically determines the magnitude of any change in collision risk as a result of the Marchwood Port Development. The methodology is described below in terms of:

- Encounter Modelling;
- Risk Modelling; and
- Model Calibration.

The collision risk modelling results are then presented for the baseline and future cases.

The collision modelling methodology uses the principals of domain analysis, a form of modelling which considers that vessel masters, pilots and watch keepers attempt to keep a region of water around them clear of other vessels, to minimise the risk of collision. Where two vessels come close enough together then this safety buffer overlaps and an encounter occurs. Encounters do not represent collisions, or even near misses, but signify the possibility that a collision could occur. By measuring the frequency and location of encounters, a measure of collision risk can be derived.

3.3.1. ENCOUNTER MODEL

To develop the domain model, analysis of ship encounters in Southampton Water was conducted and a workshop consisting of the project team (which included a ABP Southampton pilot) was undertaken to define the modelling parameters.

Based on analysis of the AIS data and defined domain geometry, encounter density maps for commercial and passenger vessels for each of the encounter situations were generated (see **Figure 27**). In each case, the vessel is orientated north-up and the density shows the frequency of encounters at that location. For example, for head-on encounters, the majority of encounters pass approximately 50m along the port side, complying with COLREGs. For overtaking encounters, an elliptical shape emerges as a safe distance is maintained in all four directions. Note that there are far fewer crossing encounters in the study area than head-on and overtaking, but vessels tend to cross some distance in front.

Based on this analysis and following review of fast time replay of the AIS data to consider some examples of critical encounters between ships, the project team convened a workshop to define appropriate ship domain parameters for Southampton Water. It was agreed that an elliptical ship domain, with a variable forward and beam depending on the size and speed of the vessels would most appropriately fit marine practise in the study area. This was iteratively developed and reviewed against different situations to ensure that the extracted encounters reflected typical navigation in the study area.

Note that modelling was only undertaken for vessels greater than 50m in length, plus all passenger vessels (e.g. ferries).

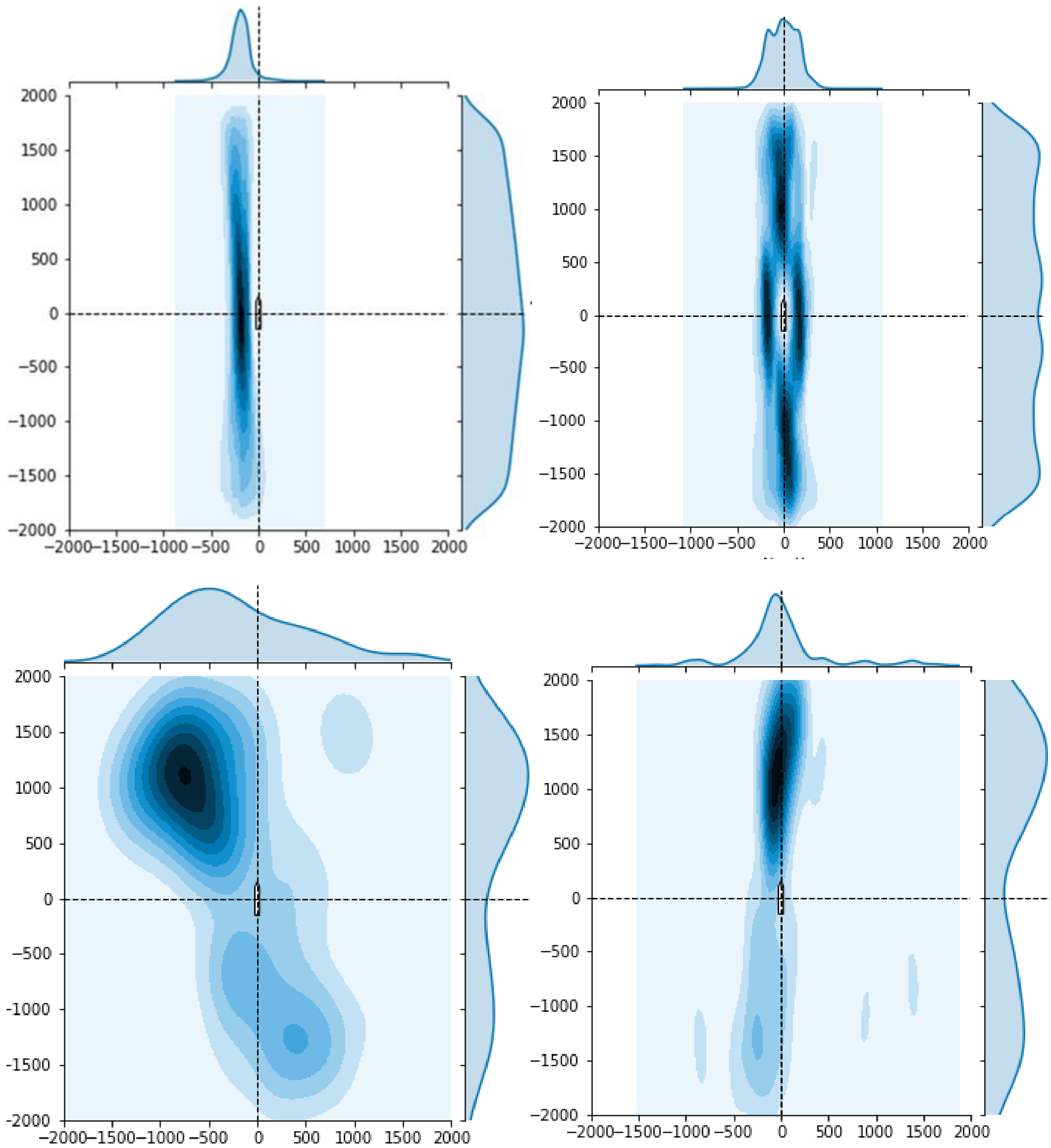
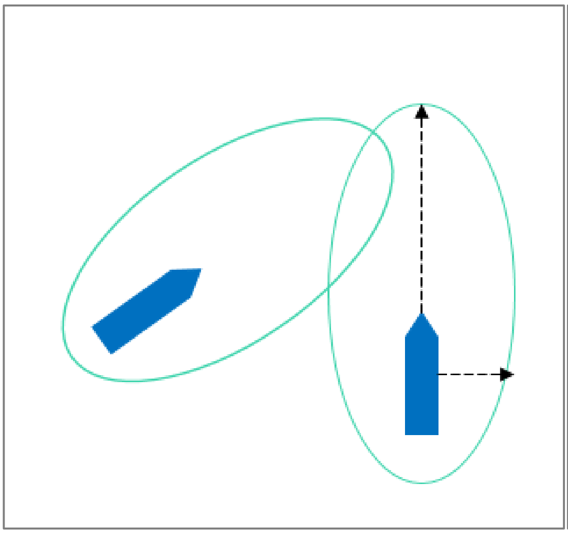


Figure 27: Ship encounter data mining in Southampton Water – scale in metres (clockwise from top left: Head-On, Overtaking, Crossing Give-Way, Crossing Stand-On).

Figure 28 shows the proposed domain shape following the analysis and workshop. It consists of an elliptical shape with a dynamic forward domain based on the vessel size and speed.



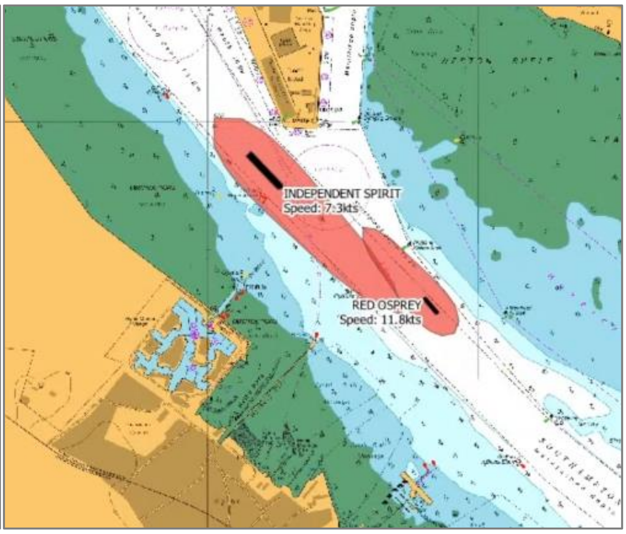


Figure 28:Left - Domain concept, right example extract from Collision Risk Model showing domains generated by vessel size and speed (i.e. fixed 1x beam width with an extendable "nose" based on vessel speed and manoeuvrability factor).

In summary the model is as follows:

1. Interpolate vessel positions from historical AIS data to 10 second resolution;
2. Create vessel outlines using the AIS offsets to show the footprint of a vessel;
3. Create vessel domains as follows (see **Figure 28**):
    a. To the sides, the domain is the vessel beam multiplied by a speed factor.
    b. To the fore, the domain is the vessel length multiplied by a speed factor.
    c. To the aft, the domain is 25% of the vessel length multiplied by a speed factor.
4. An algorithm iterates through the dataset and determines each intersection between vessel domains at each timestep. The details of each encounter are saved, including:
    a. Vessel details, type, name etc.
    b. Encounter characteristics including speed, passing distance and encounter type (head-on, crossing, overtaking
5. The results are filtered such there is one record per prolonged encounter i.e. in an overtaking situation, two vessels will spend up to a minute or more encountering as they pass, with only one record being desired in this situation. Therefore, where prolonged encounters occurred, the closest encounter in that group was retained.

3.3.2. FUTURE CASE MODELLING

To model the additional vessels to Marchwood Port, 100 randomised inbound and outbound transits for each of the proposed additional Marchwood Port Development vessels were simulated, following the proposed vessel characteristics (see **Table 1** and **Table 2**). This includes whether the vessel swings (turns) on arrival or departure, and whether it is tidally constrained to certain states of tide. For each additional transit, the number of additional encounters with baseline vessels was counted.

3.3.3. CALIBRATION

Two calibrations were required for the modelled results. Firstly, as a result of the reduced number of transits due to COVID-19 (see **Section2.5**), the number of baseline encounters was increased to reflect the expected number of transits during July 2020. Secondly, the future case transits are modelled as "blind navigators", which do not take avoiding action of other vessels. This exaggerates the number of encounters for each additional transit. To calibrate against this, the average number of encounters per transit for historical transits to Marchwood Port in the baseline model, was compared to the average number of encounters in the future case model. This showed that a 0.3 reduction factor (i.e. 30% of total) was required to account for the avoidance action that would be taken by masters of modelled vessels.

3.3.4. COLLISION RISK MODELLING RESULTS

3.3.4.1. Baseline Results

The AIS data for the baseline February and (COVID-19 calibrated) July 2020 periods show 3-39 encounters per day, with an average of 18 per day in February and 26 per day in July (based on the calibrated data). There is no clear relationship between encounter frequency and day of the week, except that Sundays seem to show typically the lowest encounter frequency in both February and July data sets. The number of encounters per day per transit however is similar, at 0.42% in February and 0.43% in July as vessel traffic in July is greater than in February.

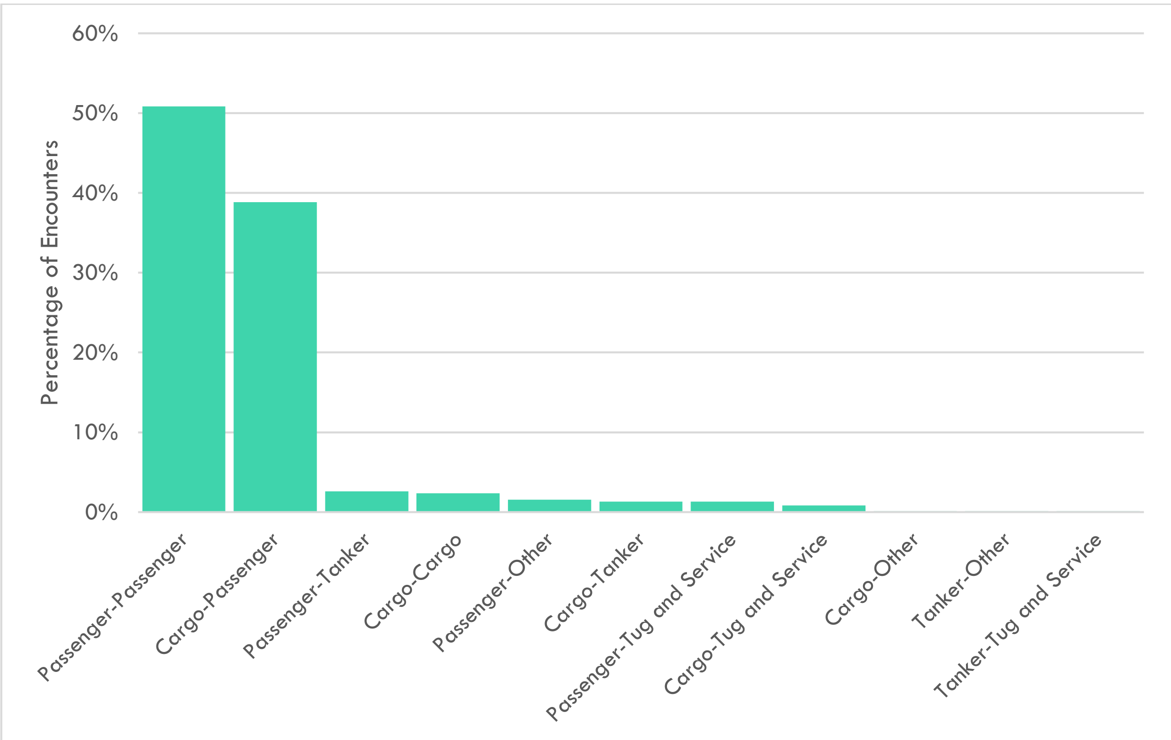


Figure 29: Baseline encounters by type

Most encounters (50%) are passenger-passenger vessels (**Figure 29**) and thus would not be significantly impacted by Marchwood Port Development vessels. However, 38% are Cargo-passenger vessel encounters, which could be impacted by the additional Marchwood Port Development vessels.

3.3.4.2. Future Case Results

For the future case the modelling indicates a small increase in the average number of encounters per year, as a result of the additional traffic to Marchwood Port.

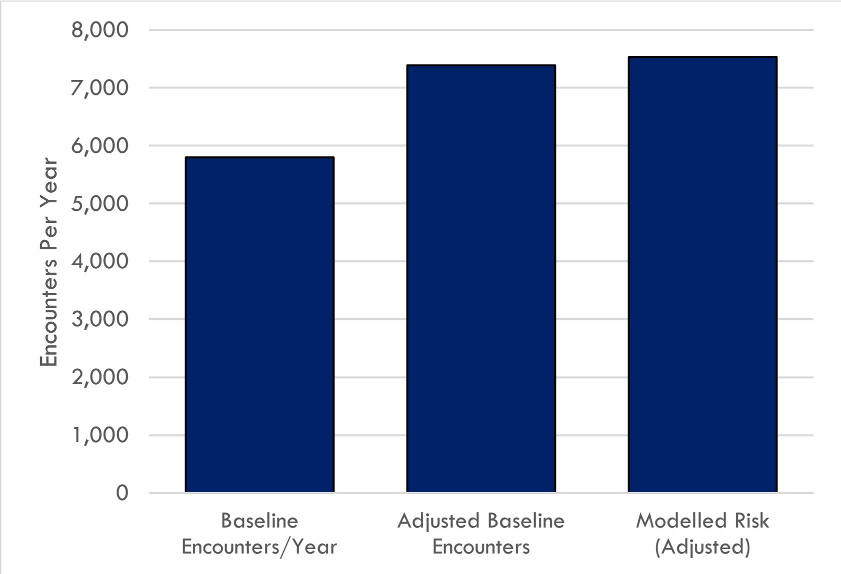


Figure 30: Future case encounters per year

Figure 30 compares the baseline and adjusted (calibrated as described in Section 3.3.3) baseline encounters with the modelled future (risk adjusted) encounters. It shows a small (2.0%) overall increase from 7,387 to 7,387 encounters per year. As illustrated in **Figure 31**, most (75%) of this minor increase is in cargo-passenger vessel encounters and 22% in cargo-cargo encounters, with other vessel encounter types all less than 5%.

Figure 32 shows where the encounters occur in the baseline (left panel) and future (central panel) cases and the difference between these (right hand panel) cases. The main increases in encounters are within the dredged navigation channel and peaks are around Dock Head and off the Esso Fawley refinery berths. The 25-100 increases in vessel encounters per year around Dock Head are likely related to Passenger-Cargo vessel encounters between Marchwood Port Development traffic and passenger ferries under way, while similar increases around Esso Fawley berths are likely cargo – bulk liquid encounters while Marchwood Port Development vessels undertake a Fawley pass.

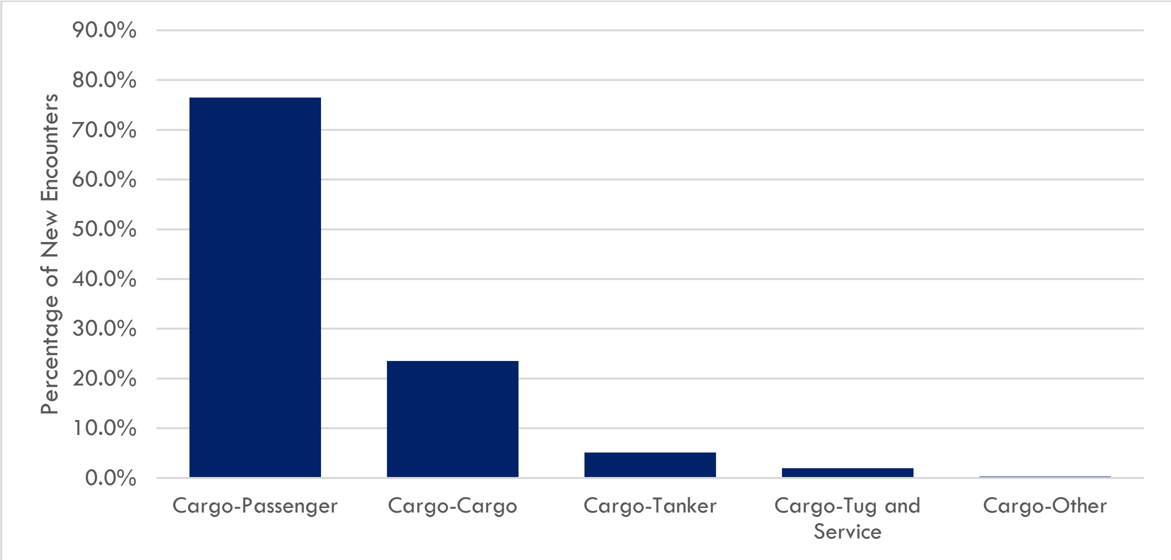


Figure 31: Future case encounters by vessel type for Marchwood Port Development vessels.

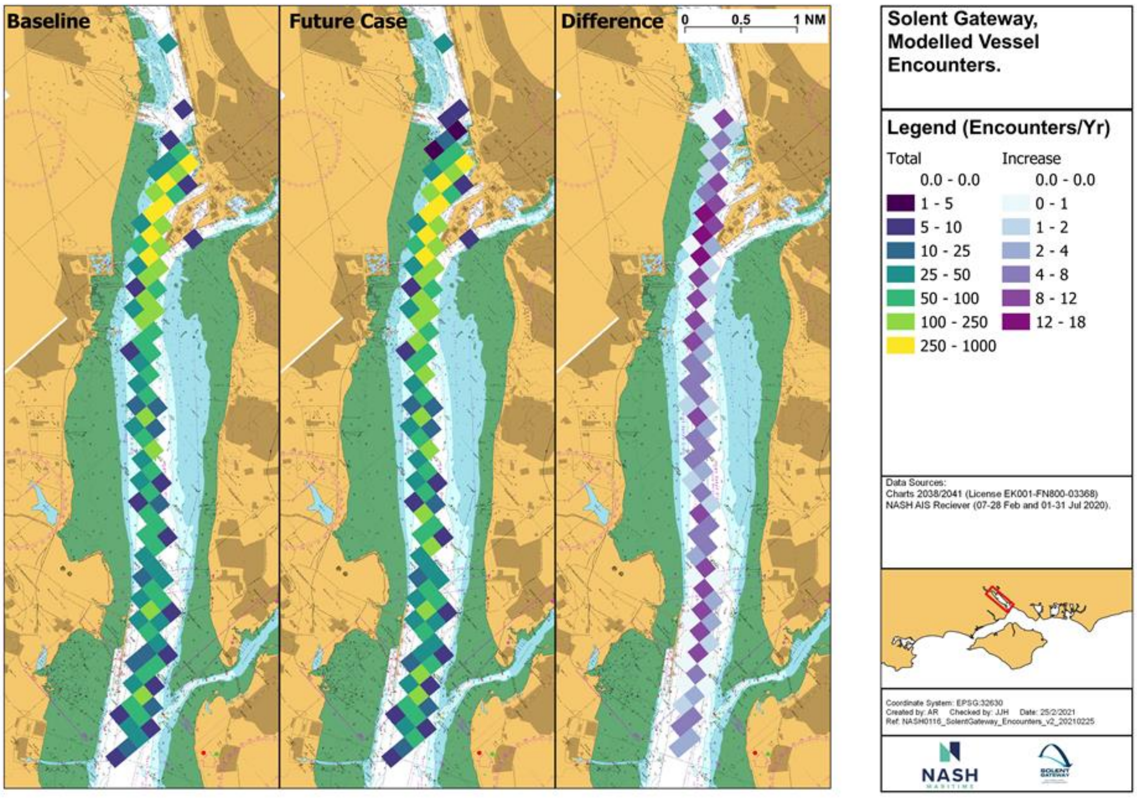


Figure 32: Baseline and future case encounter locations.

Figure 33 shows the risk profile of collisions between Calshot and the Upper Swinging Ground. The highest risk is concentrated at Town Quay (as a result of Ferries) and Dockhead (as a result of compression of traffic), with a comparatively low risk profile throughout the remainder of Southampton Water. It is notable that the future case modelling shows a minor increase across the channel, without any major hotspots – this is likely due to Marchwood Port being located in a relatively low traffic density area of ABP Southampton.

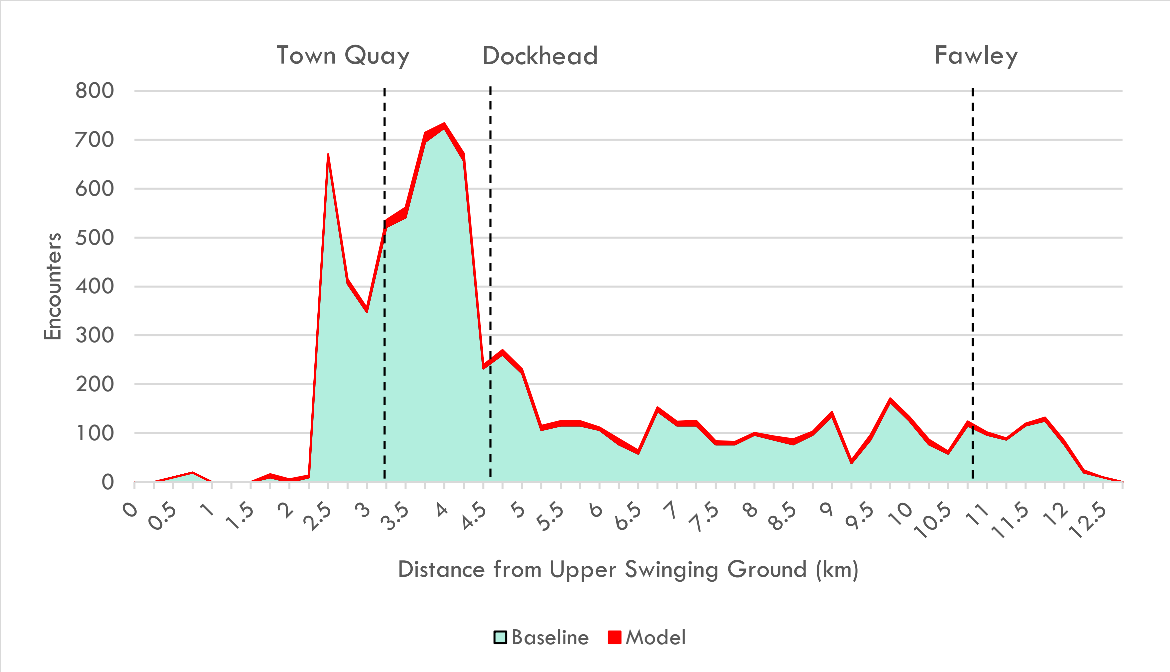


Figure 33: Collision risk profile from Upper Swinging Ground to Calshot (modelled increase is shown in red).

4. STAKEHOLDER CONSULTATION

Consultations were held with the ABP Southampton as the navigation regulator for Marchwood Port and with port stakeholders to ensure that location specific navigational concerns, related to the proposed future baseline operation at Marchwood Port, were identified and addressed. Note that during consultation 200 annual aggregate dredger movements were included in the future vessel scenario for the Marchwood Port Development, which were subsequently removed the from the proposals. The list of consultees was agreed with ABP Southampton and included:

- ABP Southampton as SHA (including key components, as put forward by ABP Southampton which included VTS, Pilotage and towage providers)
- The Port Users Group – A regular forum hosted by ABP Southampton to aid consultation with all port users including recreational users.

The following meetings were undertaken – meeting minutes are contained at **Annex A**:

- ABP Southampton – Navigation risk assessment specification meeting to establish ABP Southampton's requirements for the assessment and understand the proposed approach - 25-Nov-2020 & 10-Dec-2020
- Southampton Port Marine User Group Meeting – presentation and consultation on Marchwood Port Development project to wider shipping and navigation stakeholders - 21-Jan-2021 – attendees included:
  - Ports and Terminals:
    - ABP Southampton;
    - BP Hamble;
    - Portsmouth International Port;
    - Queens Harbour Master – Portsmouth;
    - Cowes Harbour Commission; and
    - Solent Gateway.
  - Recreational Stakeholders:
    - Calshot Activity Centre;
    - Royal Southampton Yacht Club;
    - Royal Southern Yacht Club;
    - Southampton Water Activities Centre;

        - Solent Cruising and Racing Association;
        - Royal Yachting Association; and
        - Southampton Rowing Association.
    - Towage Providers
        - Svitzer; and
        - Solent Towage.
    - Shipping & Marine Operators
        - Williams Shipping;
        - Marine Police Unit;
        - Red Funnel Ferries; and
        - Whitaker Tankers.
- ABP Southampton – Review of ABP Southampton Port Wide Navigation Risk Assessment and preliminary analysis and modelling results of the NRA - 27-Jan-2021
- ABP Southampton – Review of NRA assessment findings and conclusions – 26-Feb-2021

Adhoc correspondence, including emails, telephone calls and web meetings were used to clarify any questions or comments as they arose throughout the project.

In general the consultation and analysis recognised that the limited number of additional vessel movements to Marchwood Port are unlikely to have a significant impact on the level of risk within the port or day to day port operations.

However, there may be minimal potential impacts on the following aspects that are addressed as part of this assessment:

- Impact on existing navigation;
- Impact on the passage of draught restricted vessels (e.g. container vessels);
- Impact on the passage of time critical vessels (e.g. cruise ships);
- Impact on vessel traffic procedures – (e.g. passing points for vessels ≥180m LOA above the Hook Buoy);
- Possible impacts to ferry movements;
- Increased number of cruise ships using the turning circle off berth 102; and
- Leisure traffic transiting to and from Town Quay marina.

5. NAVIGATION IMPACT ANALYSIS

Through consultation, a number of possible impacts were identified by ABP Southampton (see above) – the following section provides a response to each possible impact based on a review of the analysis and modelling presented and judgment of the project personnel.

5.1 IMPACT ON EXISTING NAVIGATION

Vessels visiting ABP Southampton are actively managed and there are a number of policies, procedures, and rules in place the manage how and when vessel navigate. Whenever any vessel submits a final Estimated Time of Arrival at ABP Southampton pilot stations, or an agent submits a request to sail, a pilot is not allocated to the ship and arrangements never firmed up with the agent/tugs/linesmen/ship until the ABP Southampton VTS Watch Manager has given the OK that the movement will fit within his current traffic planning matrix. This will be governed by draught versus tide, tug availability, pilot availability, and scheduling of passing arrangements for large (over 180m) vessels. Where a vessel has special requirements for on-berth time or sailing time, the VTS watch manager will try to factor this in.

In general a first come first served policy is in place, but occasionally this may involve 'massaging' existing bookings 15 minutes or so either way to fit a ship in if there is good reason to do so and it doesn't mean a complete re-jig of the matrix. So it all relies on communication and planning, but no ship arrival should be a surprise and if it is, it will be held back until the necessary arrangements are in place for it to be able to transit safely.

During a vessel's transits through the port, it is monitored and given advice by the VTS operator who has a constant overview of the area via radar and AIS. This ensures that the vessel transit is going to plan, and where there is a need to 'tweak' the plan it is done in good time. A pilot onboard is constantly listening to other ship movements and advice and using this information in conjunction with the ship's own equipment to build a mental picture of what is going on, where he needs to be and when.

For a small ship e.g. *Al Avocet* (*see* **Figure 34**), which do not necessarily have a pilot onboard and will have a Pilotage Exemption Certificate holder then these vessels are able to fit in with the schedule of larger ships and through bridge to bridge VHF communications are able to agree where to slot in/pass/exit the channel etc. minimising any impact on schedules.

Fundamentally therefore the small increase in vessel numbers brought about by the Marchwood Port Development is unlikely to result in any material change to how vessels are managed and how they navigate the study area.

Figure 34: Left - CMA CGM Jacques Saade– 400m LOA x 61m Beam, right - Al Avocet (called Karissa until recently) – 100 m LOA x 12m.

5.2 IMPACT ON THE PASSAGE OF DRAUGHT RESTRICTED

Some, but not all, large container vessels (e.g. see **Figure 34***)* are tidally constrained both inward and outward. This may be outward on a rising tide, or inward on a falling tide, not necessarily at high water. A few car carriers are also constrained, notably when bound to ABP 35 berth (the berth pocket is deep but the approach is shallow). The largest container vessels will usually get priority within their tidal window and smaller vessels will be fitted in around them. Tug availability (numbers are often very limited not least due to breakdowns and crew shortage) is a major controlling factor in planning ship's movements.

Large crude tankers to Esso are a priority vessel for the Thorn Channel and usually aim to arrive at the Hook buoy between 30 mins prior to HW and 1 hour prior to second HW to be able to berth during slack water – again there may be some tweaking of estimated time of arrival (ETA) to factor in large container or cruise ship movements.

However the small increase in vessel numbers brought about by the Marchwood Port Development and specifically the very low number of tidally constrained vessels (limited to 6-12 per year) will not have a noticeable impact on large crude tanker transits.

5.3 IMPACT ON THE PASSAGE OF TIME CRITICAL VESSELS

Cruise ships visiting ABP Southampton are not tidally constrained, and they rarely need a tug. But they have demands for on-berth times (tours to get away, flights to meet, turnaround schedules, an ETA to make somewhere else tomorrow). These will juggle priority with any container ships or other large tankers, but their requests are usually met (through dialogue with ABP Southampton VTS). On occasion where a plan looks difficult, they may be brought ahead to an earlier ETA, or a sailing delayed. So, a Marchwood ship would be slotted in as best as possible, but is more likely to be inconvenienced itself than to inconvenience a cruise or container ship.

5.4 IMPACT ON VESSEL TRAFFIC PROCEDURES

Passes for vessels greater than 179.9m are either in the outer Solent (anywhere), between Hook and Cadland/Greenland buoys (i.e. passing Fawley) or, with strictly controlled timing and tug availability, off Ocean Dock. A large ship for Marchwood would need to be planned in with any others and on a busy day there may need to be an element of flexibility on all sides, on a quiet days there will be no impact. Given the limited number of these sizes of vessel proposed for Marchwood Port Development project any impact is likely to be very small and temporary only (lasting only a matter of minutes and not hours and should be factored into the vessel scheduling by ABP Southampton VTS).

5.5 POSSIBLE IMPACTS TO FERRY MOVEMENTS

Marchwood Port Development is located are further up the River Test than the Town Quay ferry terminals, therefore the 'gate' at Dock Head (off ABP 38/9 berth) is the main constriction, which may be made narrower by a large vessel alongside, and perhaps a bunker vessel outboard of that. It is a busy corner, with tugs coming and going from 37 berth, ships taking tugs and recreational traffic in the mix.

An inward car ferry may have to slow down and follow an inward ship temporarily, prior to overtaking once clear of Dock Head. A Red Jet is fast enough and shallow enough to do its own thing, either inside or outside the navigation channel. The Hythe ferry will either be able to cross ahead or will go astern and run along the dock wall.

Outward, any surprises are mitigated by having a VTS reporting point at Pier Head buoy. This triggers VTS watch keepers and ferry masters that a ship is approaching Town Quay outward from Marchwood (which would also have reported in prior to sailing).

Ships are speed restricted to 6kts in the docks (inward of Weston Shelf buoy/Hythe Pier) but ferries (apart from in fog) are not speed restricted, so they have the speed to get by as need dictates.

In summary, ferries need to be aware, but the presence of ships to and from Marchwood should not significantly impact ferries.

5.6 CONSIDERATION OF THE INCREASED NUMBER OF CRUISE SHIPS USING THE TURNING CIRCLE OFF BERTH 102

Marchwood bound vessels will need to turn on arrival or departure near the middle swinging ground. This has the impact of blocking the main channel to ships going further up the Test for 10 minutes or so, but will be factored in and coordinated by VTS in conjunction with the pilots on other vessels.

Ships may either turn on arrival or departure - this is known in advance and planned in by the VTS Watch Manager. The City Cruise Terminal (berth 102) terminal is a joint venture for MSC and NCL Cruise lines (all of which are large ships), so if there is something already on 101 berth – Royal Caribbean berth, space will be tight. In which case the MSC/NCL ships may occasionally choose to turn off Ocean

Dock and go stern first, or even turn up off 109 in the upper swinging ground. So, ships for Marchwood, 101and 102 terminals will use the same turning area, but the low numbers of vessels as a result of the Marchwood Port Development is minimal and the turns do not take too long – circa. 10 minutes.

7.5 CONSIDERATION TO LEISURE TRAFFIC TRANSITING TO AND FROM TOWN QUAY MARINA

Leisure traffic should avoid impeding the progress of a commercial vessel which can only navigate within a channel. This is no different to any leisure traffic e.g. from Hythe Yacht Club / Marina or Marchwood Yacht Club. As the Marchwood Port Development vessel traffic is minimal no impact is expected to recreational vessels.

6. RISK ASSESSMENT METHODOLOGY

6.1 INTRODUCTION

The following section outlines the parameters of the ABP Southampton risk assessment methodology, which has been adopted as the baseline navigation risk assessment, to determine the degree of any additional navigation risk posed Marchwood Port Development Project. The objective was to establish a benchmarking basis for the Marchwood Port Development Project which would be consistency with how ABP Southampton currently assess navigation risk and also enable a comparison between the baseline assessment (as provided by ABP Southampton) and the future assessment taking into consideration the navigation changes in terms of vessel arrival frequency, brought about by the Marchwood Port Development Project. This approach shared and agreed by ABP Southampton as statutory authority responsible for navigation safety within the study area.

The ABP Southampton risk assessment methodology is based on the International Maritime Organisation (IMO) Formal Safety Assessment methodology (see **Figure 35**) and is managed by ABP Southampton within a specialist software package – MarNIS provided by ABPmer Ltd (a wholly owned subsidiary of ABP Holdings Limited).

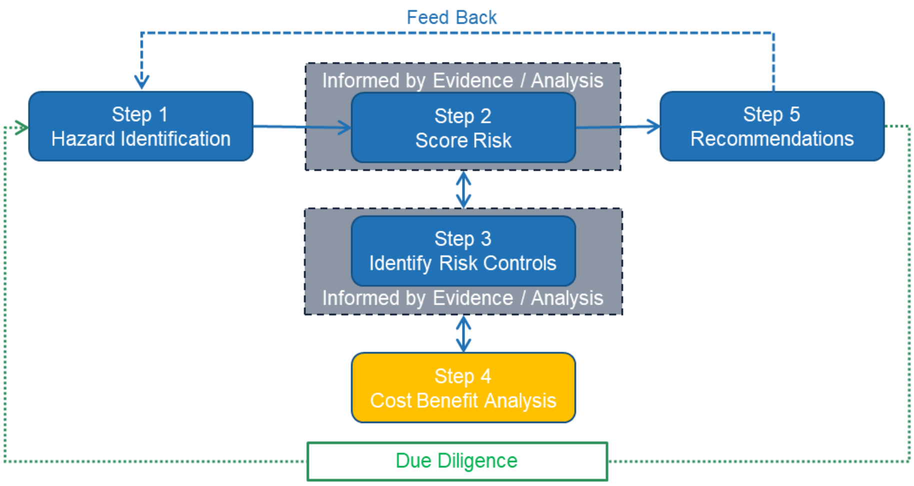


Figure 35: Formal Safety Assessment Process

The ABP Southampton navigation risk assessment was extracted from MarNIS into an excel format and reviewed by the project team. The review showed that many of the resulting risk score calculations appeared incorrect and did not follow the prescribed risk assessment methodology as presented. This observation was raised with ABP Southampton for clarification and ABPmer Ltd subsequently confirmed an error in the MarNIS software causing the calculated risk scores to be incorrect due to a software 'glitch'. Following a software update by ABPmer Ltd to rectify the issue, the majority of the hazards risk scores in the ABP Southampton risk assessment changed. Hazard risk scores presented in this report are based on the correct risk calculation. Based on the revised scoring subsequently, some hazards were reviewed by ABP Southampton to ensure and confirm that all hazards were mitigated to acceptable levels.

In the NRA the following definitions apply:

- **Hazard** - an unwanted event resulting in adverse consequences.
- **Likelihood** - a determination of how likely a hazard is to occur.
- **Consequence** – the magnitude of the consequences should a hazard occur.
- **Risk** - a non-dimensional measure of hazard consequence 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.
- **Baseline Assessment of Navigation Risk** – an assessment of hazard risk prior to the proposed operation being in place (this is the ABP Southampton MarNIS hosted Port wide Risk Assessment).
- **Inherent Assessment of Navigation Risk** – an assessment of hazard risk with the proposed operation occurring including existing ("Embedded") risk control or mitigation measures.
- **Residual Assessment of Navigation Risk** – an assessment of hazard risk with the proposed operation occurring including existing ("Embedded") risk control or mitigation measures, and "additional" project / risk control or mitigation measures.

6.2 RISK ASSESSMENT METHODOLOGY

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

$$Navigation\ Risk = likelihood\ of\ hazard\ occurence\ .\ consequence\ of\ hazard\ occurence$$

Table 6: Hazard Likelihood Classifications.

Likelihood Score	Description
1	Very Unlikely (1:50 yrs)
2	Unlikely (1:25 yrs)
3	Occasionally (1:10 yrs)
4	Probably (1:5 yrs)
5	Likely (> 1 per year)

In order to determine hazard likelihood, the assessment uses a likelihood classification table to allocate likelihood scores to hazards – see **Table 6**.

Hazard consequence classifications are as shown in Table 7 and relate in board terms to hazard outcome to People, Property, Environment and Port business.

Table 7: Hazard Consequence Classifications.

Consequence Score	People	Property	Environment	Port business
0 - Negligible	No injury	Negligible (£0 - £10,000)	None (No incident - or a potential incident/near miss)	None
1 - Minor	Minor injury(s)	Minor (£10,000 - £750,000)	No Measurable Impact (An incident or event occurred, but no discernible environmental impact - Tier 1 but no pollution control measures needed)	Minor (Little local publicity. Minor damage to reputation. Minor loss of revenue, £0 - £750,000)
2 - Moderate	Serious injury(s) (MAIB/RIDDOR reportable injury)	Moderate (£750,000 - £4m)	Minor (An incident that results in pollution with limited/local impact - Tier 1, Harbour Authority pollution controls measures deployed)	Moderate (Negative local publicity. Moderate damage to reputation. Moderate loss of revenue, £750,000 - £4m)
3 - Serious	Single fatality	Serious (£4m - £8m)	Significant (Has the potential to cause significant damage and impact - Tier 2, pollution control measures from external organisations required)	Serious (Negative national publicity. Serious damage to reputation. Serious loss of revenue, £4m - £8m)
4 - Major	Multiple fatalities	Major (> £8 million)	Major (Has the potential to cause catastrophic and/or widespread damage - Tier 3, requires major external assistance)	Major (Negative national and international publicity. Major damage to reputation. Major loss of revenue, > £8 million)

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 proposed operation, each hazard is scored using the matrix as defined in **Table 8**. Hazard risk scores are assessed for the "*most likely*" and "*worst credible*" outcome of an individual hazard. In total therefore there are:

- "Most Likely" Likelihood score for
  - People
  - Property
  - Environment
  - Port business
- "Worst Credible" likelihood score for:
  - People
  - Property
  - Environment
  - Port business

Hazard risk scores for each individual hazard consequence score are then brought together using a weighted averaging formula to give a single overall risk score. The averaging formula, which generates a single risk score on a scale of 1 to 10 is generated by taking the average of:

- The highest "Mostly Likely" risk score;
- Average of the "Mostly Likely" risk scores;
- The highest "Worst Credible" risk score; and
- Average of the "Worst Credible" risk scores.

Table 8: Risk Score Matrix.

Risk Matrix							
Frequency	Very Unlikely	5	0	6	8	9	10
	Unlikely	4	0	3	6	7	8
	Occasionally	3	0	2	4	6	7
	Probably	2	0	2	3	5	6
	Likely	1	0	1	3	4	5
			0	1	2	3	4
			Negligible	Minor	Moderate	Serious	Major
			Consequence				

6.3 ACCEPTABILITY

Hazards with risk scored at "Negligible" or "Low" would be deemed acceptable, which puts the acceptability threshold at risk scores lower than 3.0 / 10 (see **Table 9** for risk score classifications). Where hazards are scored between 3-5.99 (Moderate) then additional control measures are necessary unless their cost is disproportionate to their benefit – e.g. following the As Low As Reasonable Practicable (ALARP) principle. Where hazard risk scores are greater than 6/10 ("Medium", "" or "High" risk), risk controls must be identified and allocated to hazards to reduce risk. Hazard risk scores are then recalculated using the same method as above and a residual assessment of risk determined.

Table 9: Hazard risk score classifications.

Risk Level	Risk Score	Tolerability
Negligible	0 - 0.99	Acceptable
Low	1 - 2.99	Acceptable
Medium	3 - 5.99	Acceptable if ALARP
Significant	6 - 8.99	Unacceptable
High	9 - 10	Unacceptable

6.4 RISK ASSESSMENT RESULTS

Navigation hazards were identified based on the ABP Southampton Port Wide Risk Assessment resulting in 37 individual navigation hazards that could be impacted by the additional vessel traffic forecast for Marchwood Port Development project (see **Table 10**).

Table 10: Summary of Identified Hazards.

MarNIS Haz ID	Scenario Name	MarNIS Haz ID	Scenario Name
EP0182	Ship wash: Across Port of Southampton SHA	NS0297	Striking with Floating Object: Vessel <20m collides with navigational mark
EP0316	Marine Pollution (Minor): Tier 1,2 & 3	NS0298	Impact with structure: Any vessel impact with mooring or pontoon
EP0316	Marine Pollution (Minor): Tier 1,2 & 3	NS0299	Impact with structure: Vessel impacts with Empress Dock entrance
NS0281	Collision Ship-Ship: Commercial vessel with a leisure vessel	NS0300	Impact with structure: Commercial vessel colliding with Bridge.
NS0282	Collision Ship-Ship: Two commercial vessels	NS0301	Impact with structure: Commercial vessel impacts with quayside infrastructure.
NS0283	Collision Ship-Ship: Multiple vessels boarding and congestion at the Nab	NS0302	Other Nautical Safety: VTS loss of Communications
NS0284	Collision Ship-Ship: Dredger operations	NS0303	Other nautical safety: Man-overboard from leisure or commercial vessel
NS0285	Collision Ship-Ship: Vessel dragging anchor	NS0304	Other nautical safety: Loss of stability/ inadequate stability
NS0286	Collision Ship-Ship: Recreational craft pan Solent events	NS0306	Other nautical safety: VTS loss of traffic image
NS0287	Equipment failure (vessel): Failure of steering and propulsion	NS0307	Other nautical safety: Lost of metrological information
NS0288	Equipment failure (vessel): Towage equipment failure	NS0308	Pilot boarding arrangements: Pilot boarding arrangements
NS0289	Event Management : Large recreational event	NS0310	Ranging: Alongside Docks
NS0290	Fire/Explosion: Onboard leisure vessel	NS0311	Sinking and capsizing: Any vessel

MarNIS Haz ID	Scenario Name	MarNIS Haz ID	Scenario Name
NS0291	Fire/Explosion: Onboard commercial vessel	NS0312	Striking and capsizing: Tug girting
NS0292	Grounding : Any Vessel	NS0313	Striking with floating object: High speed craft makes contact with floating object.
NS0293	Grounding : ULCV in precautionary area	NS0314	Striking with ship (moored): Underway vessel strikes moored vessel
NS0294	Heaving Lines: Use of inappropriately weighted heaving lines	NS0315	Striking with ship (moored): Small vessel collides with a moored vessel
NS0295	Impact with structure: Impact with Ocean Dock	NS0317	Striking with Floating Object: Vessel >20m collides with navigational mark
NS0296	Impact with structure: Impact with Nab Tower or Forts		

6.4.1. EMBEDDED RISK CONTROL MEASURES

ABP Southampton have 83 risk control measures identified in the MarNIS system aimed at reducing risk and ensuring medium scored hazards are deemed to be ALARP (see **Table 11**). As noted above, these are termed "embedded" risk control measures. They are considered as included in the assessment of inherent risk.

Table 11: ABP Southampton Risk Control Measures (extracted from MarNIS).

#	Control Name	#	Control Name	#	Control Name
1	Pilots - training and authorisation	29	Pollution response equipment - available	57	PAVIS
2	Notices to mariners	30	General directions	58	Shoreside facility maintenance programme
3	Passage planning (Pilot/PEC)	31	Communications - other port users	59	Tugs - tug/workboat and crew certification checked
4	Safety procedures - vessel	32	Safe systems of work	60	Bunkering areas restricted
5	Bridge resource management training	33	Communications equipment - operational	61	Mooring studies & plans
6	VTS - traffic organisation service	34	Passage planning (VTS/LPS/PAVIS function)	62	Pilotage directions
7	Byelaws	35	Ship personnel - training	63	Tugs - fire tug available
8	Channel/fairway - Management of	36	STCW	64	Anchorage positions - designated
9	Guard/patrol vessels	37	Towage guidelines	65	Business Continuity Plan
10	Emergency plans - port (local)	38	Berths - allocation (depth, available, suitable)	66	PMSC compliance - marine policy
11	VTS personnel - training and authorisation	39	Hydrographic surveying program	67	Prohibited anchorage areas
12	Tidal information - accurate	40	Hydrographic information - latest available	68	Port state inspection - MCA
13	International COLREGS 1972 (as amended)	41	Risk assessment - personal safety	69	Pilot launch/other vessels - operational
14	VTS broadcast - navigation and safety information	42	Tugs - escort towage/accompanying	70	Marine engineering support
15	Ship personnel - training	43	Draught - accurate, declared and within max limits	71	Pre-bunkering checklist
16	VTS - navigation information service	44	Pilot/Master exchange - records of	72	Emergency response centre (MRC)
17	Radar coverage & redundancy provision	45	SOPs - operational	73	Port marine/operations personnel - training
18	Portable Pilot Units (PPU)	46	Pilot boarding point - designated	74	Ramps/hatches - closed when underway
19	Fatigue & Health monitoring	47	Harbour/Dock Masters powers (inc. special directions)	75	Tugs - non routine towage assessment

#	Control Name	#	Control Name	#	Control Name
20	Simulator based studies	48	Arrival/departure - advance notice of	76	Line/Boatmen - available and suitably qualified
21	Tugs - availability of appropriate	49	Communications - port and agents	77	Emergency power supply
22	Vessel defects - requirement for notification	50	Unusual vessels - specific risk assessments	78	Hydrocarbon tankers certified gas free
23	Aids to navigation - provision & maintenance of	51	Dredging programme	79	ABP Environmental policy
24	C.C.T.V. coverage	52	Oil spill contingency plans	80	Hazardous cargoes - advance notice of
25	VTS broadcast - traffic information	53	Emergency Services / Equipment - shoreside availability	81	ISPS compliance
26	AIS coverage	54	ABP Health & Safety policy	82	Pre arrival information (Port to Ship)
27	Emergency plan exercises	55	ABP Security policy	83	Waste management plan - port
28	Guidance for small craft	56	Communications - dock/jetty and traffic		

6.4.2. RISK ASSESSMENT RESULTS

The baseline assessment of risk is as undertaken by ABP Southampton, and was reviewed (in terms of hazard likelihood and consequence scoring) by the project team, to score hazards in relation to the Marchwood Port Development Project - a summary table of which is provided in **Table 12**. The results of the NRA are contained in full in the "*Risk Assessment Logs*" which are at **Annex C**.

The results of the risk assessment review undertaken by the project team and shared with ABP Southampton during a meeting held on 26-Feb-2021, found that no individual hazards would be affected to the extent of changing either likelihood or consequence classifications from those in the ABP Southampton risk assessment. The general reasons this was the case, is because:

- The increase in vessel traffic proposed by project are not considered significant in the context of ABP Southampton's typical vessel numbers.
- The types of vessels proposed to visit Marchwood Port already regularly visit ABP Southampton and are not considered to be onerous in navigation terms. An exception to this may be deeper draught vessels laden with bulk aggregates that are tidally constrained arrivals and may need to discharge cargo to stay "always afloat" whilst alongside and the tide falls – the risk of these vessels whilst on transit through the study area however is no different to other vessels regularly visiting ABP Southampton, and where there are particular hazards during cargo operations these will be assessed separately on a case by case basis (as is the current practise in ABP Southampton).
- The results of the modelling indicate small increases in risk as follows (see **Section 3** for more details):
    - Collision ~ 2.0% increase
    - Grounding ~3.3% increase.

- Allision ~0.6% increase.

None of which materially required any hazard risk score likelihoods to change category (which are assessed on a logarithmic scale within the ABP Southampton risk assessment (see **Table 6**)).

Specific comments on each hazard and the impact related to increases in Marchwood Port Development vessel movements is presented in the Hazards Log at **Annex C**.

In reviewing the risk assessment with ABP Southampton the following comments were made:

- NS0281 Collision Ship-Ship: Commercial vessel with a leisure vessel.

  ABP Comment: This hazard was subsequently removed in a future review as it is a duplicate of NS0286 which has been recently reviewed and updated.

- NS0289 Event Management: Large recreational even.

  ABP Comment: ABP Southampton may review the hazard scoring as the baseline was determined as high risk (as a result of previous ABP risk assessment review) – but this hazard is considered to not materially change based on project vessel movements.

- NS0292 Grounding: Any Vessel ABP Comment.

  ABP Comment: Any vessels calling to SGL berths would be needing to comply with the SHA requirements regarding Under keel Clearance, etc.

- NS0301 Impact with structure: Commercial vessel impacts with quayside infrastructure.

  ABP Comment: As a result of a review undertaken by the project team and ABP the hazard scoring was updated. It was noted that Solent Gateway should consider all landside obstructions in vicinity of vessel (e.g. include cranes).[14]

- NS0310 Ranging: Alongside Docks.

  ABP Comment: ABP Southampton may review scoring as the baseline risk score is higher than expected.

- EP0316 Marine Pollution (Minor): Tier 1,2 & 3.

  ABP Comment: ABP to follow up with SGL regarding Oil Spill Response and Co-operation Plan

- NS0317 Striking with Floating Object: Vessel >20m collides with navigational mark.

  ABP Comment: SGL should consider the close proximity to Dibden Bay buoy when manoeuvring for berth – this will be considered by the pilot and or PEC of vessel bound for Solent Gateway.

[14] It was noted that the SGL Cranes Procedure is that cranes are not to be manned and should be stowed when vessels arrive and depart the jetty.

These comments have been incorporated and addressed in the risk assessment review.

Of the 37 hazards extracted from the MarNIS system once reviewed, a number were deemed to not be affected by Marchwood Port Development vessels - mostly as the hazard fell outside of the study area or were not related to the vessel types that would visit Marchwood Port (e.g. recreational vessels) – these are identified by * in **Table 12**.

This related to a number of hazards scored as "Significant" risk in the ABP Southampton risk assessment that were not applicable to SGL vessels. Hazard EP0182 Ship wash: Across Port of Southampton SHA which was scored by ABP Southampton at "Significant", was subsequently reviewed by ABP Southampton as they believe it was scored too high, and was given a revised scoring of 4.25/10. NS0283 Collision Ship-Ship: Multiple vessels boarding and congestion at the Nab, whilst not pertinent to the Marchwood Port Development, was also reviewed and subsequently scored at 5.19/10 by ABP Southampton. Also, hazard EP0182 Ship wash: Across Port of Southampton SHA was also subsequently re-scored at 4.25/10 by ABP Southampton.

A number of hazards are scored at "Medium" risk, and with the existing risk control measures identified and in place (see **Table 11**), then these hazards are considered to meet the ALARP principle and are therefore considered acceptable.

Therefore based on a review the ABP Southampton hazards with the future Marchwood Por Development vessel traffic included, no hazards are scored at a level where additional risk controls would be necessary, and that the existing risk control measures (which are managed and reviewed by ABP Southampton as Statutory harbour Authority), are considered to adequately manage the future navigation risk for the project within the study area.

*Table 12: Baseline assessment of risk (hazards marked at * not considered to affected by the Project).*

MarNIS Haz ID	Scenario Name	Risk Score	Classification
NS0281	Collision Ship-Ship: Commercial vessel with a leisure vessel	4.3	Medium
NS0284	Collision Ship-Ship: Dredger operations	5.4	Medium
NS0283	Collision Ship-Ship: Multiple vessels boarding and congestion at the Nab*	6.0	Significant
NS0286	Collision Ship-Ship: Recreational craft pan Solent events	4.6	Medium
NS0282	Collision Ship-Ship: Two commercial vessels	3.8	Medium
NS0285	Collision Ship-Ship: Vessel dragging anchor	4.4	Medium
NS0287	Equipment failure (vessel): Failure of steering and propulsion	3.9	Medium
NS0288	Equipment failure (vessel): Towage equipment failure	3.0	Medium
NS0289	Event Management: Large recreational event	2.9	Low
NS0291	Fire/Explosion: Onboard commercial vessel	4.1	Medium
NS0290	Fire/Explosion: Onboard leisure vessel*	6.0	Significant
NS0292	Grounding: Any Vessel	4.3	Medium
NS0293	Grounding: ULCV in precautionary area*	5.2	Medium

MarNIS Haz ID	Scenario Name	Risk Score	Classification
NS0294	Heaving Lines: Use of inappropriately weighted heaving lines	3.9	Medium
NS0298	Impact with structure: Any vessel impact with mooring or pontoon	3.4	Medium
NS0300	Impact with structure: Commercial vessel colliding with Bridge.*	5.1	Medium
NS0301	Impact with structure: Commercial vessel impacts with quayside infrastructure.	4.3	Medium
NS0296	Impact with structure: Impact with Nab Tower or Forts*	2.6	Low
NS0295	Impact with structure: Impact with Ocean Dock*	5.3	Medium
NS0299	Impact with structure: Vessel impacts with Empress Dock entrance*	2.9	Low
EP0316	Marine Pollution (Minor): Tier 1,2 & 3	3.0	Medium
NS0304	Other nautical safety: Loss of stability/ inadequate stability	3.1	Medium
NS0307	Other nautical safety: Lost of metrological information	4.1	Medium
NS0303	Other nautical safety: Man-overboard from leisure or commercial vessel	2.2	Low
NS0302	Other Nautical Safety: VTS loss of Communications	4.3	Medium
NS0306	Other nautical safety: VTS loss of traffic image	3.4	Medium
NS0308	Pilot boarding arrangements: Pilot boarding arrangements	3.8	Medium
NS0310	Ranging: Alongside Docks	3.3	Medium
EP0182	Ship wash: Across Port of Southampton SHA	6.6	Significant
NS0311	Sinking and capsizing: Any vessel	2.3	Low
NS0312	Striking and capsizing: Tug girting	4.6	Medium
NS0313	Striking with floating object: High speed craft makes contact with floating object.	2.5	Low
NS0297	Striking with Floating Object: Vessel <20m collides with navigational mark	3.8	Medium
NS0317	Striking with Floating Object: Vessel >20m collides with navigational mark	3.3	Medium
NS0315	Striking with ship (moored): Small vessel collides with a moored vessel	3.9	Medium
NS0314	Striking with ship (moored): Underway vessel strikes moored vessel	4.5	Medium

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The assessment has reached the following conclusions:

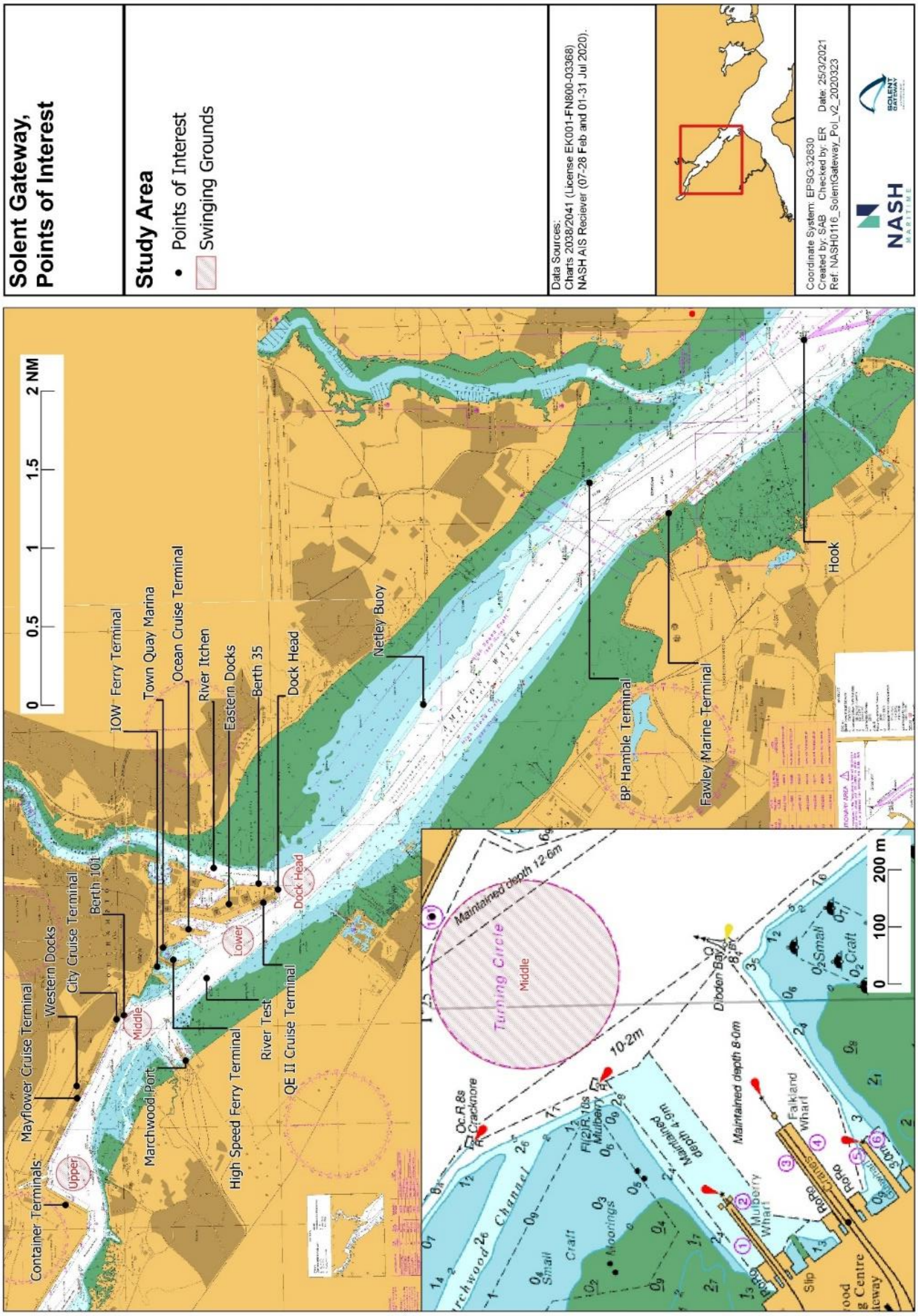
1. The proposed Marchwood Port Development results in a small increase in vessel traffic movements to and from the port, but no changes are proposed to the existing marine infrastructure.
2. The types and sizes of vessel likely to visit the port associated with project are similar to vessel sizes and types already visiting the Port of Southampton and are not considered navigationally onerous vessel.
3. A project study area of Southampton Water was defined in conjunction with ABP Southampton as Statutory Harbour Authority for the area.
4. The proposed increase in vessel numbers visiting Marchwood Port (which it is assumed will gradually increase over a number of years) as a result of the development is as follows:
    a. Automotive – 22 vessels per year;
    b. Aggregates:
        i. Specialist Aggregates - 25 vessels per year; and
        ii. Bulk Aggregates - 6 /15 vessels per year.
    c. Steel - 20 vessels per year;
    d. Project cargo / Other - 70 vessels per year;
    e. Other (Barge/Support vessel) - 5 vessels per year;
    f. MOD (Non-Commercial) - 4 vessels per year; and
    g. Total increase 189-198 vessel per year.
5. A baseline assessment of vessel traffic activity in the study area was conducted based on collected vessel traffic data AIS and included vessel:
    a. Track Analysis
    b. Density Analysis
    c. Swept Path Analysis
    d. Gate Analysis
    e. Incident Analysis
    f. Influences of the Covid-19 pandemic.
6. Based on a review of the baseline vessel traffic analysis approximately 28,903 vessels pass Marchwood Port annually.
7. The additional Marchwood Port Development vessels equate to an increase of approximately 1.37% of vessels that transit past the Marchwood Port site in the navigation channel.

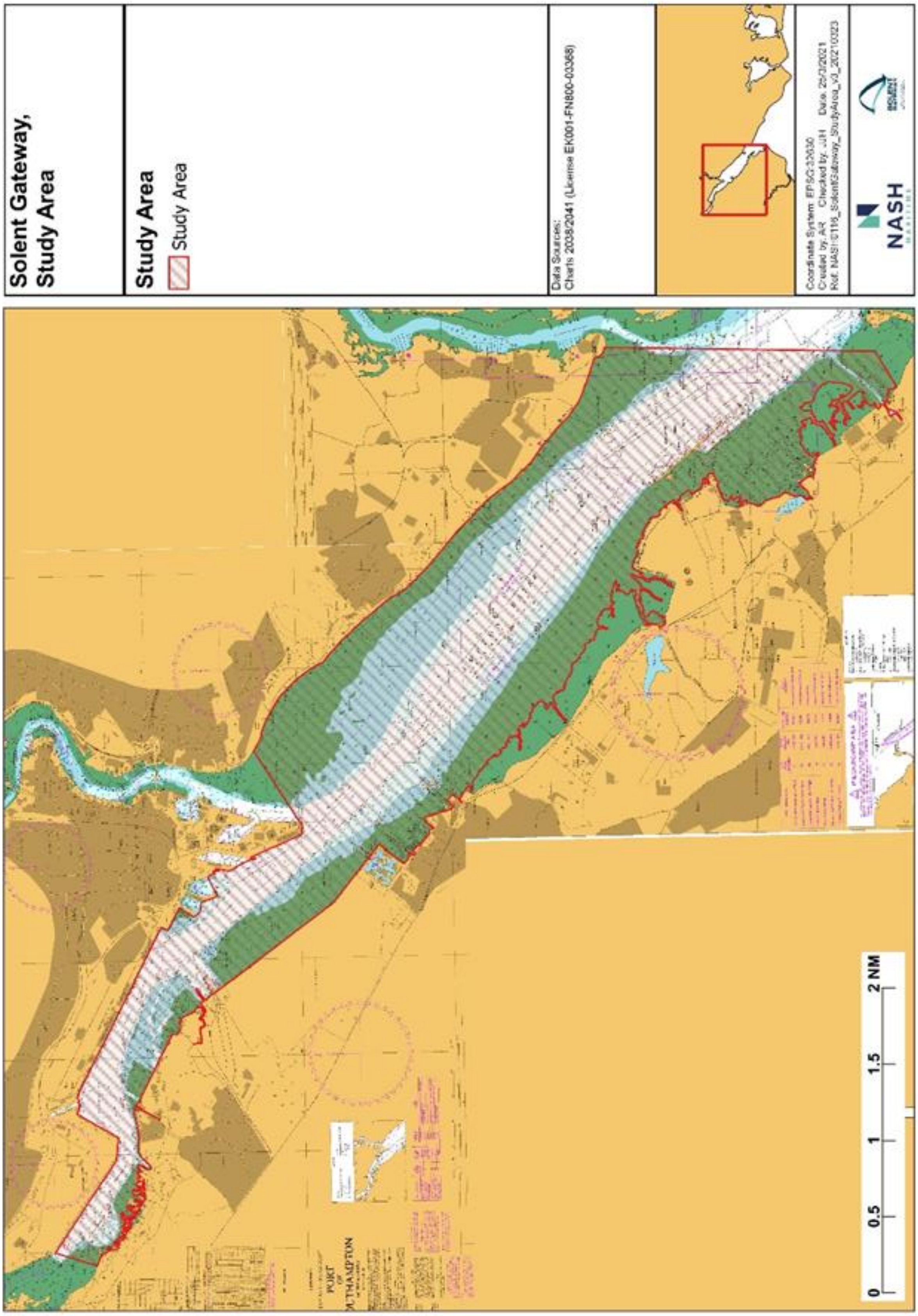
8. Modelling of future vessel traffic associated with the Marchwood Port Development project was undertaken to determine the increase in navigation risk brought about within the study area. The results of the modelling indicate that:
    a. There is an increase in collision risk (likelihood) of 2.0%;
    b. There is an increase in grounding risk (likelihood) of 3.3%; and
    c. There is an increase in allision / contact / impact risk (likelihood) of 0.6%.
9. Stakeholder consultation was undertaken extensively throughout the project with ABP Southampton and with wider Shipping and Navigation stakeholders through the Southampton Port Marine User Group Meeting.
10. The ABP Southampton Port Wide Risk assesment was used as the basis for the risk assessment methodology and reviewed in regards to the modest increase in future vessel traffic numbers projected for the Marchwood Port Development project. A review of pertinent hazards from the Port Risk Assessment showed that 37 individual hazards could be affected by the Marchwood Port Development Project, however on review of each individual hazard, and based on the minor increase in vessel numbers and small increase in risk determined through the risk modelling – no individual hazard scores required updating or changing. This is due to the increase in vessel numbers for Marchwood Port being insignificant in contrast to the wider changes and fluctuations in vessel numbers visiting ABP Southampton.
11. No risk control measures are therefore identified as part of this assessment based on the results of the risk assessment.

7.2 RECOMMENDATIONS

The assessment recommendations are that the modest increase in vessel traffic because of the Marchwood Port Development project would not have a measurable impact on navigation risk in the study area and as such no additional risk control or mitigation measures are needed over and above the 86 measures already in place for all vessel s transiting Southampton Water. Should the nature, type, or frequency of future vessel movements significantly alter from those contained within this assesment then Solent Gate ltd should notify ABP Southampton as the Statutory Harbour Authority, who will be able to advise on the need or not to review and update this assessment.

ANNEX A: HIGH RESOULTION PLOTS


Solent Gateway, Points of Interest
Study Area
Points of Interest
Swinging Grounds
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368)
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
Created by: SAB Checked by: ER Date: 25/3/2021
Ref: NASH0116_SolentGateway_PoI_v2_2020323
0 0.5 1 1.5 2 NM
Container Terminals
Mayflower Cruise Terminal
Western Docks
City Cruise Terminal
Berth 101
IOW Ferry Terminal
Town Quay Marina
Ocean Cruise Terminal
River Itchen
Eastern Docks
Berth 35
Dock Head
Netley Buoy
BP Hamble Terminal
Fawley Marine Terminal
Hook
Marchwood Port
High Speed Ferry Terminal
River Test
QE II Cruise Terminal
Upper
Middle
Lower
Turning Circle
Maintained depth 12.6m
Dibden Bay
Maintained depth 8.0m
Maintained depth 4.9m
Falkland Wharf
Mulberry Wharf
Small Craft
Moorings
0 100 200 m



Solent Gateway, Study Area
Study Area
Study Area
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368)
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 25/3/2021
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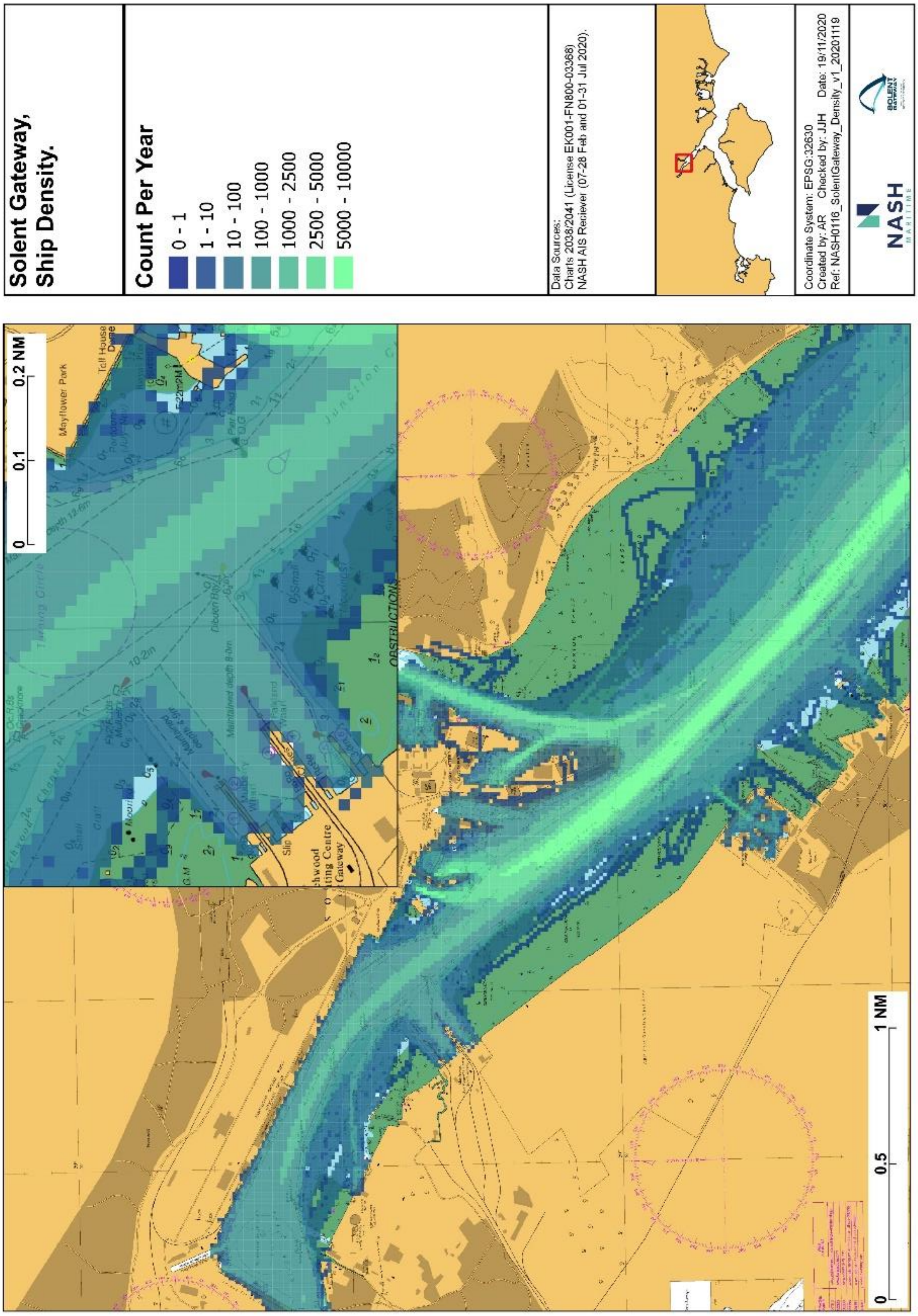
PORT OF SOUTHAMPTON
0
0.5
1
1.5
2 NM


Solent Gateway, Ship Density.
Count Per Year
0 - 1
1 - 10
10 - 100
100 - 1000
1000 - 2500
2500 - 5000
5000 - 10000
Data Sources:
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NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
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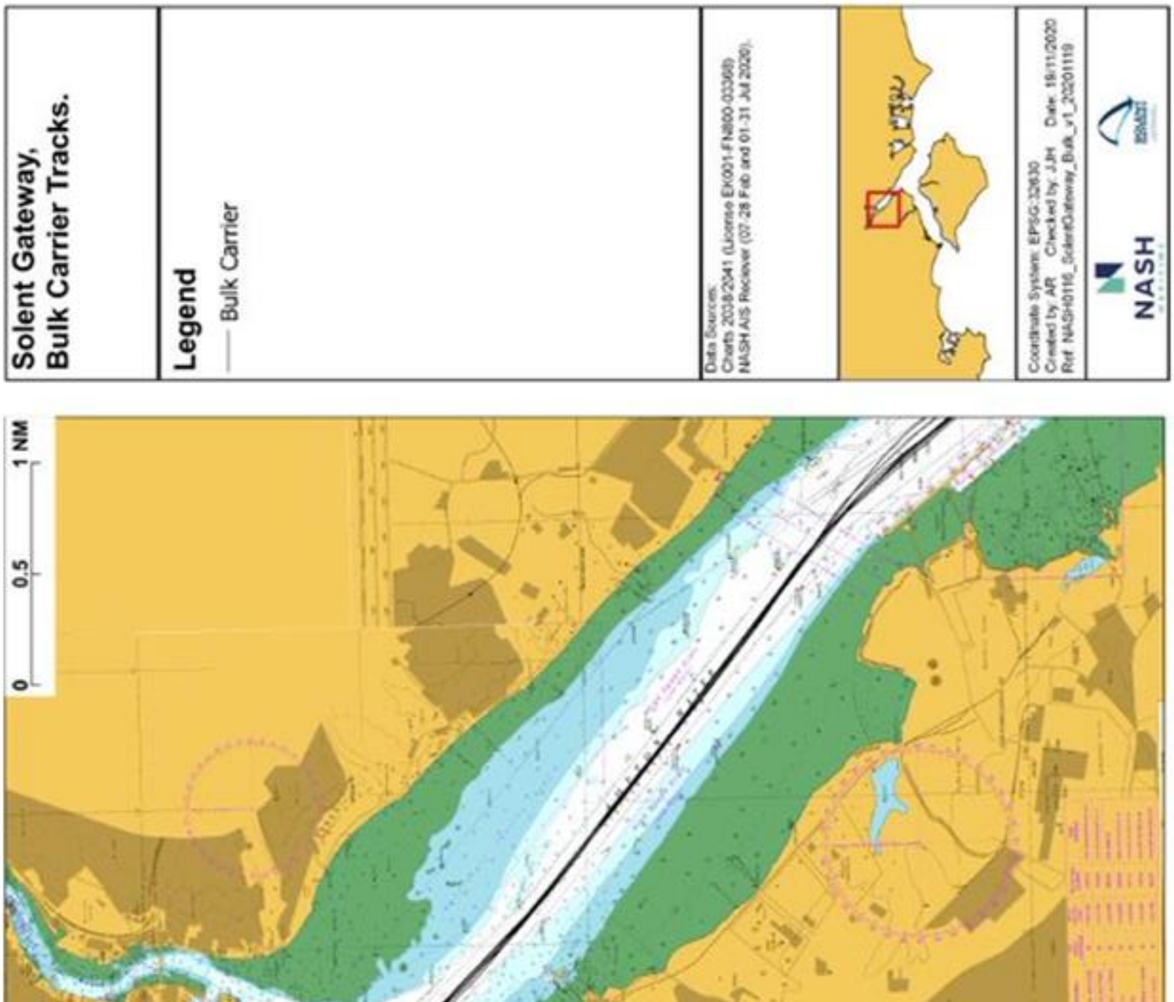
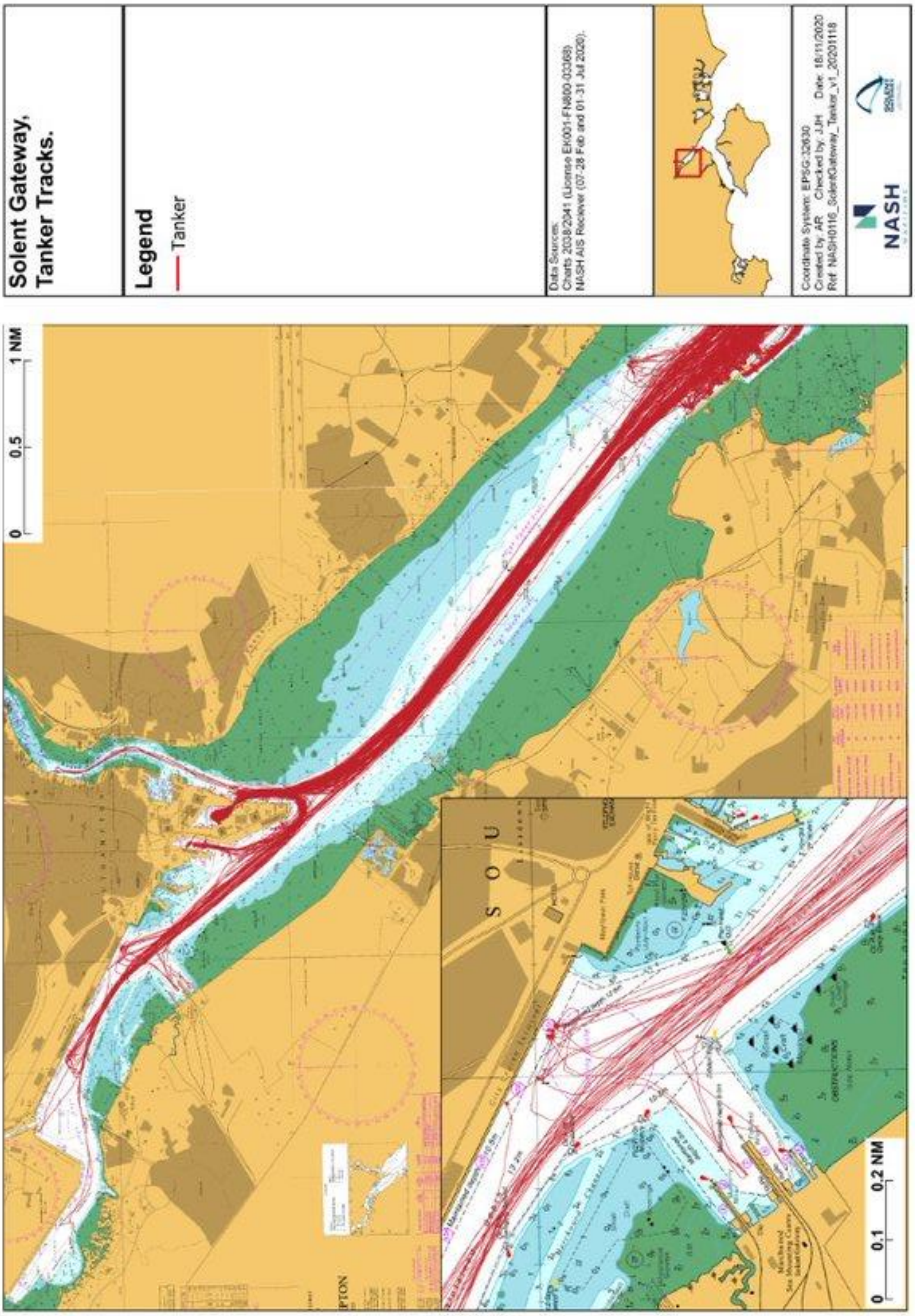
0 0.5 1 NM


Solent Gateway,
Bulk Carrier Tracks.
Legend
Bulk Carrier
0
0.5
1 NM
0
0.1
0.2 NM


Solent Gateway,
Tanker Tracks.
Legend
Tanker
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368)
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Coordinate System: EPSG:32630
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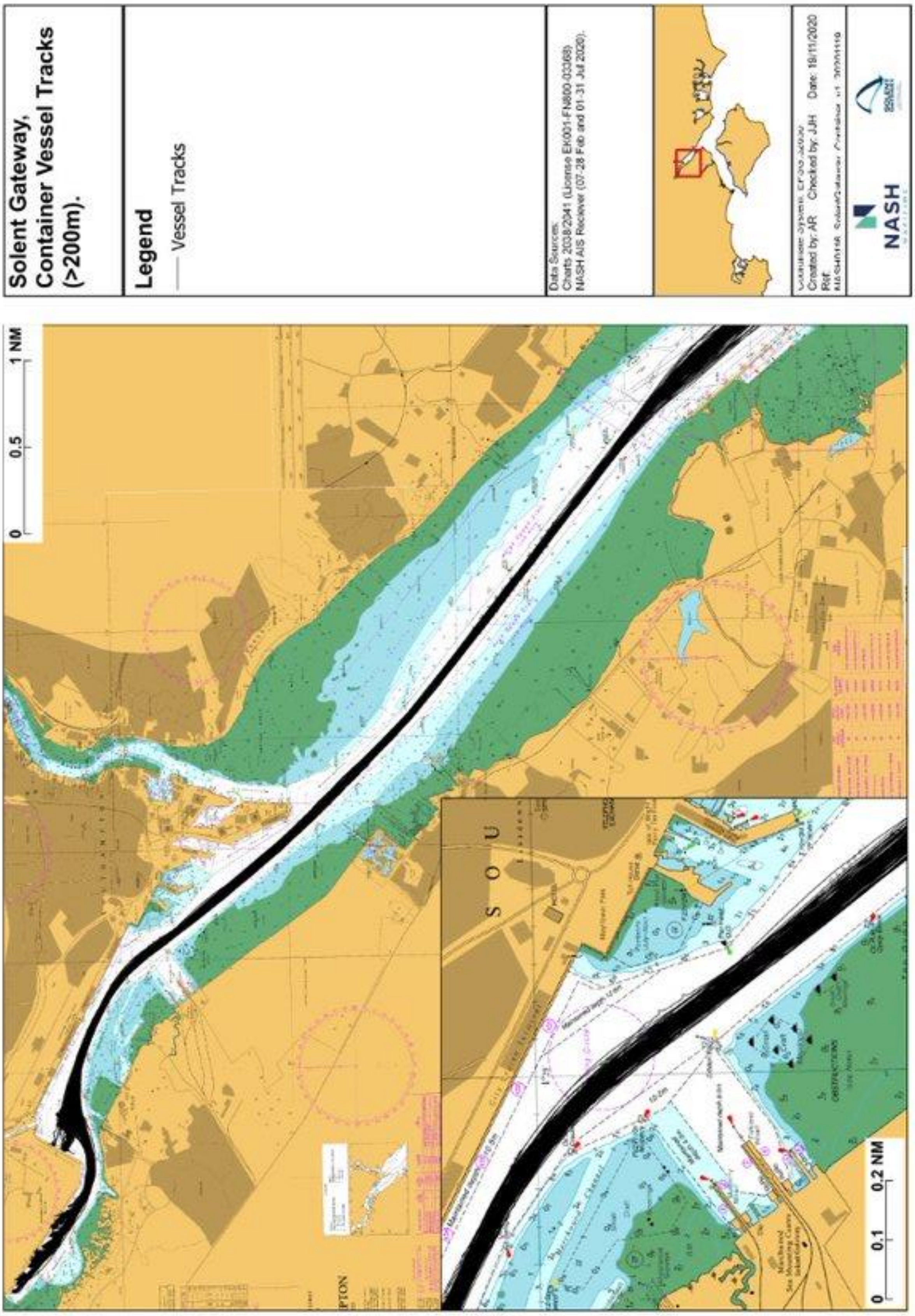
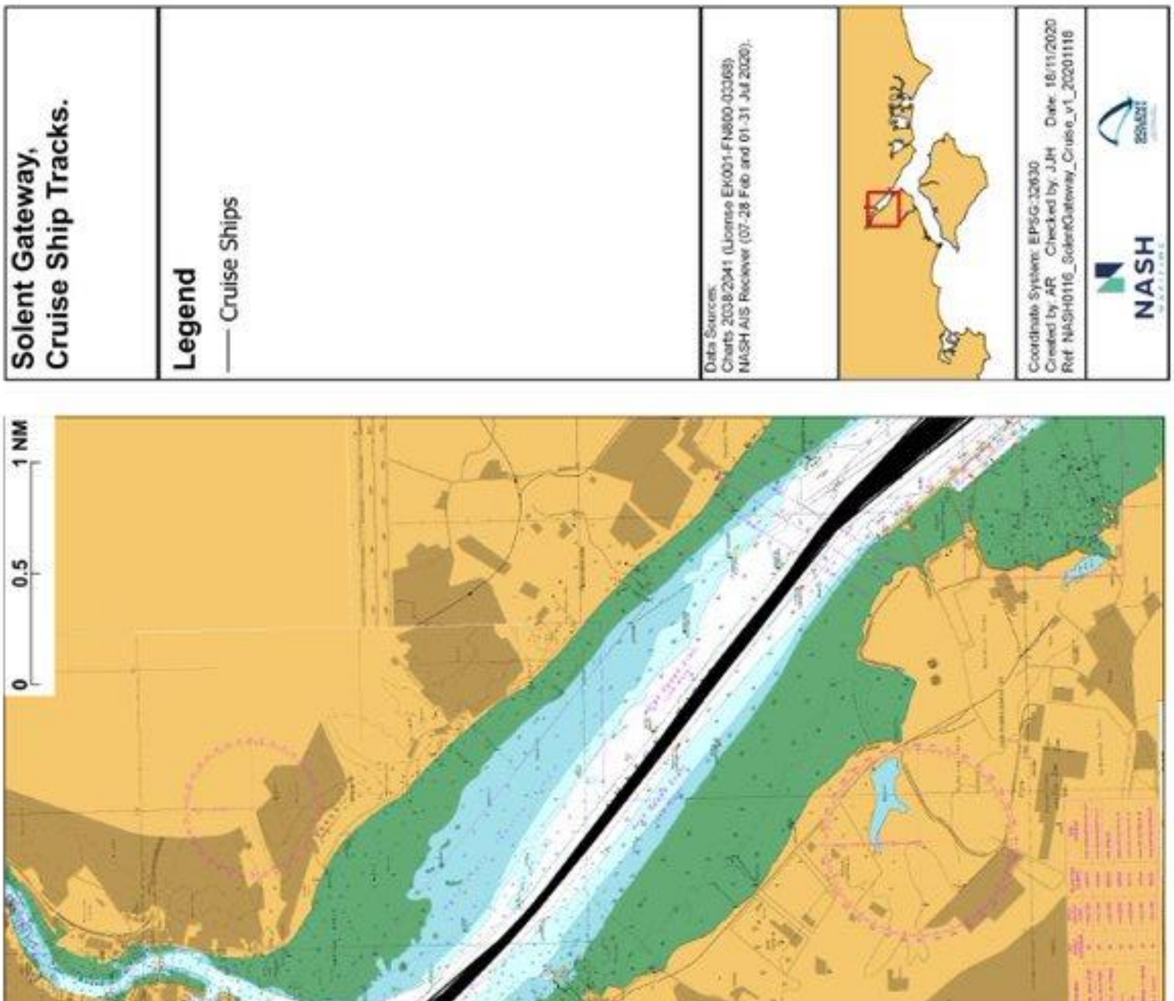
NASH
0
0.5
1 NM
0
0.1
0.2 NM


Solent Gateway,
Container Vessel Tracks
(>200m).
Legend
Vessel Tracks
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368).
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Created by: AR Checked by: JJH Date: 18/11/2020
0
0.5
1 NM
0
0.1
0.2 NM


Solent Gateway,
Cruise Ship Tracks.
Legend
Cruise Ships
Data Sources:
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Created by: AR Checked by: JJH Date: 18/11/2020
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NASH
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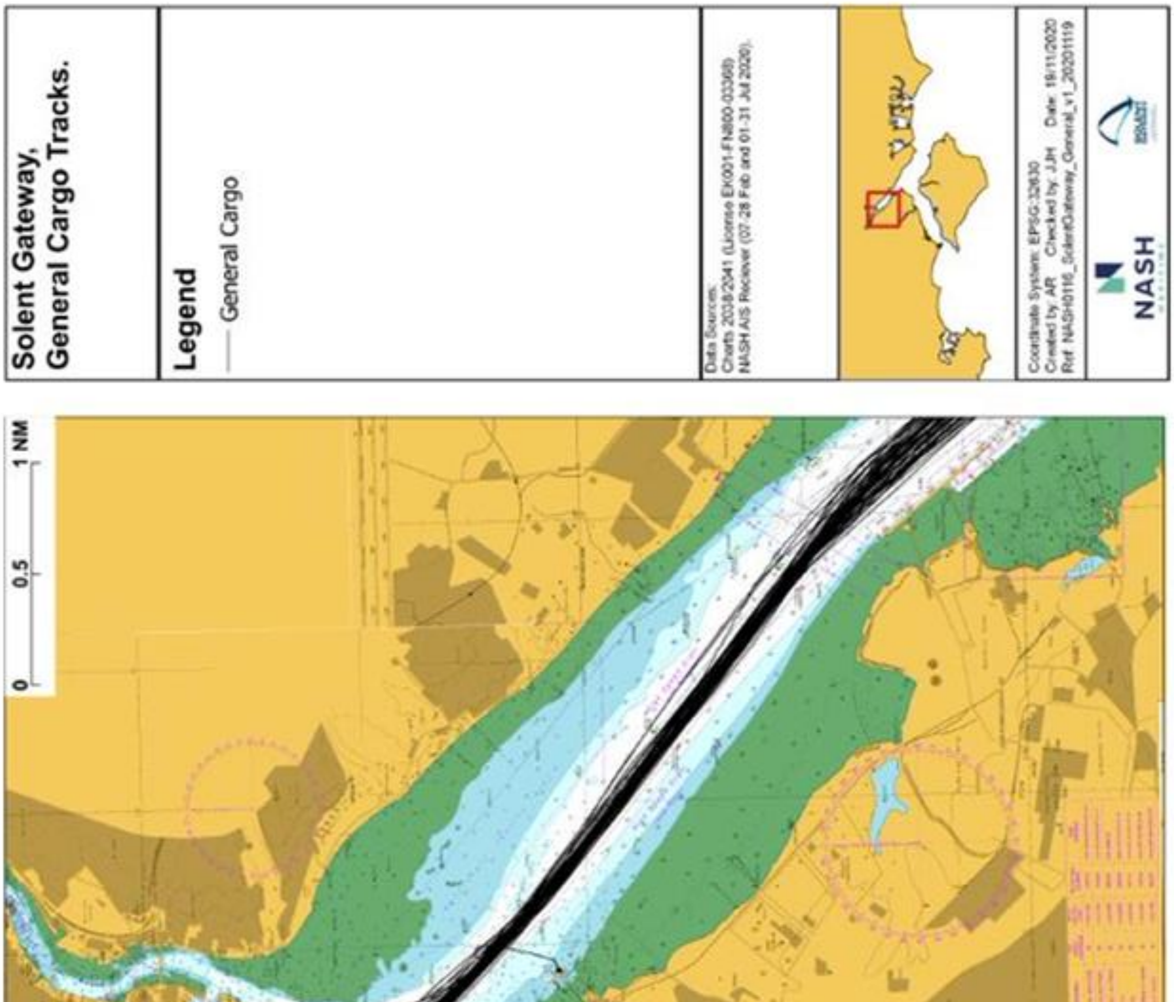
0 0.1 0.2 NM


Solent Gateway,
General Cargo Tracks.
Legend
General Cargo
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Charts 2038/2041 (License EK001-FN800-03368)
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
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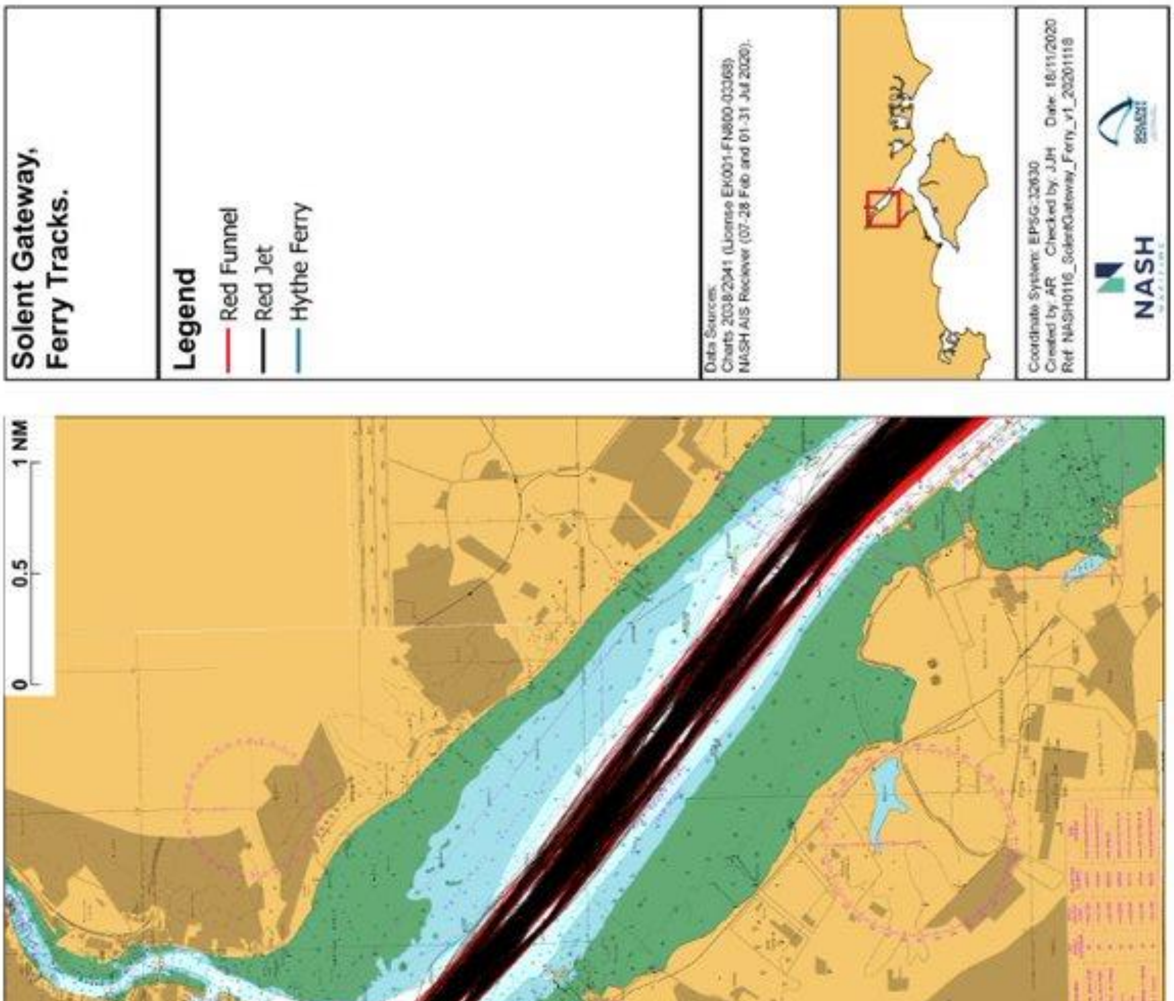
NASH
0 0.5 1 NM
0 0.1 0.2 NM


Solent Gateway, Ferry Tracks.
Legend
Red Funnel
Red Jet
Hythe Ferry
Data Sources:
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 18/11/2020
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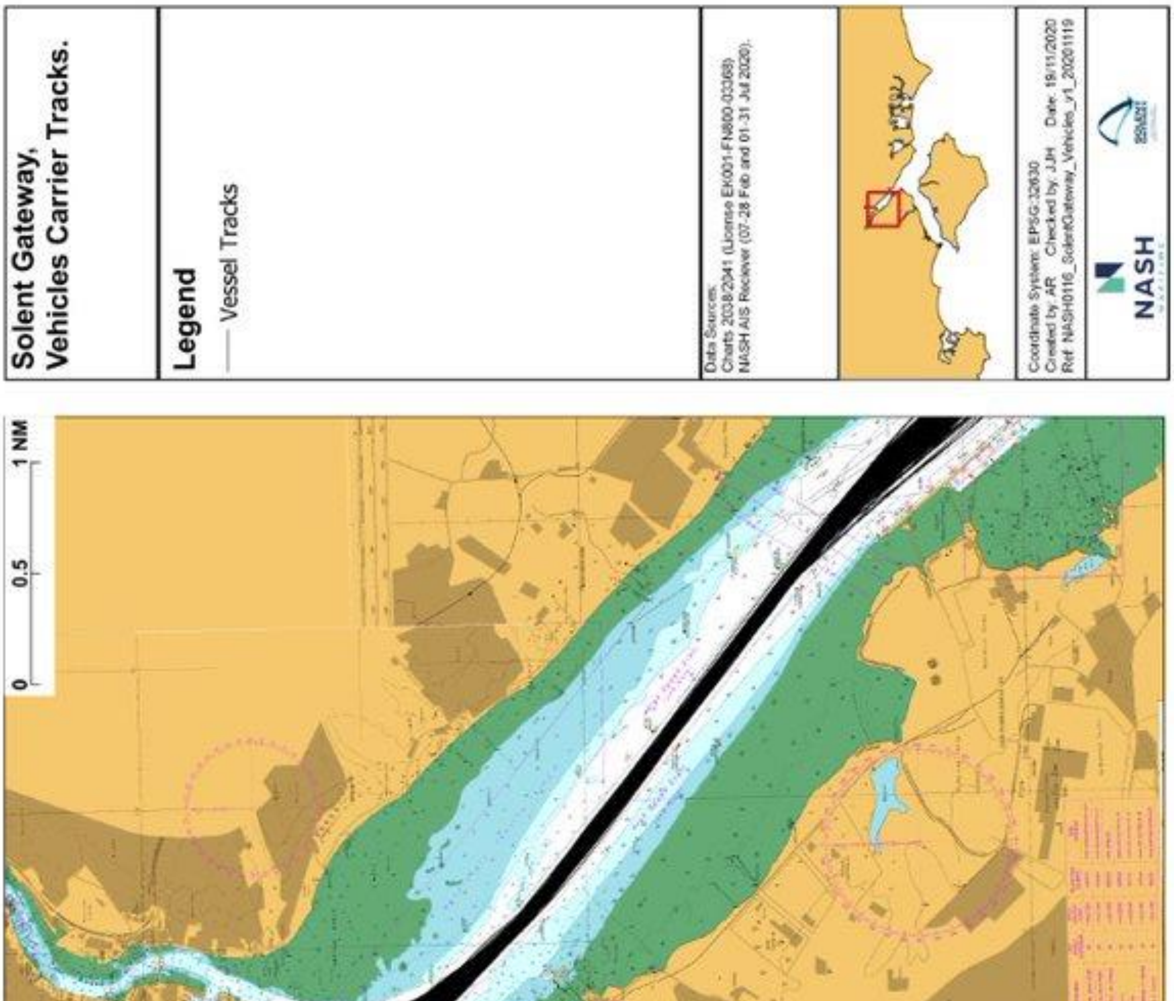
NASH
0
0.5
1 NM
0
0.1
0.2 NM


Solent Gateway,
Vehicles Carrier Tracks.
Legend
Vessel Tracks
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368).
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 19/11/2020
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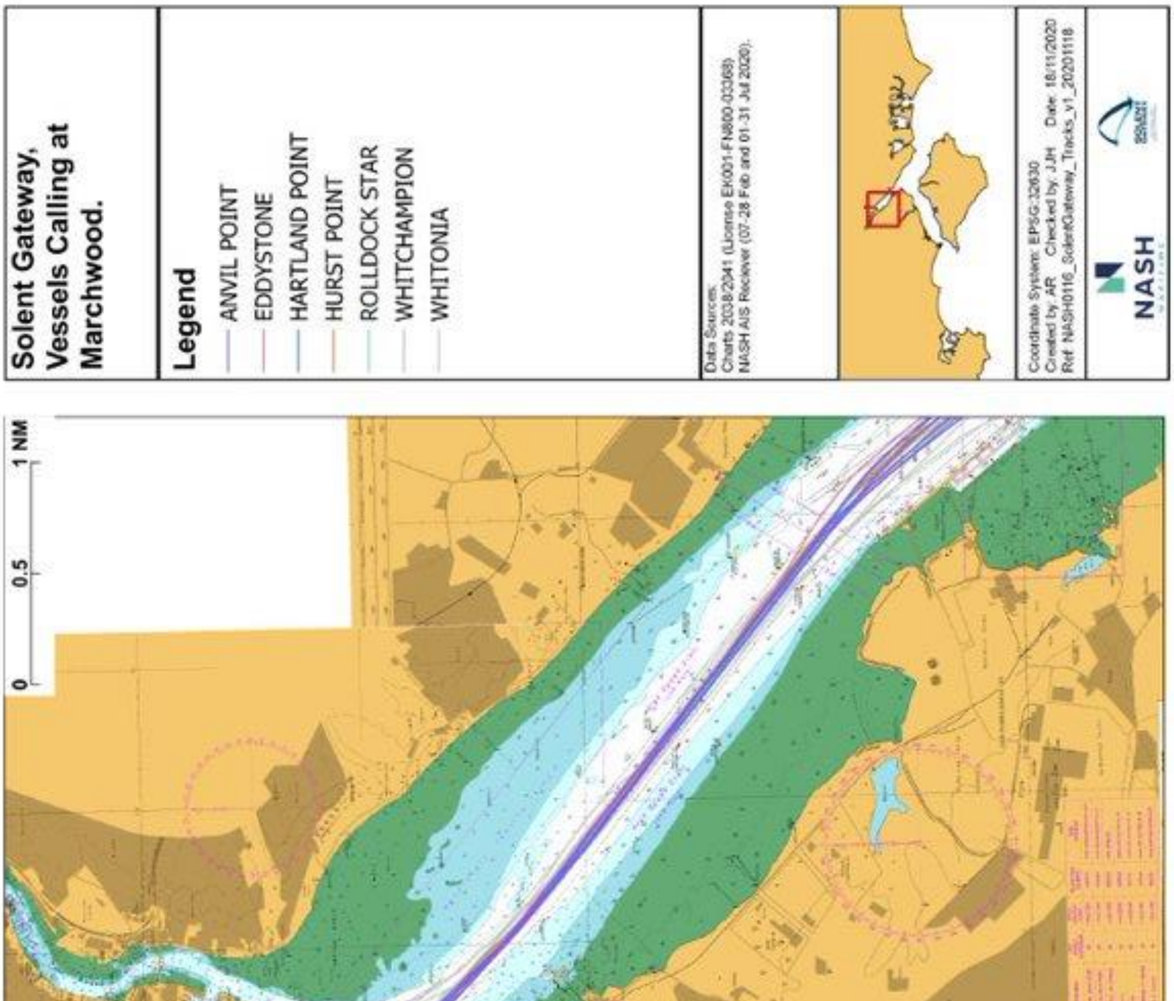
NASH
0
0.5
1 NM
0
0.1
0.2 NM


Solent Gateway, Vessels Calling at Marchwood.
Legend
ANVIL POINT
EDDYSTONE
HARTLAND POINT
HURST POINT
ROLLDOCK STAR
WHITCHAMPION
WHITONIA
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368).
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 18/11/2020
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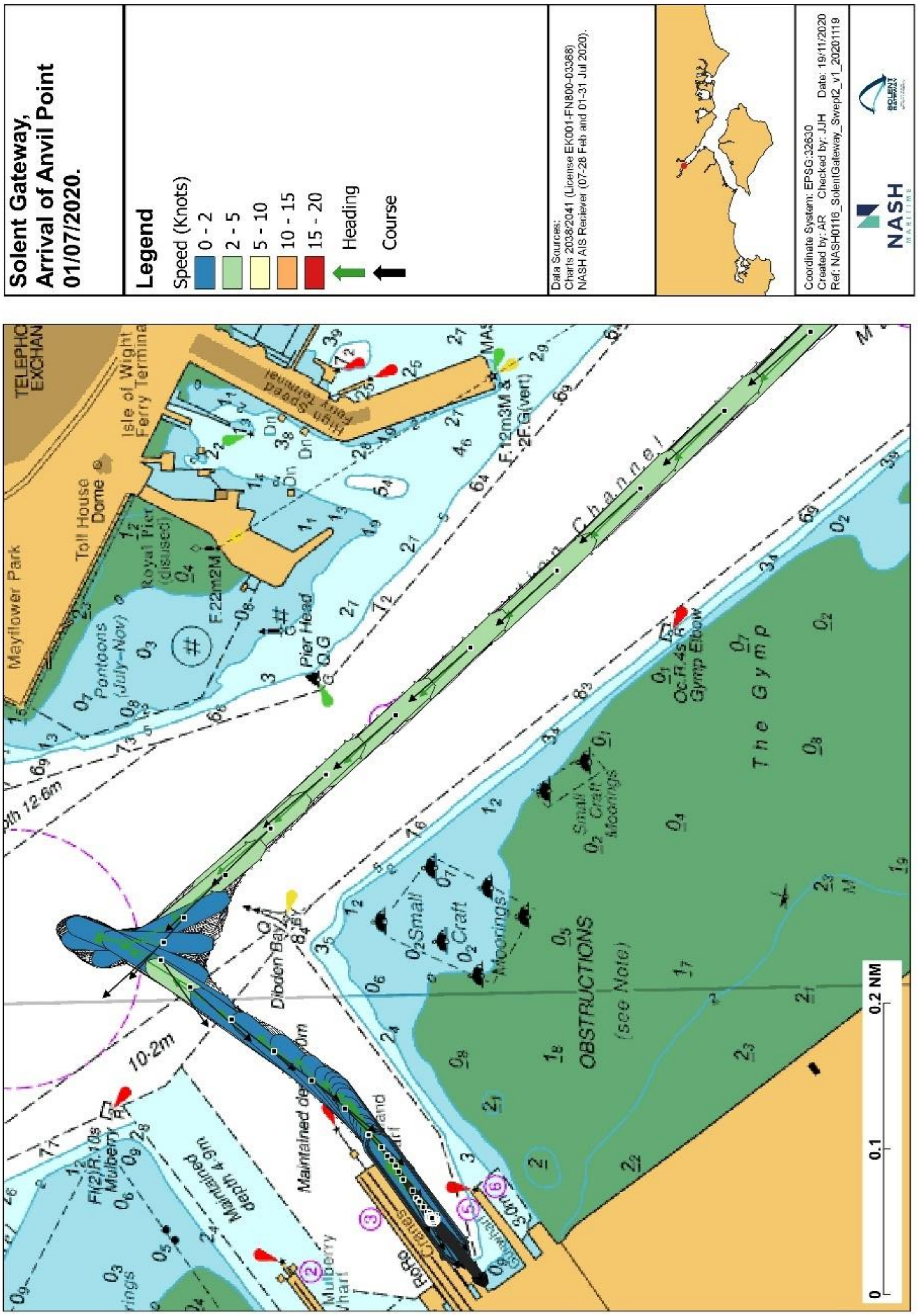
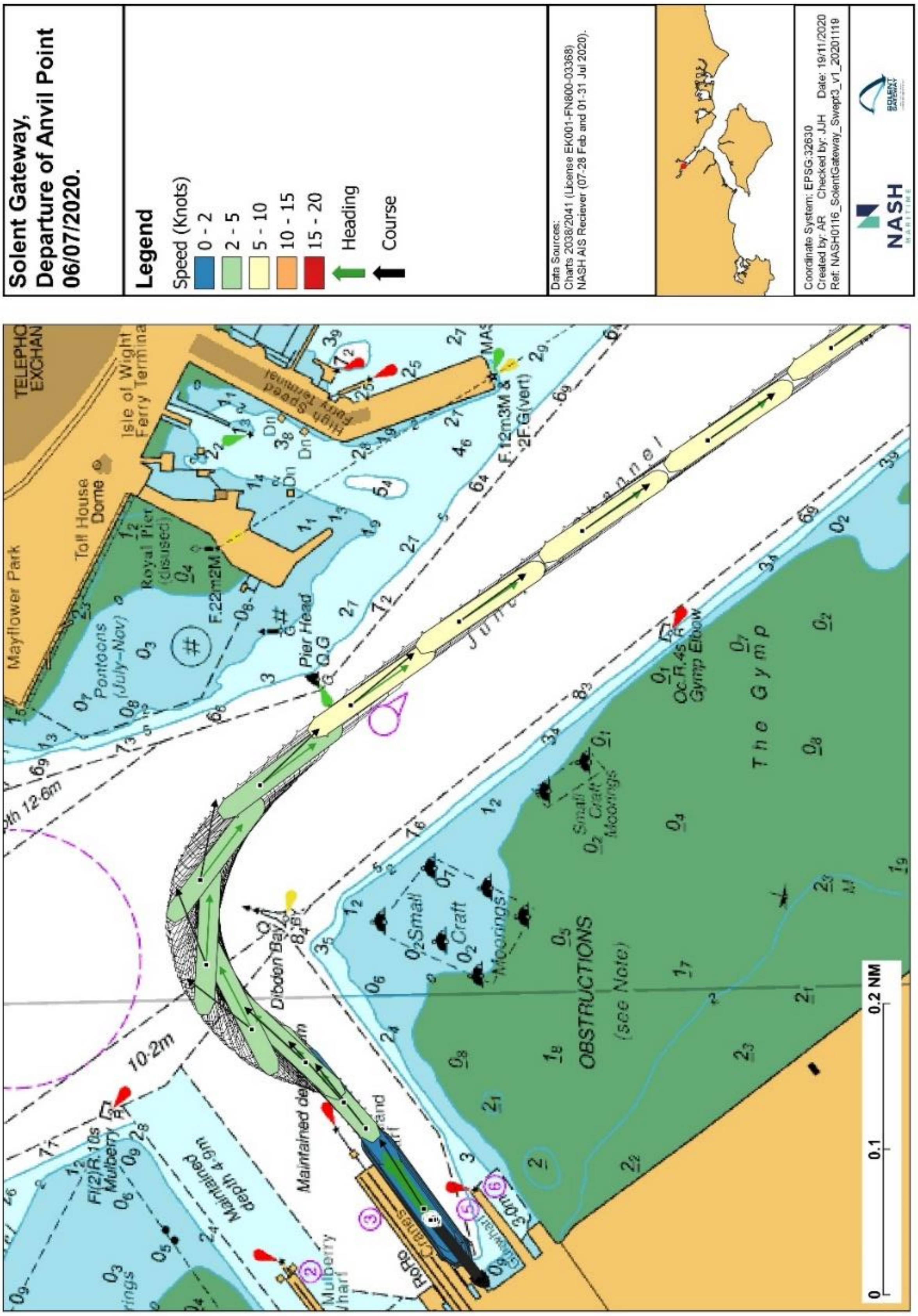
NASH
0
0.5
1 NM
0
0.1
0.2 NM


Solent Gateway,
Arrival of Anvil Point
01/07/2020.
Legend
Speed (Knots)
0 - 2
2 - 5
5 - 10
10 - 15
15 - 20
Heading
Course
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368)
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 19/11/2020
Ref: NASH0116_SolentGateway_Swept2_v1_20201119
NASH MARITIME
0
0.1
0.2 NM


Solent Gateway,
Departure of Anvil Point
06/07/2020.
Legend
Speed (Knots)
0 - 2
2 - 5
5 - 10
10 - 15
15 - 20
Heading
Course
Data Sources:
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NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
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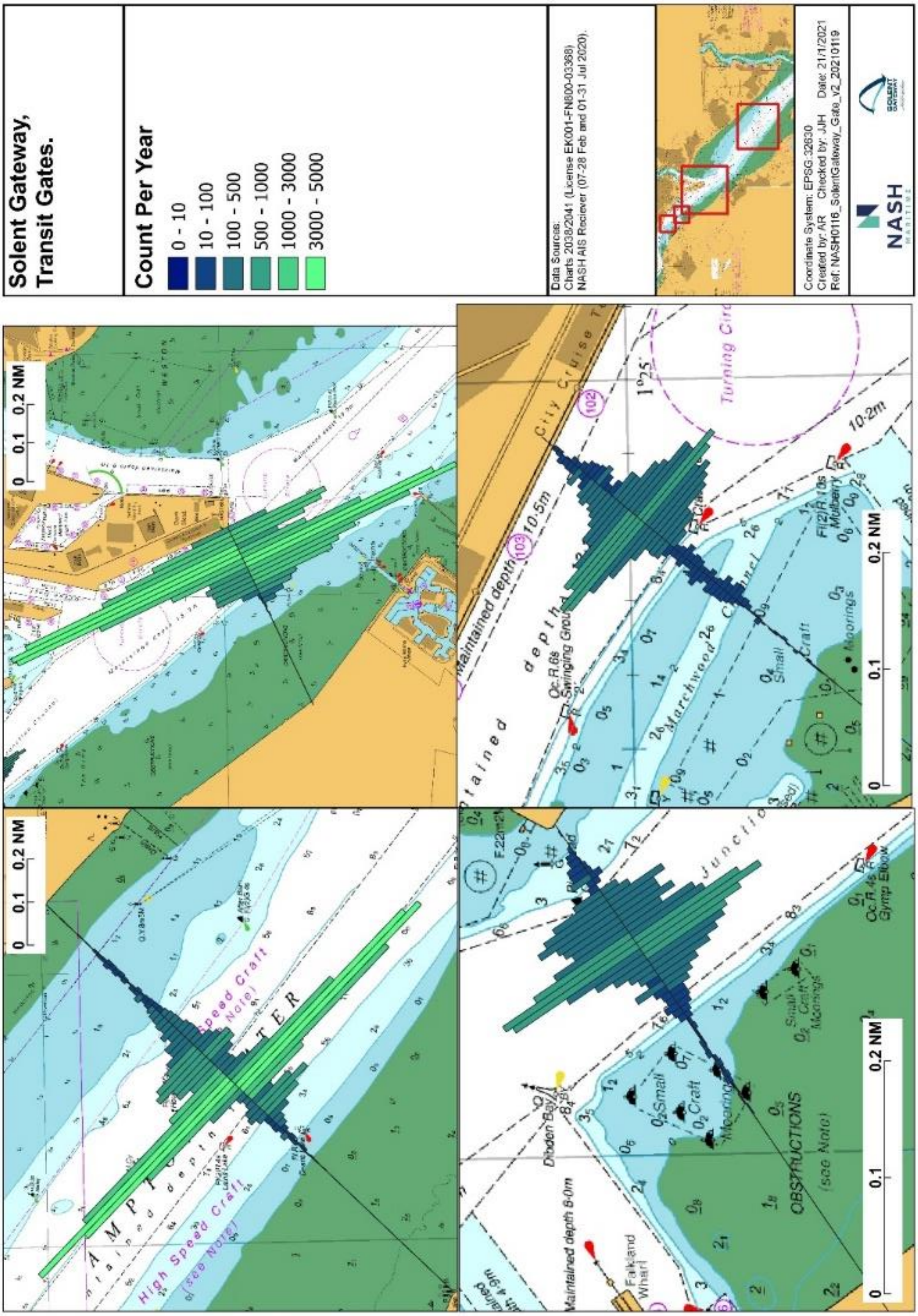
Ref: NASH0116_SolentGateway_Swept3_v1_20201119
NASH
MARITIME
Mayflower Park
Toll House Dome
Isle of Wight Ferry Terminal
Royal Pier (disused)
Pontoons (July–Nov)
Pier Head
High Speed Ferry Terminal
The Gymp
Gymp Elbow
OBSTRUCTIONS
(see Note)
Small Craft Moorings
Dibden Bay
Mulberry Wharf
Maintained depth 4.9m
0.2 NM
0.1
0


Solent Gateway, Transit Gates.
Count Per Year
0 - 10
10 - 100
100 - 500
500 - 1000
1000 - 3000
3000 - 5000
Data Sources:
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NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
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NASH MARITIME
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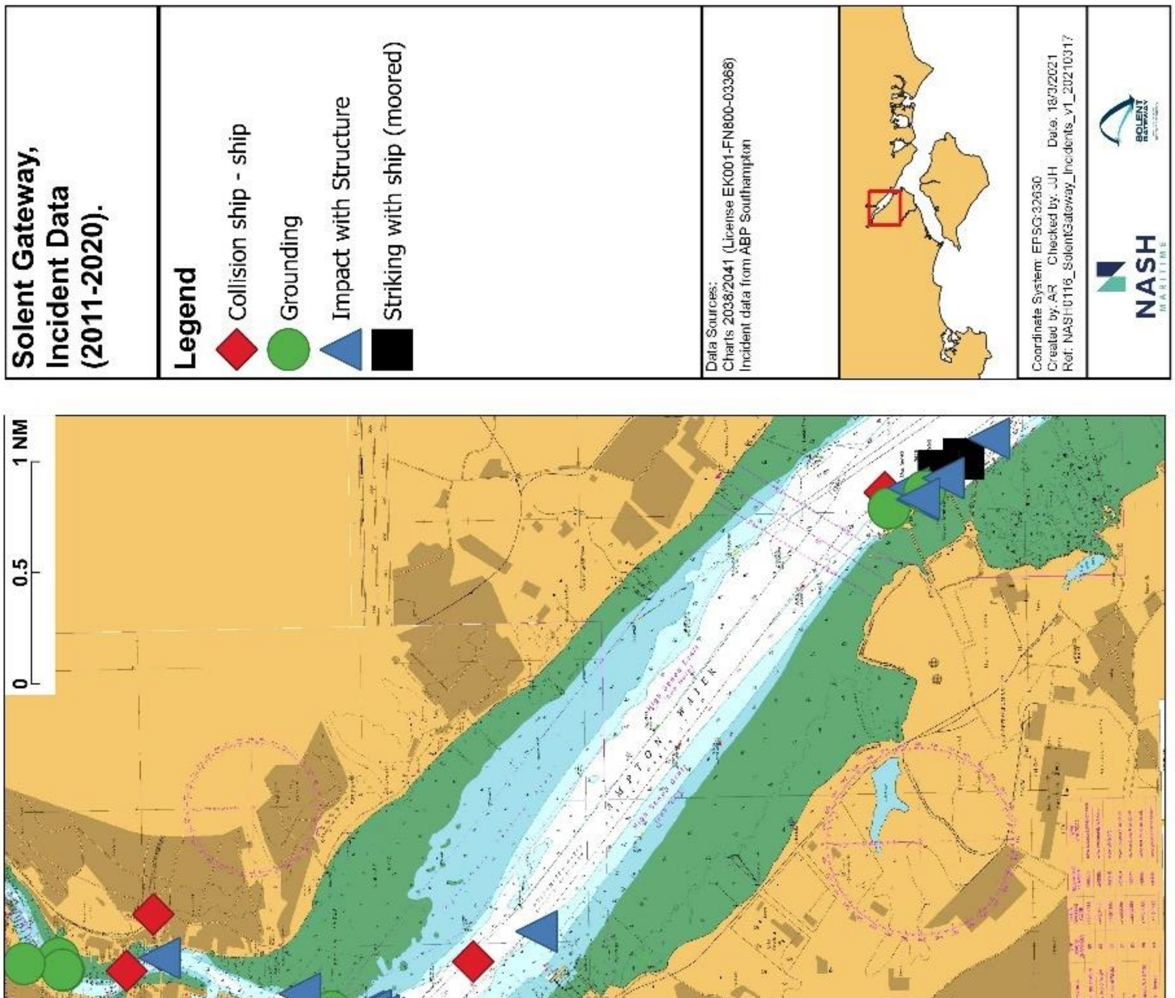
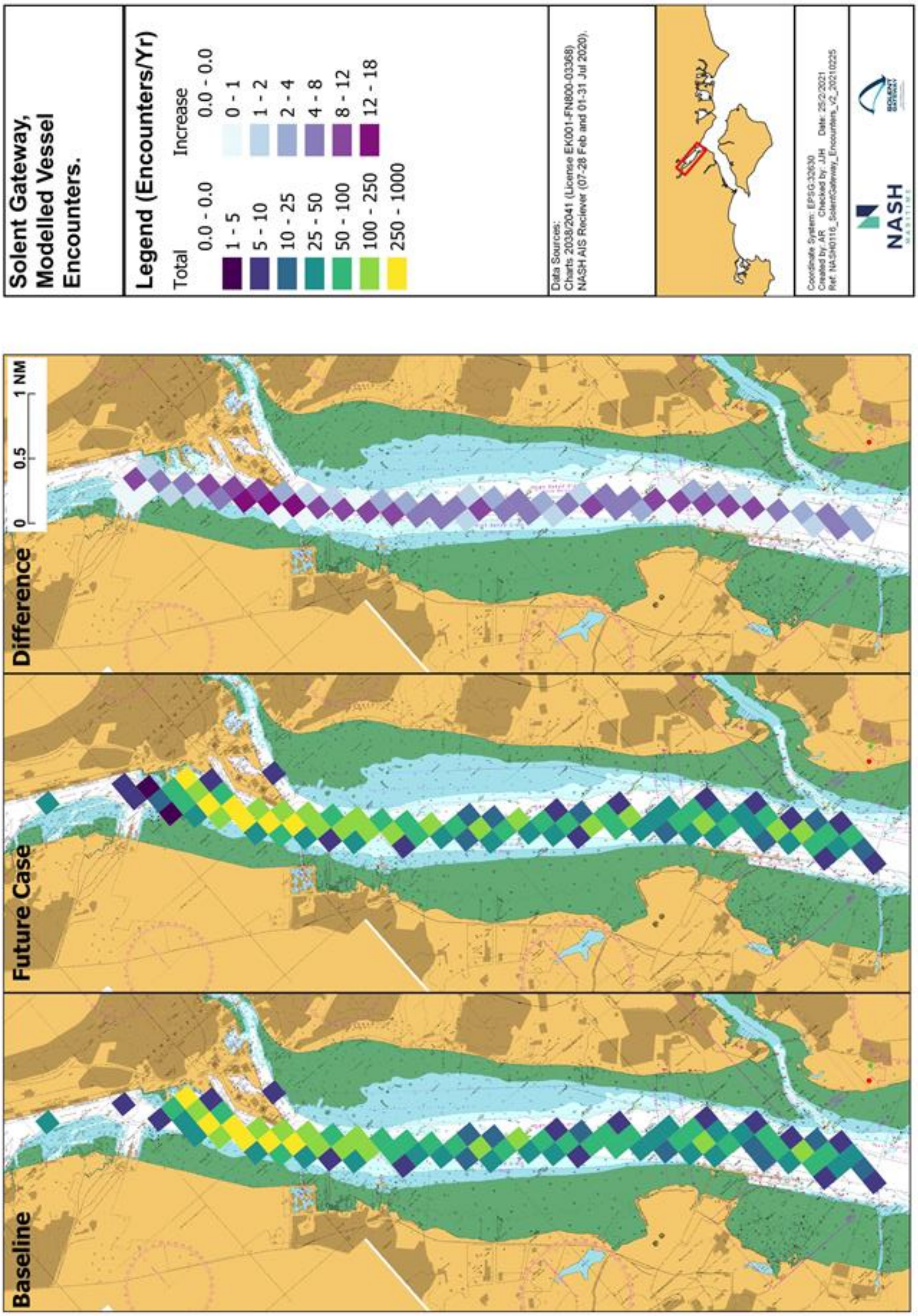

Solent Gateway, Incident Data (2011-2020).
Legend
Collision ship - ship
Grounding
Impact with Structure
Striking with ship (moored)
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368)
Incident data from ABP Southampton
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 18/3/2021
Ref: NASH0116_SolentGateway_Incidents_v1_20210317
0 0.5 1 NM
0 0.1 0.2 NM


Solent Gateway, Modelled Vessel Encounters.
Legend (Encounters/Yr)
Total
0.0 - 0.0
1 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 - 250
250 - 1000
Increase
0.0 - 0.0
0 - 1
1 - 2
2 - 4
4 - 8
8 - 12
12 - 18
Data Sources:
Charts 2038/2041 (License EK001-FN800-03368)
NASH AIS Reciever (07-28 Feb and 01-31 Jul 2020).
Coordinate System: EPSG:32630
Created by: AR Checked by: JJH Date: 25/2/2021
Ref: NASH0116_SolentGateway_Encounters_v2_20210225
NASH MARITIME
Baseline
Future Case
Difference
0
0.5
1 NM

ANNEX B: CONSULTATION MEETING MINUTES AND PRESENTATIONS

Notes of Meetings

Solent Gateway (20-NASH-0116)

Client:	Solent Gateway Ltd
Project:	Solent Gateway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	10-Dec-2020 (11:30-12:00)

Present:

ABP Southampton	Steven Masters – SM
ABP Southampton	Pippa Moody – PM
Solent Gateway Ltd	Scott Willmore – SW
NASH Maritime	Ed Rogers - ER
NASH Maritime	Sam Anderson-Brown - SAB
Basset Maritime	Nigel Bassett

1.	**Introductions and Meeting Objectives**
	- Brief introductions were held, and SAB explained the purpose of the meeting was to give an update on the future baseline vessel movements to be considered as part of the NRA.
2.	**Review of Solent Gateway Planning Application: Marine Aspects**
	- SAB explained that since the meeting on 25-Nov-2020 Solent Gateway had been provided with details of the required number of vessel movements by an aggregate contractor they are currently discussing commercial arrangements with. The further detail results in an increase in the future baseline vessel movements by approx. 200 vessels. - A list of exemplar vessel was shared, SAB explained that NASH Maritime Ltd would use the vessels shown to help inform the assessment of risk in the NRA. - NB gave an overview of the proposed marine operation for the arrival of the - *Yeoman Bank* (a large self-discharging bulk carrier). - A list of vessels of similar sizes that had previously visited Marchwood Port was also shared. - SM stated that an appropriate baseline number of vessel movements should be used to inform the NRA. ER explained that overall vessel movements would help inform risk scoring when considering likelihood of hazard occurrence. - SM confirmed that the increase in vessel movements and knowledge of the exemplar vessels did not change the scope, study area or methodology for the NRA and that the approach NASH Maritime Ltd had outlined on the 25-Nov-2020 was still appropriate.
3	**Actions**
	- SAB to provide previous minutes for review and minutes from today's discussion. (10-Dec-2020) - SAB to liaise with PM in regard to meeting to discuss appropriate Risk Assessment Methodology and NASH attendance at the Port User Group Forum in Jan 2021.

Client:	Solent Gateway Ltd
Project:	Solent Gateway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	25-Nov-2020 (1400-1440)

Present:

ABP Southampton	Steven Masters – SM
Solent Gateway Ltd	Scott Willmore – SW
NASH Maritime	Ed Rogers - ER
NASH Maritime	Sam Anderson-Brown - SAB

1.	**Introductions and Meeting Objectives**
	- ER introduced topics to be covered and shared Power Point presentation. - Purpose of discussion was to agree the scope of the proposed NRA. - ER ran though the project team and other parties.
2.	**Review of Solent Gateway Planning Application: Marine Aspects**
	- Planning application in with NFDC – currently at EIA stage. - No changes to marine aspects of operation as part of the planning application. - Future baseline predicted to be 208 arrivals at Southern Gateway a year. - All new trade rather than displaced existing trade. - No anticipated change in MOD vessel movements. - No tidal restrictions applicable.
3.	**Review of Scoping Opinion**
	- Change in vessel numbers does not change requirement for NRA but makes things less onerous. - NRA scoping stage to be agreed and the followed by full NRA – SM agreed this was a sensible approach.
4	**Proposed Navigation Risk Assessment Scope**
	a) Methodology - SM - Happy that NRA sits as a separate study and does not necessarily have to follow MarNIS matrix but can use the hazards and controls currently utilised in the RA for the Port. SM - Happy that NASH RA follows general format of existing ABP Southampton RA and will arrange some time so that Pippa Moody (Deputy HM (Compliance) can run through the current RA methodology with the NASH team. **b) Key Issues** - SM confirmed key issues identified were appropriate. - SM noted that NRA should also give due consideration to: I. Fast Ferry movements in and around the Red Funnel terminal. II. The new cruise terminal at berth 102 will result in an increased number of cruise ships using the turning circle off Solent Gateway and the NRA should take this in to account. II. Due consideration should be given to leisure traffic transiting to and from town quay marina.

NASH MARITIME

	- ER asked about appropriate recreational user groups to consult with and SM explained that the Port User Group meeting in Jan includes many leisure stakeholders and would be a good forum for consultation. MS to advise of date and time so NASH representative can attend. **c) Study Area** - SM – NRA does not need to consider anything outside Southampton waters. - SM – noted it was worth reaching out to QHM Portsmouth to see if they have any issues or concerns with the proposed operation. - It was agreed that the NRA will focus on navigation hazards related to Solent Gateway operation rather than any wider port hazards. - The NRA will not consider a construction phase within the scope of work because there are no marine works due to take place. - The NRA will consist of a one phase assessment and will assume the future baseline outlined will be realised on the first day of operation. – SM happy with this assumption. - SM – confirmed there were no other parameters to consider at this stage. - **d) Data analysis** - ER presented the data analysis proposed to be carried out as part of the NRA - SM advised that due to Covid-19 vessel traffic within the port was down by 30% - The biggest impact has been on the cruise sector. - ER suggested NASH carry out analysis and then review jointly with SM once carried out to review results and discuss any further analysis that might be required. - SM advised that channel deepening works on larger container ship berths will result in an increase in deeper drafted vessels - SM to provide DP world forecast to help inform future baseline assessment. - MS to ask Pippa Moody to provide incident data to NASH. - **e) Consultation** - User group meeting enable consultation with wide range of leisure users. - MS suggested agreed that socio-economic impacts were out of scope of NRA but it would be useful to consult with ABP commercial team in order to accurately predict future baseline vessel movements. - It was agreed that during MS would invite relevant parties to the next NRA consultation meeting. - It was agreed that such a meeting should take place before the Port User Group meeting. - Hazard scoring workshop will follow. - Draft report to be shared with SM before submission as part of EIA.
5.	**Summary**
	- ER presented summary of full NRA scope - SM confirmed that scope outlined met with ABP Southampton expectations for NRA.
6.	**Actions**
	- SM to make introduction to Pippa Moody so that MarNIS methodology and matrix can be shared with NASH. - ABP (via Pippa Moody) to share port incident data - SM to provide time and date for next Port User Group meeting – expected to be Jan 2021

Notes of Meetings

Solent Gateway (20-NASH-0116)

Client:	Solent Gateway Ltd
Project:	Solent Gateway
Venue:	Video/telecon (MS Teams)
Date of Meeting:	27-Jan-2021 (15:00-15:30)
Present:	
ABP Southampton	Steven Masters – SM (Harbour Master)
NASH Maritime	Andrew Rawson - AR
NASH Maritime	Sam Anderson-Brown - SAB
Basset Maritime	Nigel Basset - NB

1.	**Introductions and Meeting Objectives**
	- Brief introductions were held, and SAB explained the purpose of the meeting was to give an update on the methodology that NASH Maritime will be using to complete the NRA.
2.	**Risk Assessment Methodology**
	- SAB presented slides relating to: o The proposed process for calculating navigational risk. o The hazards adopted from the ABP port wide risk assessment. o The hazard scoring methodology that will be adopted.
4.	**Analysis of Baseline and Inherent Risk**
	- AR presented slides relating to: o Analysis undertaken to characterize vessel traffic and inform the associated review of baseline risk. o Analysis to inform the assessment of inherent risk, including domain modelling. o A summary of the process to inform the residual assessment of risk. - SM asked that the reduction in annual vessel movements in 2020 (attributed to of Covid-19) be considered as part of the analysis and modelling that informs the assessment of inherent risk.
3	**Actions**
	- SAB to provide organise hazard scoring workshop to review the inherent risk assessment scoring. - SM to provide details of annual shipping movements for 2019 and 2020.

Notes of Meeting.

Solent Gateway Navigation Risk Assessment (20-NASH-0116)

Client:	Solent Gateway Ltd
Project:	Solent Gateway Navigation Risk Assessment
Venue:	Video/telecon (MS Teams)
Date of Meeting:	26-Feb-21

Present:

ABP Southampton	Steven Masters – SM
ABP Southampton	Pippa Moody – PM
NASH Maritime	Ed Rogers - ER
NASH Maritime	Chris Hutchings
NASH Maritime	Nigel Bassett

1.	Meeting Objectives
	ER shared a presentation. - Progress to date - NRA Specification - Consultation - Vessel traffic analysis - Vessel traffic modelling - Risk Assessment - Key Issues
2.	**Analysis - vessel traffic analysis**
	- AIS data Feb and Jul 2020 - plus ~30% COVID adjustment. - Tracks, density, gates, swept path presented. - Solent Gateway (Cargo) about 350 vessels increase vs 3,000 - 5,000 cargo vessels in the area.
3.	**Risk Modelling Approach**
	Grounding and contact assessment through IWRAP model - Use same AIS data. Assessed LW and MHWS. Conservative assessment of overall risk, but useful for comparative assessment. - Illustrates the known contact/ground risk hot spots - Overall ~5% increase in grounding likelihood and 2.5% increase in allision likelihood. Collision through domain model approach - can understand where collision risk is high and what type of collision risk is most likely (e.g. head on vs overtaking vs crossing stand-on vs crossing give-way); - Collision heatmap shows vessel encounters peak around Dock Head - mostly Passenger-Passenger then Passenger-Cargo.

	- Future case (with COIVD adjustment) shows 2% increase in transits -> 4% increase in encounters. Highest at Dock Head with second peak around Fawley. [note tugs excluded in all analysis]. - Summary - small change in grounding, contact and collision risk.
4.	**Hazard Risk Review**
	- Started with ABP risk assessment for Southampton and reduced to relevant hazards. - MarNIS risk assessment - corrected and generally resulted in lower estimates for same inputs. - One anomalous scoring - Ranging alongside - different likelihood scores - once corrected, increased risk from low to medium - ABP advised that ABPmer has updated MarNIS to correct the calculations.
5.	**Hazard Scoring s/sheet**
	- Focused on hazards in the study area based on ABP MarNIS risk assessment and provided commentary on SGL Hazard. Seek to change hazard likelihood scores only as a result of SGL plans, not hazard consequence - as new vessels similar to existing vessels in Southampton - NASH ignored the calculation of risk reduction with full effect of all risk controls. - Overall SGL made no overall change to likelihood scores and therefore overall risk. - ABP noted - not an unexpected result particularly as increase from SGL will be built over a period of time, allowing review of impact and considering additional controls if/when required.
6.	**Summary of Key Issues/Impacts of SGL vessel movements**
	- Impact on existing navigation - small and mitigated with existing controls. - Impact on draught restricted vessels - minimal and mitigated through existing management. - Impact on time critical vessels - minimal as mostly have flexible schedule. - Impact on traffic procedures - as above. - Impact on ferry movements - biggest interaction - but still small number of SGL vessels. - Cruise ships turning off berth 102 - yes SGL will use turning area off berth 101 but number of vessels will be low. - Impact on leisure traffic to Town Quay - minimal if any impact. - ABP - agreed in principle with the outcomes of the assessment
7.	**Next Steps**
	ER to send copy of presentation to ABP for review. ABP to review next week with VTS managers. ABP to advise corrected MarNIS scores.

Southampton Port Marine Users Group Meeting

Thursday 21st January 2021

Agenda

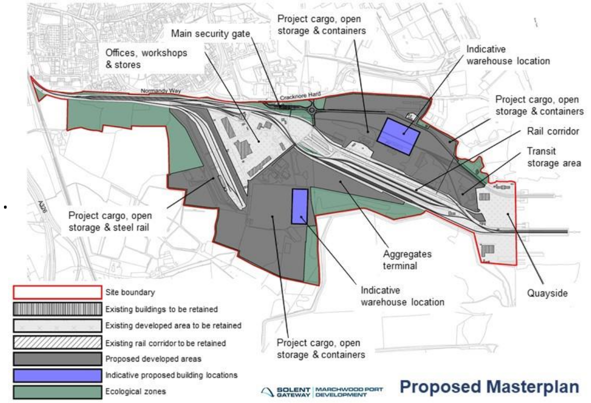
- ❑ Welcome
- ❑ Previous SPMUG Meeting Minutes / Matters that arose for discussion
- ❑ Port & Marine Update
- ❑ Southampton Hydrography update
- ❑ Incident Management
- ❑ Nash Maritime update
- ❑ AOB

Marchwood Port Development

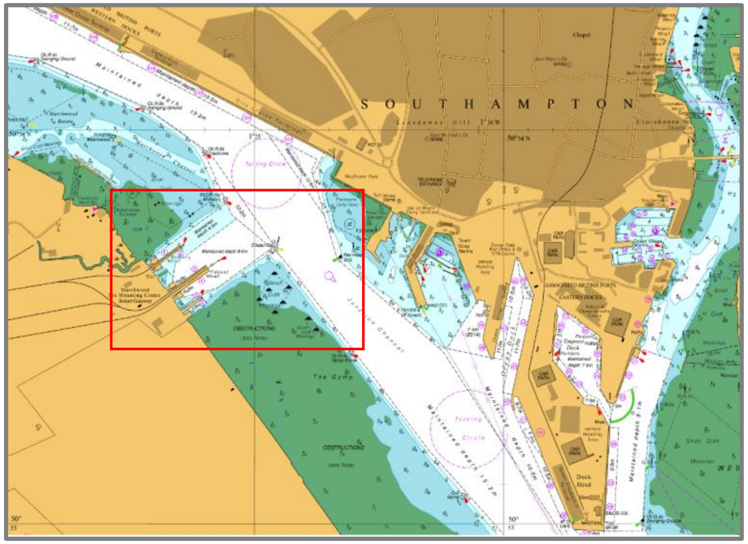
Southampton Port Marine User Group Update

Marchwood Port Development Overview

- Planning Application to NFDC – currently at EIA stage.
- The development includes plans for:
  - Additional hardstanding for open storage.
  - Buildings for warehousing, industrial, office, security and staff welfare purposes.
  - Access improvements.
- No marine infrastructure or works to quays are proposed.
- But, an increase in vessel movement numbers is expected.



Marchwood Port Location

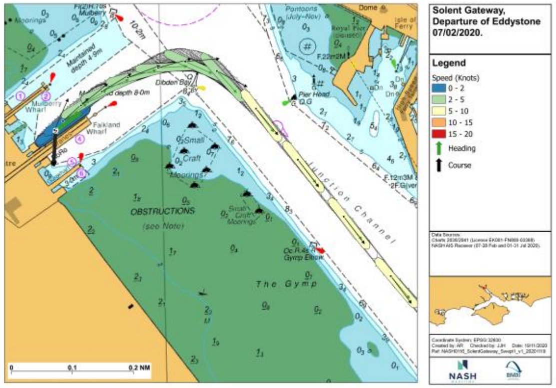


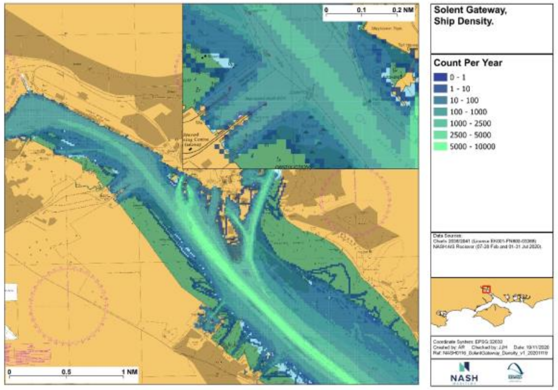
21/01/2021

KEEPING BRITAIN TRADING

NASH Maritime's Role

- Carry out a Navigation Risk Assessment (NRA) on behalf of Solent Gateway Ltd.
- To date consultation with ABP Southampton has been undertaken in developing the NRA scope.
- Navigation risk overview:
  - Review plans for Solent Gateway and associated changes in marine activity.
  - Analysis of vessel traffic data to understand baseline vessel traffic activity and modelling of additional vessel activity as a result of the development.
  - Consultation:
    - *ABP Southampton*
    - *Other port users (purpose of meeting today to introduce project)*
  - Identification of navigation hazards and associated assessment to determine acceptability changes brought about by the project.
  - Recommendations made as necessary.





Solent Gateway Vessel Movements

Cargo Types	Recorded Baseline (2019)	Estimated Future Baseline
	Arrivals	Arrivals
Automotive (e.g. Auto Premier)	1	22
Aggregates		
Specialist Aggregates		25
Dredged Aggregates		200
Bulk Aggregates (e.g. Yeoman Bank)		15 or 6
Steel	3	19
Project cargo / Other	6	72
Other (Barge/Support vessel)	0	5
MOD (Non-Commercial)	36	40
Totals	**46**	**398 or 389**

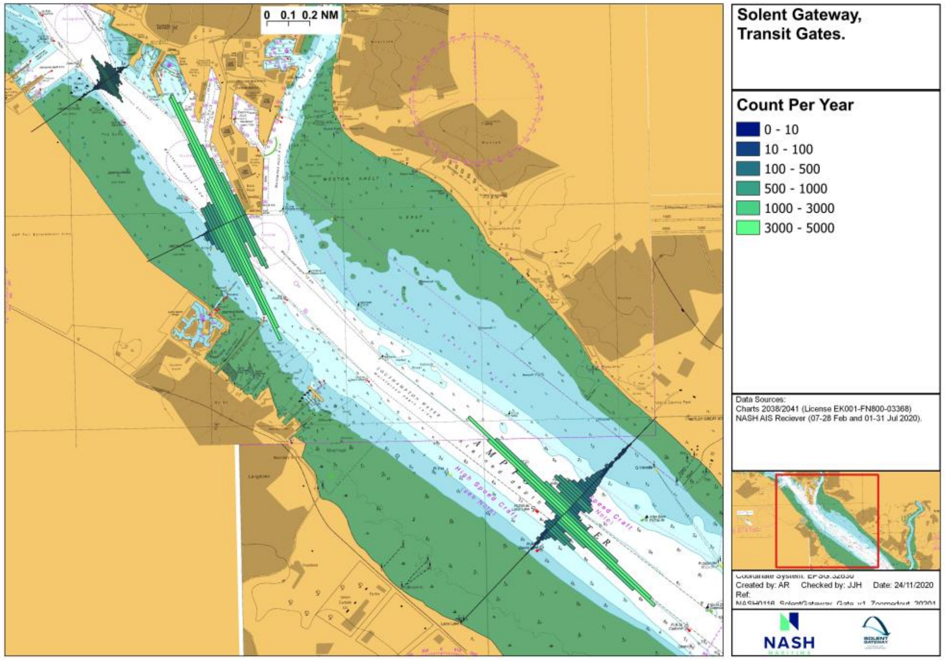





Movement Numbers

- AIS data received during Feb 2020 and July 2020

	Vessel Movements (Annualised)		
Vessel Type	**Netley**	**Dock Head**	**Royal Pier**
Other	113	92	56
Cargo	5054	4547	2780
Fishing	70	0	0
Passenger (Ferry & Cruise)	20763	31173	908
Recreational	12831	3857	2147
Tanker	880	422	260
Tug and Service	7686	14028	10002
Total	**47397**	**54119**	**16153**



Focus Areas

- Consultation to date with ABP Southampton has highlighted the following key considerations:
  - The impact on existing navigation.
  - Impact on the passage of draught restricted vessels (e.g. container vessels).
  - Impact on the passage of time critical vessels (e.g. cruise ships).
  - Impact on vessel traffic procedures – (e.g. passing points for vessels ≥180m LOA above the Hook Buoy).
  - Possible impacts to ferry movements.
  - Take in to consideration the increased number of cruise ships using the turning circle off berth 102.
  - Consideration to leisure traffic transiting to and from Town Quay marina.
- Request for interested parties to engage with the risk assessment process – please get in touch.

Contact Details

Sam Anderson-Brown

- **t:** [redacted]
- **e:** [redacted]
- **w:** [redacted]

Southampton Port Marine User Group Meeting
ABP Southampton
Thursday 21st January 2021

Attendee	Organisation	Attendee	Organisation
Steven Masters	ABP - HM	Becky Walford	QHM Safety/Conservancy
Pippa Moody	ABP - AHM	Richard Orris	Marine Police Unit
Simon Lockwood	ABP – Pilot Manager	Sam Anderson Brown	Nash Maritime
Sam Quilliam	ABP - Hydro	Ed Rogers	Nash Maritime
Barry Sadler	ABP – Pilot	John Selby	RYA
Matthew Wright	ABP - VTS	Ben Walmsley	Calshot Activity Centre
Keven Hall	BP Hamble	Ben Lidstone-Scott	Calshot Activity Centre
Dave Martin	Royal Southampton YC	Laurence Mead	SCRA
Ed Walker	Cowes Harbour Commission	Scott Willmore	Solent Gateway
Jack Woodland	Svitzer	Nick Jeffery	Solent Towage
David Ayres	Svitzer	Richard Brooks	Williams Shipping
Emily Robertson	Royal Southern YC	Alex Bell	SWSA
Ben McInnes	PIP HM	John Purkess	Southampton Rowing Association
Jon Stage	Red Funnel	Dougal	
Leigh Marsh	Whitaker Tankers		

The purpose of this meeting is to keep Port of Southampton Marine Users informed of Marine matters that are of relevance and interest be it directly or indirectly.

The following is a summary of the discussion:

- **Welcome**
- **Introductions**

  Steve Masters (SM) introduced the new Marine Team in Southampton as there has been a lot of staff changes over the previous year.
- The **Port and Marine** update:
  - SM explained that the department will be revamping the Marine Safety Management system over the next year. Looking at:
  - The Pilotage Directions and the all the processes and procedures
  - Simon Lockwood (SL) explained that the Port User and Navigational Guide (PUNG) has been updated and it on the website. Added in items which were LNtM's, 6 hour notice period for departure, dangerously weighted heaving lines, the Nab Matric and areas within the Towage section.

- The Oil Spill Response Plan has its 5 yearly review due in March 2021. ABP will consult with stakeholders.
- Leisure RA Review process to bring in line with other ports and will be put into General Directions.
  - General Directions: Southampton has had the power to issue them but hasn't in the past. It is an updated way to manage the Port alongside the Byelaws and are easier to change then the Byelaws. At the end of March 2021 they should be in force and include some NTM's that have been in force for a while. It puts a legal basis in place. 6 week consultation to start end of Feb and will be issued as a LNtM. SM invites people to come back with feedback.
  - Wreck and Abandoned Vessels: 72 vessels on the River Itchen, some are liveaboards and 95% are illegally moored. It is a long process to resolve but legal advice has been provided last week and ABP will work with stakeholders and a meeting is in the process of being organised.
  - VTS upgrade
  - Pilot Launch upgrade
  - Terminal 5 update
  - SCT Dredge: Phase 2 yet to be approved but should commence late 2022.
  - Brexit Leisure changes: LNtM issued

- Hydrographic Presentation: Sam Quilliam – Principal Hydrographer
- Pippa Moody (PM) gave an **Incident Management** update and highlighted weighted heaving line incidents and pilot boarding arrangements along with the measures taken to try and reduce repeat occurrences. PM explained the MarNIS recording system and briefed on some of the "Other" incidents in the SHA in 2020. Operation wave breaker was discussed and the plan for 2021 along with mention of the Enforcement Letters that have been issued and the plans for how to use this moving forward. Calshot Watersports area was briefed.
- Nash Maritime presentation: A brief was given on the Solent Gateway developments.

Next meeting will be held 18th November 2021

ANNEX C: HAZARD LOG

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores: Most Likely: Frequency	People	Property	Planet	Port Business	Worst Credible Scenario Assessment: Frequency	People	Property	Planet	Port Business	Baseline ABP MarNIS Risk Scores by Consequence Category: Most Likely Risk Sore: People	Property	Planet	Port Business	Worst Credible Risk Score: People	Property	Planet	Port Business
29	EP0182	Ship wash : Across Port of Southampton SHA	**Worst Credible Outcome:** Wash from vessel floods/capsizes smaller vessel leading to fatality. Moderate damage and minor pollution. Significant adverse publicity **Most Likely Outcome:** Wash from vessel affects another water user. No injury, minor damage or pollution. Some complaints but no adverse publicity.	Vessel speeds not considered a significant hazard when associated with SGL vessels. ML - at max. likelihood. WC - unlikely that SGL vessel can cause this outcome and absolute number (e.g. exposure to risk) very low.	Freq. Score for WC Property scored at 3 compared to 2 for other consequence categories - rescored at 2.	5	1	0	0	1	2	3	1	2	1	6.0	0.0	0.0	6.0	5.0	2.0	3.0	2.0
21	EP0316	Marine Pollution (Minor): Tier 1,2 & 3	**Worst Credible:** Vessel has a major uncontrolled release of marine pollutant. Leading to multiple fatalities and major damage to property and major pollution. With significant negative international publicity. **Most Likely Outcome:** Vessel and shoreside have a minor release of marine pollutant resulting in no injuries to personnel, negligible damage to property and no measurable damage to the ecology of the district and no negative publicity or loss of revenue.	Not a navigation hazard.	ABP Comment: ABP to follow up with SGL regarding OSCP	5	0	0	2	1	1	4	4	4	4	0.0	0.0	8.0	6.0	5.0	5.0	5.0	5.0
1	NS0281	Collision Ship-Ship: Commercial vessel with a leisure vessel	**Worst Credible Outcome:** Commercial vessel collides with a leisure vessel resulting in leisure vessel sinking. Multiple fatalities, loss of leisure vessel, minor damage to the commercial vessel, tier 1 pollution, national adverse publicity. **Most Likely Outcome:** Vessels take avoiding action resulting in a minor collision at slow speed. Moderate damage to the leisure vessel, minor injuries from the impact, local adverse publicity.	Minimal increase in vessel movements (commercial only) resulting in negligible increase in overall risk - therefore unlikely that baseline scores will change.	ABP Comment: This hazard may be removed in future reviews as it is a duplicate of NS0286 which has been recently reviewed and updated.	5	1	2	0	1	2	4	3	2	4	6.0	8.0	0.0	6.0	6.0	5.0	3.0	6.0
2	NS0284	Collision Ship-Ship: Dredger operations	**Worst Credible Outcome:** Dredger and ULCV collide 4 miles south of Nab resulting in multiple fatalities, dredger sinks, tier 2 pollution from dredger, significant damage to tanker. Negative international publicity. **Most Likely Outcome:** Dredger collides with unpiloted vessel transiting to pilot station resulting in significant damage to the dredger, major injuries to crew, minor pollution negative national publicity.	Assumed to be related to aggregate dredgers working aggregate grounds near the Nab - 2-3 dredge areas milling around aggregate dredge area at low water.		2	2	3	1	3	1	4	4	3	3	3.0	5.0	2.0	5.0	5.0	5.0	4.0	4.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
3	NS0283	Collision Ship-Ship: Multiple vessels boarding and congestion at the Nab	**Worst Credible Outcome:** Large passenger vessel and a large tanker collide in the deep water route resulting in multiple deaths, closure of the deep water channel, tier 3 pollution. International adverse publicity. **Most Likely Outcome:** Large vessel and small vessel at the Nab collide at slow speed whilst waiting for pilot boarding resulting in minor injuries damage to both vessels creating minor pollution and negative impact on port business	Nab not within study area and commercial ship-ship collision covered by NS0282		2	1	2	1	1	1	4	4	4	4	2.0	3.0	2.0	2.0	5.0	5.0	5.0	5.0
4	NS0286	Collision Ship-Ship: Recreational craft pan Solent events	**Worst Credible Outcome:** A commercial vessel collides with a recreational craft resulting in multiple fatalities, no pollution and adverse national publicity. **Most Likely Outcome:** A recreational craft collides with a paddle craft such as kayak or rowing boat resulting in minor injuries, no pollution and local adverse publicity.	Increase in vessel movements from SGL results in negligible increase in overall likelihood but unlikely that baseline scores will change. Assumes Cowes week / round the island race, etc.. SGL study area stops at Southampton Water only. Note likelihood and consequences different to Haz NS0281		5	1	0	0	0	2	4	1	2	3	6.0	0.0	0.0	0.0	6.0	2.0	3.0	5.0
5	NS0282	Collision Ship-Ship: Two commercial vessels	**Worst Credible Outcome:** Cruise ship collides with another commercial vessel resulting in multiple passenger fatalities. Significant damage results in vessel sinking or capsizing and blocking channel. Port operations cease during emergency, tier 3 pollution, international adverse publicity. **Most Likely Outcome:** Minor collision between two commercial vessels causing minor injuries to persons onboard, tier 1 oil spill and local adverse publicity. Damaged vessels require survey and repair.	Collision modelling, density analysis, future baseline vessel traffic disposition used to quantify risk. Results show up to 5% increase in collision likelihood. ABP consideration could be given to breaking this hazard down into vessel types. Consider an F2 in most likely to be a conservative assessment based on expert judgement and incident records - therefore small increase will not materially change the score to an F3 (1 in 10 year event). Similar rationale for Worst Credible.		2	1	2	2	1	1	4	4	4	4	2.0	3.0	3.0	2.0	5.0	5.0	5.0	5.0
6	NS0285	Collision Ship-Ship: Vessel dragging anchor	**Worst Credible Outcome:** VLCC drags anchor and collides with another anchored vessel at slow speed, with minor injuries to crew, tier 3 pollution and international adverse publicity. **Most Likely Outcome:** Vessel drags anchor and is involved in a minor collision with	There are no anchorage areas (with exception of Hook small ships anchorage (for vessels less than 85m LOA) which isn't applicable for project vessels), within the study area and therefore project vessels will not anchor		3	0	1	0	1	1	1	4	4	4	0.0	2.0	0.0	2.0	1.0	5.0	5.0	5.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
			another vessel, tug assistance required to bring vessel back to anchorage. No injury or pollution, local adverse publicity.	within study area. Therefore, no increase in risk is expected.																			
7	NS0287	Equipment failure (vessel): Failure of steering and propulsion	**Worst Credible Outcome:** A cruise ship blacks out in confined waters during a critical manoeuvre resulting in a grounding or collision with another commercial vessel causing significant injuries and pollution. Negative impact on port reputation and business. **Most Likely Outcome:** A small commercial vessel experiences equipment failure and anchors or gets towed to a safe location. No injury or environmental impact. No reputational damage.	Hazard seems to be hazard cause and not a specified hazard. However, the small increase in project vessel movements would result in negligible increase in overall risk and therefore unlikely that baseline scores will change. No change to Most Likelihood frequency as it doesn't change risk score. Worst Credible frequency considered to be a conservative assessment - example incidents being *Hoegh Osaka* (but outside of study rea and consequences were less than defined in WC scoring).		4	0	0	0	0	3	3	3	2	3	0.0	0.0	0.0	0.0	6.0	6.0	4.0	6.0
8	NS0288	Equipment failure (vessel): Towage equipment failure	**Worst Credible Outcome:** A tug's tow line parts and recoils back to tug causing damage and serious injury to crew on deck. Loss of tug and/or vessel control. No pollution and tug continues with vessel until another tug is repositioned. **Most Likely Outcome:** Equipment failure onboard a tug causes loss of propulsion and steering for a limited period. No injury to personnel. Towage restored with limited impact. No pollution and no negative publicity.	Hazard seems to be hazard cause and not a specified hazard. Most proposed project vessels movement will not have towage (e.g. 1% increase in tug usage in port as a result of SGL project vessels). Most Likely frequency score is at highest category so no change possible. Worst Credible frequency occurring once in 5 years is conservative and 1% increase in tug use unlikely to change this.		5	0	0	0	1	4	2	1	0	1	0.0	0.0	0.0	6.0	6.0	3.0	0.0	3.0
9	NS0289	Event Management : Large recreational event	**Worst Credible Outcome:** Large commercial vessel transiting during unannounced yachting event resulting in multiple collisions with yachts, multiple fatalities, small scale pollution, multiple wrecks in channel becomes navigational hazard. Negative international publicity. **Most Likely Outcome:** High speed vessel makes contact	Annual Seawork Exhibition and Southampton Boat show in close proximity to Marchwood Port. No material change likely based on project vessel movements.	To be discussed as high risk.	4	1	1	2	0	4	4	2	2	4	3.0	3.0	6.0	0.0	8.0	6.0	6.0	8.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores: Most Likely – Frequency	Most Likely – People	Most Likely – Property	Most Likely – Planet	Most Likely – Port Business	Worst Credible Scenario Assessment – Frequency	Worst Credible – People	Worst Credible – Property	Worst Credible – Planet	Worst Credible – Port Business	Baseline ABP MarNIS Risk Scores by Consequence Category: Most Likely Risk Sore – People	Most Likely Risk Sore – Property	Most Likely Risk Sore – Planet	Most Likely Risk Sore – Port Business	Worst Credible Risk Score – People	Worst Credible Risk Score – Property	Worst Credible Risk Score – Planet	Worst Credible Risk Score – Port Business
			with single yacht results in MOB and injury. Minor pollution and negative local publicity.																				
10	NS0291	Fire/Explosion: Onboard commercial vessel	**Worst Credible Outcome**: Fire onboard ULCV passing Fawley resulting in explosion and multiple fatalities, major damage to vessel, major pollution and negative international publicity, operations at Fawley cease for prolonged period and limited access into or out of the Docks in the short term. **Most Likely Outcome:** Fire on a pilot launch causing some injuries to crew and pilots, minor pollution, disruption to port shipping schedule and adverse local publicity.	IMDG Code hazardous cargo for SGL is only associated with MOD vessels which are unchanged. Project vessels (e.g. aggregate, cars, project cargo are unlikely to carry IMDG and therefore no overall change in Fire/Explosion hazard with IMDG per vessel arrival. Fire / Explosion possible as per all over vessels, but considered minimal in context of all port movements and therefore no change in scoring.		3	2	2	1	1	1	4	4	4	4	4.0	4.0	2.0	2.0	5.0	5.0	5.0	5.0
11	NS0290	Fire/Explosion: Onboard leisure vessel	**Worst Credible Outcome:** Significant fire causing vessel to sink with multiple fatalities, tier 2 pollution and local adverse publicity. **Most Likely Outcome:** Small fire contained onboard a leisure vessel. Vessel is immobilised requiring assistance to be towed to safety. Minor injuries to crew, minor pollution, minimal local publicity.	Hazard not applicable to SGL Project vessels.		5	1	1	1	0	2	4	2	3	2	6.0	6.0	6.0	0.0	6.0	3.0	5.0	3.0
12	NS0292	Grounding : Any Vessel	**Worst Credible Outcome**: ULCV or a ULCC grounds across the main channel, minor injury to crew, minor pollution. Disruption to traffic and port operations and International adverse publicity for the port. **Most Likely Outcome:** Small commercial vessel aground outside of navigational channel, no injuries and minor damage to the yacht. No pollution or adverse publicity.	Most Likely frequency scored at highest category and occurrence not materially changed by small increase in project vessels. Worst Credible - IWRAP grounding assessment shows net change in likelihood of ~5% - therefore frequency score unchanged. Historical WC incidents relate to large vessels at Thorn bend outside the study area. Project vessels are smaller than ULCV and ULCC.	ABP Comment: Any vessels calling to SGL berths would be needing to comply with the SHA requirements regarding UKC etc	5	0	1	0	0	2	1	2	1	3	0.0	6.0	0.0	0.0	2.0	3.0	2.0	5.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
13	NS0293	Grounding : ULCV in precautionary area	**Worst Credible Outcome:** ULCV fails to complete bramble turn inbound resulting in channel blockage on last day of spring tides. No loss of life, No environmental damage. Large negative International publicity, vast commercial impact from loss of access to port. **Most Likely Outcome:** ULCV fails to complete turn, grounds resulting in a short term closure to vessel traffic until vessel refloats on rising tide. No enviromental polltuion and local negative publicity.	Not applicable.		3	0	0	0	2	2	0	3	0	4	0.0	0.0	0.0	4.0	0.0	5.0	0.0	6.0
14	NS0294	Heaving Lines: Use of inappropriately weighted heaving lines	**Worst Credible Outcome:** A vessel uses a dangerously weighted heaving line with a tug, seriously injuring one of the tug crew and minor damage to vessel, no pollution, delay to operations. **Most Likely Outcome:** A vessel uses an inappropriately weighted heaving line which is removed. Which does not cause any delay to vessel.	Not applicable (non-navigation hazard).		5	0	0	0	1	5	2	1	0	1	0.0	0.0	0.0	6.0	8.0	6.0	0.0	6.0
15	NS0298	Impact with structure: Any vessel impact with mooring or pontoon	**Worst Credible Outcome:** Commercial vessel contact with multiple pontoons/leisure vessels in marina. Multiple fatalities, moderate damage to port infrastructure and property, tier 2 oil spill and international adverse publicity. **Most Likely Outcome:** A small craft collides with mooring pontoon causing minor damage to infrastructure or property, no injuries and no pollution and no negative publicity	Only possible with respect to local yacht mooring, but water depth likely too shallow for consideration. Theoretically possible but unlikely impact with Seawork's / Southampton Boat Show Yacht Moorings / Town Quay Marina (with limited water depth). Total increase in impact (alision) increase brought about by project vessels was modelled at ~1.5% - therefore only a subset of this is apportioned for mooring / marina, so therefore minimal change in likelihood.		4	0	2	0	0	1	4	3	3	4	0.0	6.0	0.0	0.0	5.0	4.0	4.0	5.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
16	NS0300	Impact with structure: Commercial vessel colliding with Bridge.	**Worst Credible Outcome:** Vessel collides with Itchen Bridge, rendering the bridge deemed unsuitable for further use until structural inspection completed and damage to vessel requiring inspection. Minor injuries to those on the vessel , minor pollution, adverse national publicity and reputational damage. **Most Likely Outcome:** Vessel has a minor impact with bridge causing slight cosmetic damage to the vessel, no injury, no pollution and no impact to port's reputation.	Not applicable.		3	0	1	0	0	2	1	2	1	3	0.0	2.0	0.0	0.0	2.0	3.0	2.0	5.0
17	NS0301	Impact with structure: Commercial vessel impacts with quayside infrastructure.	**Worst Credible Outcome:** Vessel makes contact with shoreside container crane causing crane to collapse. Multiple fatalities, major property damage, tier 2 pollution and International adverse publicity. **Most Likely Outcome:** Vessel impact with flat quayside, near miss with quayside infrastructure causing minor damage to vessel, no pollution, injury or effect on ports reputation.	Total increase in impacts (alisions) brought about by SGL project vessels was modelled at ~1.5%. No change to ML as currently at Max. likelihood. No change to WC as likelihood set at 1 in 10 year event (which is considered a conservative assessment). Possible greatest risk of fatality associated with crane (container) collapse - Marchwood cranes set well back and SOP of no personnel in cranes until ship fully secured (moored up).	ABP Comment: Updated the RA. Should consider all landside obstructions in vacinity of vessel (e.g. include cranes)	5	0	1	0	0	3	4	4	3	4	0.0	6.0	0.0	0.0	7.0	7.0	6.0	7.0
18	NS0296	Impact with structure: Impact with Nab Tower or Forts	**Worst Credible Outcome:** Non piloted cruise vessel strikes Nab Tower resulting in penetration of the hull causing ingress of water and major pollution, severe injuries to passengers and International adverse publicity. **Most Likely Outcome:** Unpiloted vessel is involved in a minor impact with the Nab Tower or Forts resulting in superficial damage to vessel and the structure. No injurys and no pollution and no negative publicity	Not applicable outside study area.		2	0	1	0	0	1	2	3	4	4	0.0	2.0	0.0	0.0	3.0	4.0	5.0	5.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores – Most Likely: Frequency	People	Property	Planet	Port Business	Worst Credible Scenario Assessment: Frequency	People	Property	Planet	Port Business	Baseline ABP MarNIS Risk Scores by Consequence Category – Most Likely Risk Sore: People	Property	Planet	Port Business	Worst Credible Risk Score: People	Property	Planet	Port Business
19	NS0295	Impact with structure: Impact with Ocean Dock	**Worst Credible Outcome:** Commercial vessel hits the entrance to Ocean dock, moderate damage to berth and vessel. Tier 2 pollution from ruptured tanks, minor injuries for crew onboard, adverse local publicity, berth unavailable until repairs completed, vessel requires survey and repair. **Most Likely Outcome:** Minor impact with berth causing minor damage to berth and cosmetic damage to vessel, no injuries, pollution or negative publicity.	Not applicable outside study area.		4	0	1	0	0	2	1	2	3	2	0.0	3.0	0.0	0.0	2.0	3.0	5.0	3.0
20	NS0299	Impact with structure: Vessel impacts with Empress Dock entrance	**Worst Credible:** Commercial vessel impact with entrance to dock, moderate damage to ship and quayside. Tier 2 oil spill and minor injuries to crew. Local adverse publicity. **Most Likely Outcome:** Vessel has a minor impact with dock entrance causing minor damage to vessel and port infrastructure. No injuries, pollution or publicity.	Not applicable outside study area.		4	0	1	0	0	2	1	3	3	2	0.0	3.0	0.0	0.0	2.0	5.0	5.0	3.0
21	EP0316	Marine Pollution (Minor): Tier 1,2 & 3	**Worst Credible:** Vessel has a major uncontrolled release of marine pollutant. Leading to multiple fatalities and major damage to property and major pollution. With significant negative international publicity. **Most Likely Outcome:** Vessel and shoreside have a minor release of marine pollutant resulting in no injuries to personnel, negligable damage to property and no measurable damage to the ecology of the district and no negative publicity or loss of revenue.	Not a navigation hazard.	ABP Comment: ABP to follow up with SGL regarding OSCP	5	0	0	2	1	1	4	4	4	4	0.0	0.0	8.0	6.0	5.0	5.0	5.0	5.0
22	NS0304	Other nautical safety: Loss of stability/ inadequate stability	**Worst Credible:** Large vessel capsizes and sinks due to issues with stability. Multiple fatalities, fairway is blocked until vessel can be refloated or recovered, tier 2 pollution, international adverse publicity. **Most Likely Outcome:** Vessel develops a list and unable to resolve through movement of ballast. Vessel anchors or returns to berth with no pollution loss of life or traffic disruption.	Bulk - unlikely Car Carrier - possible but unlikely Project Cargo - possible but unlikely MOD - no change Minimal increase in risk anticipated, risk scores likely to remain the same. ML scored at maximum likelihood (therefore no change possible). WC - no change as currently scored conservatively.		4	0	1	0	1	2	4	4	3	4	0.0	3.0	0.0	3.0	6.0	6.0	5.0	6.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
23	NS0307	Other nautical safety: Lost of metrological information	**Worst Credible Outcome:** All weather and metolgical data is offline causing significant vessel delays, no pollution, injurys or damage to property. Loss of port revenue and advese publicity. **Most Likely Outcome:** Weather data is obtained from other sources, no affect to ports operations.	Not a navigation hazard.		5	0	0	0	0	4	0	0	0	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0
24	NS0303	Other nautical safety: Man-overboard from leisure or commercial vessel	**Worst Credible Outcome:** Person falls overboard makes contact with vessel and is unconcious on enterintg the water resulting in drowning. No pollution or propoerty damage, local adverse publicity. **Most Likely Outcome:** Person enters the water and is recovered and treated for cold water immersion. No damage, pollution or publicity.	Minimal increase in risk anticipated, risk scores likely to remain the same. ML at max. likelihood so no change possible WC - project vessels don't materially increases exposure of hazard (assumed to be most closely related to tugs / workboats and leisure vessel activity) and therefore hazard likelihood not materially changed.		5	1	0	0	0	4	3	0	0	1	6.0	0.0	0.0	0.0	7.0	0.0	0.0	3.0
25	NS0302	Other Nautical Safety: VTS loss of Communications	**Worst Credible Outcome:** Complete loss of VHF and telephones requiring delays to operations to avoid nautical safety isues and an increase in close quarter situations. Impact on port reputation. **Most Likely Outcome:** Partial loss of VHF and phones, communications are transferred to mobile phones, QHM, pilots and Southampton patrol to issue broadcasts. Minor delays to operations.	SGL project doesn't materially change this hazard, except more vessels may increase exposure to risk if the hazard occurs whilst SGL vessel moving in study area.		5	0	0	0	1	2	0	0	0	3	0.0	0.0	0.0	6.0	0.0	0.0	0.0	5.0
26	NS0306	Other nautical safety: VTS loss of traffic image	**Worst Credible Outcome:** VTS loses all monitroing equipment Radar/network. Unable to provide VTS service to vessels in confined water. Reduce efficiency and a decrease in protection for safety and the marine environment. Minor loss of revenue, local adverse publicity and damage to reputation. **Most Likely Outcome:** VTS lose primary Radar and experience a reduction in traffic image;. Loss of the ability to provide NAS. Minor/no effect to users.	SGL project doesn't materially change this hazard, except more vessels may increase exposure to risk if the hazard occurs whilst SGL vessel moving in study area.		5	0	0	0	1	4	0	0	0	2	0.0	0.0	0.0	6.0	0.0	0.0	0.0	6.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
27	NS0308	Pilot boarding arrangements: Pilot boarding arrangements	**Worst CredibleOutcome:** Failure of equipment resulting in death of pilot, international negative publicity, disruption to vessels schedules and marine traffic, potential damage to the pilot vessel. **Most Likely Outcome:** Pilot boarding arrangements cause minor injury and delay to vessels arrival.	Outside study area. Piloted vessel movements would be around 50% for SGL bound vessels as understand *Al Avocet* likely to operate under a PEC. This is a relatively low number in total considering the ~10,000 acts of pilotage per year, which may increase by only 400 additional movements (split between Nab (large vessels only), North Sturbridge, & Lepe). Therefore no material change to hazard likelihood. Also SGL project vessels not particularly challenging to board compared to other vessels.		3	1	0	0	1	2	4	2	1	3	2.0	0.0	0.0	2.0	6.0	3.0	2.0	5.0
28	NS0310	Ranging: Alongside Docks	**Worst Credible Outcome:** Moored passenger vessel ranges as large vessel passes. Air bridge detaches whilst in use causing multiple injuries and possible fatalities to passengers. Bunker barge ranges from vessel and surges causing spill and tier 2 pollution. Negative international publicity. Tanker alongside ranges due to passing vessel resulting in lines parting and breakout, damage to cargo manifolds causing tier 3 pollution, moderate injuries to crew on deck. Vessel movements restricted until drifting vessel brought alongside, national adverse publicity. **Most Likely Outcome:** Snapping and parting of lines & loss or damage to ship or shore infrastructure caused by ranging or weather on moored vessel or of bunker barge, minor injuries and no pollution. Little adverse negitive publicity. Vessel movement on berth results in single line parting, cargo operations cease until vessel secured, no pollution or injury.	Only applies to large deep draught vessels bound to / from berths passing Berth 38/39 (QE2 terminal) - in reality this hazard is most likely to apply to ULCV's. Therefore, with minimal number of deep draught SGL vessels, this will not impact risk scoring.	ABP: May review scoring	5	1	1	2	1	2	4	3	4	4	6.0	6.0	8.0	6.0	6.0	5.0	6.0	6.0

NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
30	NS0311	Sinking and capsizing: Any vessel	**Worst Credible Outcome:** ULCV or a ULCC sinks or capsizes in main channel, minor injury to crew but they all safely abandon the vessel, Major pollution and disruption to traffic and port operations. International adverse publicity for the port. **Most Likely Outcome:** Recreational craft or vessel capsizes outside of the main navigational channel with no injuries, no pollution and no impact on the port.	Causes of this hazard related to navigation risk from SGL project vessels are as a result of a collision, grounding, contact or loss of stability etc. - all of which are considered in other hazards.		4	0	0	0	0	1	1	4	4	4	0.0	0.0	0.0	0.0	1.0	5.0	5.0	5.0
31	NS0312	Striking and capsizing: Tug girting	**Worst Credible Outcome:** Conventional twin screwed tug girts and capsizes resulting in multiple fatalities, loss of tug, tier 3 pollution and adverse national publicity. **Most Likely Outcome:** Tug hook is tripped and vessel escapes with minor injuries and vessel is left without towage until tug reconnects causing minor delay.	Only a minority of proposed project vessel movements will have towage (e.g. 1% increase in tug usage). Most likely is at "Probably" frequency consider no change as towage increase only anticipated to be 1%. Worst Credible "occasional" frequency occurring once in 10 years is conservative and 1% increase unlikely to change this.		4	1	0	0	1	3	4	4	3	4	3.0	0.0	0.0	3.0	7.0	7.0	6.0	7.0
32	NS0313	Striking with floating object: High speed craft makes contact with floating object.	**Worst Credible Outcome:** High speed craft makes contact with large floating debris causing minor injury to crew, damage to vessel, with possibility of sinking. Delay to passenger service, negative publicity to port and minor pollution. **Most Likely Outcome:** High speed craft transits over or through fishing nets and pots disabling the vessel. Delay in services, no injuries or pollution.	Not applicable to project vessels.		3	0	1	0	1	3	1	2	1	2	0.0	2.0	0.0	2.0	2.0	4.0	2.0	4.0
33	NS0297	Striking with Floating Object: Vessel <20m collides with navigational mark	**Worst Credible:** High Speed leisure vessel has an impact with a navigational mark causing damage to port infrastructure and possible deaths to crew / passenger from impact and ongoing trauma. Minor pollution and national negative publicity. **Most Likely Outcome:** Leisure vessel has a glancing blow with a navigational mark causing minor damage to vessel and port infrastructure, no pollution or injuries.	Not applicable to project vessels. (No vessels under 20m included in project exemplar vessels and therefore nor increase in transits by such vessel.)		4	0	1	0	0	3	4	2	1	2	0.0	3.0	0.0	0.0	7.0	4.0	2.0	4.0

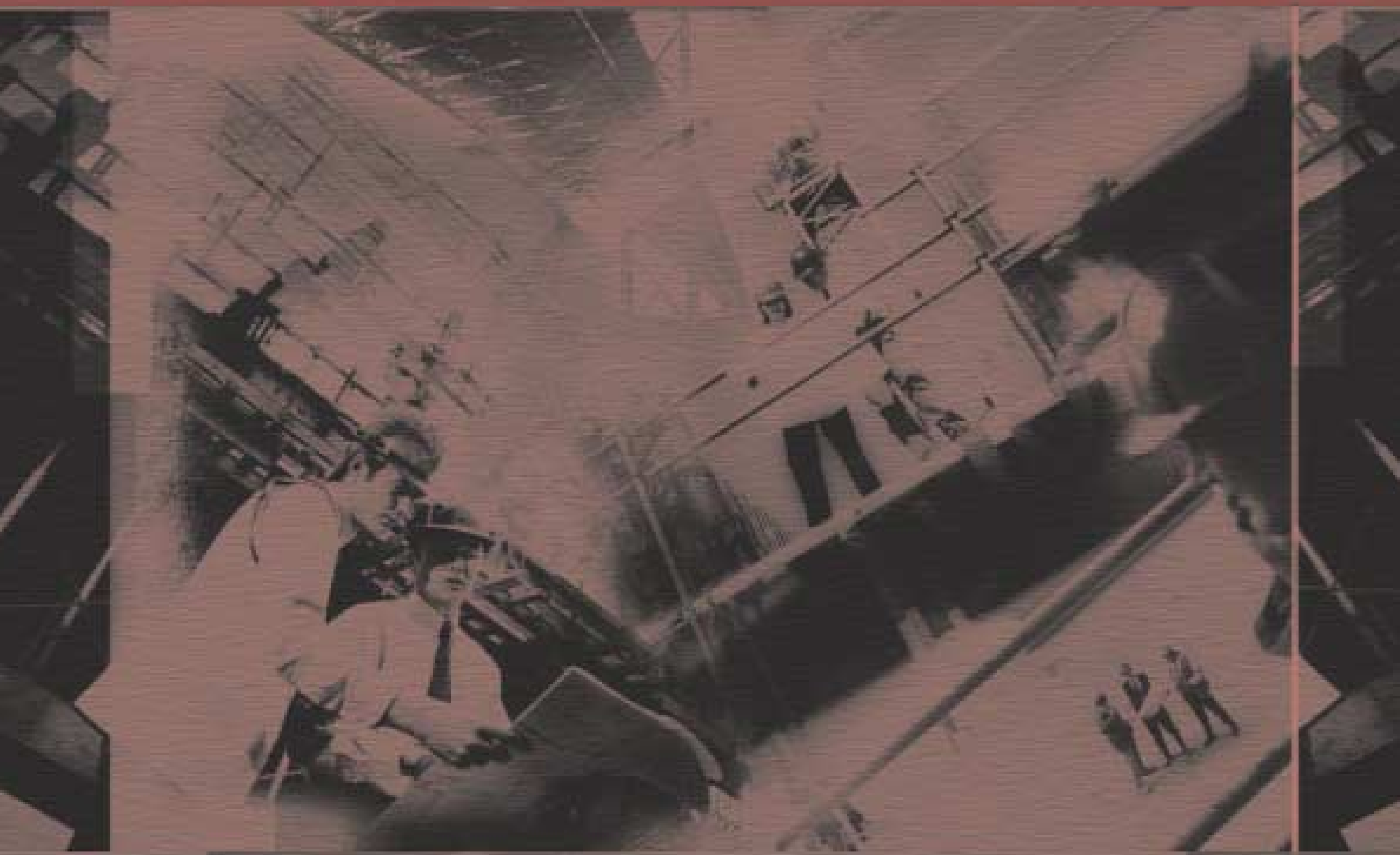
NASH HazID	MarNIS Haz ID	Scenario Name	Hazard Description	SGL Hazard Notes	Notes on Frequency Scoring	Baseline ABP MarNIS Input Scores										Baseline ABP MarNIS Risk Scores by Consequence Category							
						Most Likely					Worst Credible Scenario Assessment					Most Likely Risk Sore				Worst Credible Risk Score			
						Frequency	People	Property	Planet	Port Business	Frequency	People	Property	Planet	Port Business	People	Property	Planet	Port Business	People	Property	Planet	Port Business
34	NS0317	Striking with Floating Object: Vessel >20m collides with navigational mark	**Worst Credible Outcome:** High speed vessel collides with navigational mark causing injuries and fatalities to crew/passengers and ongoing trauma. Severe damage to vessel and navigational mark, minor pollution and national negative publicity. **Most Likely Outcome:** Power driven vessel has a glancing blow with navigational mark, no injuries, minor damage to vessel and navigational mark, no pollution and no negative press.	Project vessels not high speed unlikely to generate consequences as identified hazard and increase in vessel movements is negligible increase, so no overall change in baseline scores.	ABP Comment: Should consider the close proximity to Dibden Bay buoy when maneouvering for berth.	4	0	1	0	0	2	4	2	1	2	0.0	3.0	0.0	0.0	6.0	3.0	2.0	3.0
35	NS0315	Striking with ship (moored): Small vessel collides with a moored vessel	**Worst Credible Outcome:** Commercial launch collides with yacht in marina causing minor injury, damage, and pollution. Negative local publicity. **Most Likely Outcome:** Small recreational vessel collides with moored vessel in a glancing below causing minor cosmetic damage. No pollution and no injuries.	Not relevant to assessment.		5	0	1	0	0	2	3	2	2	1	0.0	6.0	0.0	0.0	5.0	3.0	3.0	2.0
36	NS0314	Striking with ship (moored): Underway vessel strikes moored vessel	**Worst Credible Outcome:** ULCV strikes passenger vessel moored in western dock. Damage to moored vessel results in flooding. Multiple serious injuries, tier 2 pollution and International adverse publicity. **Most Likely Outcome:** Minor collision causing structural damage to the moored vessel, small number of minor injuries and local adverse publicity.	Total increase in impacts (alisions) brought about by project vessels was modelled at ~1.5%. No change to ML as currently at Max. likelihood. No change to WC as likelihood set at 1 in 10 year event (which is considered a conservative assessment). Possible greatest risk of fatality associated with crane (container) collapse - Marchwood cranes set well back and SOP of no personnel in cranes until ship fully secured (moored up).		4	1	2	0	1	1	2	3	4	3	3.0	6.0	0.0	3.0	3.0	4.0	5.0	4.0

DFDS COMMENTS ON D3 SUBMISSION

APPENDIX 4

HSE

HSE
Health & Safety Executive



Reducing risks, protecting people

HSE's decision-making process

HSEBOOKS

Reducing risks, protecting people

HSE's decision-making process

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Contents

Preface

We are pleased to present the document *Reducing risks, protecting people* revised in the light of comments on the discussion document.

The Health and Safety Executive (HSE) published the original discussion document *Reducing risks, protecting people* in May 1999. It set out how the statutory bodies responsible for the administration of the Health and Safety at Work Act 1974[1] ('the HSW Act') approached those decisions about the management of risk that are required of them under the Act. For the Health and Safety Commission (HSC) these include making arrangements to secure the health, safety and welfare of people at work, and the health and safety of the public, in the way undertakings are conducted – including proposing new laws and standards, conducting research and providing information and advice. HSE advises and assists HSC in its functions, including the preparation of draft regulations and Approved Codes of Practice. It has some specific statutory responsibilities of its own, notably for the enforcement of health and safety law, the licensing of nuclear power stations and dealing with a variety of safety case regimes etc. Local authorities also have statutory responsibilities for enforcement of health and safety law, mainly in the distribution, retail, office, leisure and catering sectors.

A major purpose of the document was to set out an overall framework for decision taking by HSE which would ensure consistency and coherence across the full range of risks falling within the scope of the Health and Safety at Work Act. This framework was based on the method which HSE applies to the control of risk at nuclear power stations, originally published in 1988 as *The tolerability of risks from nuclear power stations (TOR)*.[2]

Events since the publication of the discussion document have reinforced the need to publish a description of HSE's decision-making process. Over recent years, public concern over such matters as Bovine Spongiform Encephalopathy (BSE), railway safety and food safety has intensified the call for openness about how decisions are taken on the regulation of risks. The public is also more aware that, given few activities are without any risk, there must be a balance between the health and safety measures introduced to eliminate or control risks, and the costs arising or benefits forgone when the measures are introduced. Hence the recent lively debate about where that balance lies.

Not surprisingly, there was great interest in the discussion document. It was widely distributed both in print and electronically in a portable format. We received over 150 responses, many of them representing consolidated replies from a number of interested parties, and around 10 000 hits on the Internet site. We thank all those who have responded. Your comments have proved invaluable and the new version has taken them into account.

In fact most of the comments received were generally favourable. The concept of a single document explaining HSE's decision-making process was welcomed, as was the extension of TOR beyond the nuclear industry. Moreover, the decision-making framework was accepted as being universally applicable, and no area was identified where the proposed criteria on tolerability would create difficulties. The majority of respondents also found that good practice had been given the right emphasis and supported the principles for conducting cost benefit analysis.

Nevertheless, the consultation has highlighted some points which could benefit from clarification. One of these relates to the status of the document. We would like to emphasise that the document is aimed at explaining the decision-making process in HSE rather than providing guidance to individual duty-holders on what they need to do. Such guidance is available in other documents and particularly *Management of health and safety at work regulations 1999. Approved Code of Practice and Guidance*.[3] The consultation process has shown that many duty holders, and others involved in occupational health and safety, would like to emulate HSE's approach to devising the control regime that should be put in place for addressing hazards at work. As the new document says, we welcome this as long as those who want to emulate the regulator recognise the different context in which HSE applies the framework and take this into account when applying our process to their own decisions. We have amended the text to make this distinction clearer.

We have also taken the opportunity to dispel any perception that we were moving away from a risk-based approach. The new version emphasises the role of risk assessment, both quantitative and qualitative, in the decision-making process and expands on the role of good practice in determining the control measures that must be put in place for addressing hazards. We also make clear that the philosophy and approach set out in the document operate within, and not as an alternative to, the principles of good regulation published by the Better Regulation Task Force.

In presenting this latest document we recognise there will be scope for further development and refinement. We shall revise it as necessary so that it remains a document attuned to current needs.

Improving health and safety requires attention to the assessment and management of risk. For this to be achieved, we need to raise public understanding of the issues involved and of our own understanding of the concerns of society and the values people employ when they consider matters of risk. Prompting a more informed public debate on how to handle risk is an essential part of this and we hope that publication of this document will help to stimulate this debate. We will certainly play our part in doing so.

Finally, we would like to thank all those, both in HSE and outside, who have contributed to the redrafting of this document.

[redacted]

Chair
Health and Safety Commission

[redacted]

Director General
Health and Safety Executive

Introduction

This document is aimed primarily at stakeholders who want to know more about HSE's philosophy for securing the health, safety and welfare of persons at work and for protecting others against risks to health and safety arising from work activities, and the procedures, protocols and criteria underpinning the philosophy. It sets out the basis and criteria by which HSE, in complying with its functions, decides upon the degree and form of regulatory control that it believes should be put in place for addressing occupational hazards. It considers the way scientific evidence (or the lack of it) and uncertainties are taken into account and how the balance is struck between the benefits of adopting a measure to avoid or control the risks, and its disadvantages.

It is in three parts and has four appendices, as follows:

Part 1

- Sets out the aims of the document, namely the need to:
  - open to scrutiny HSE's approach to the regulation and management of risk, and the philosophy underpinning it;
  - make transparent the factors that inform our decisions on how risks should be regulated and managed, for example how account is taken of the scientific knowledge of the risks concerned, the technology available for controlling them, the resource implications of adopting the decisions, public attitudes towards the risks and the benefits they engender and show how these shape the form and content that our regulations and guidance take;
  - help reassure the public that risks to people from work activities are properly addressed, taking due account of the benefits of the activities giving rise to the risk. In particular to satisfy the public that industry, in taking advantage of technological advances and in responding to economic pressures, will not be allowed to impose intolerable risks on people;
  - let other regulators, whose responsibilities may overlap with those of HSC/E, know the basis for the management of health and safety risks from work activities and thereby help to promote consistency of decision-making amongst regulators. In this instance, consistency does not mean uniformity, it means the particular application of a coherent philosophy in a way suitable to the particular context.

- Mentions some of the difficulties inherent in meeting the above aims, particularly those involved in taking account of ethical, social, economic and scientific considerations and the preference values of society at large.

- Introduces the concept of tolerability which is central to the document. This concept (explained in greater detail in Part 3) refers to a willingness to live with a risk so as to secure certain benefits.

- Points out that the proper regulation of risks requires that both the individual risks and societal concerns engendered by a hazard must be addressed.

Part 2

- Reviews some of the developments that have influenced our approach to decision-making since the HSW Act was enacted. The developments examined include advances in knowledge on how people view risks; changes in the regulatory environment and on the industrial scene; and shifts in the values, preferences and expectations of our society.

- Describes the principles of good regulation that have evolved in adapting our approach to take account of the developments; namely:
  - the targeting of action: focusing on the most serious risks or where the hazards are less well controlled;
  - consistency: adopting a similar approach in similar circumstances to achieve similar ends;
  - proportionality: requiring action that is commensurate to the risks;
  - transparency: being open on how decisions are arrived at and what are their implications; and
  - accountability: making clear, for all to see, who is accountable when things go wrong.

- Notes some of the above developments which have been particularly important, ie:
  - the need for the meaning of risk to encompass more than physical harm by taking into account other factors such as ethical, economic and social considerations;
  - the recognition that, because the system for informing and reaching decisions is iterative, it is often very difficult to put a demarcation line between risk assessment and risk management;
  - a discussion by the Courts of the meaning of 'risk' in the HSW Act which implies that approaches for managing risks must ensure that anything in an undertaking presenting the possibility of danger (or what conceptually is regarded as a hazard) has to be properly addressed.

Part 3

- Describes the six stage iterative system adopted by HSE for reaching decisions on how risks should be regulated and managed, namely:
  - deciding whether the issue is primarily one for HSC/E;
  - defining and characterising the issue;

- examining the options available for addressing the issue, and their merits;
- adopting a particular course of action for addressing the issue efficiently and in good time, informed by the knowledge gained going through the six stage iterative system and by the expectation that as far as possible the course of action will be supported by stakeholders;
- implementing the decisions;
- evaluating the effectiveness of actions taken and revising the decisions and their implementation if necessary.

- Sets out the framework, known as the Tolerability of Risk (TOR),[2] for reaching decisions on whether risks from an activity or process are unacceptable, tolerable or broadly acceptable and its application in practice. In this context, 'tolerable' does not mean 'acceptable'. It refers instead to a willingness by society as a whole to live with a risk so as to secure certain benefits in the confidence that the risk is one that is worth taking and that it is being properly controlled. However, it does not imply that the risk will be acceptable to everyone, ie that everyone would agree without reservation to take the risk or have it imposed on them.

- The framework makes clear that:
  - both the level of individual risks and the societal concerns engendered by the activity or process must be taken into account when deciding whether a risk is unacceptable, tolerable or broadly acceptable;
  - the decision-making process and criteria adopted are such that action taken is inherently precautionary;
  - moreover, HSE starts from the position that, for every hazard, the law requires that:
    - a suitable and sufficient risk assessment must be undertaken to determine the measures needed to ensure that risks from the hazard are adequately controlled;
    - suitable controls must be in place to address all significant hazards, and
  - HSE also starts with the expectation that:
    - those controls, at a minimum, must achieve the standards of relevant good practice precautions, irrespective of specific risk estimates;
    - where there is no relevant good practice, or the existing good practice is considered by HSE to be insufficient or inadequate, the decision as to what control measures are suitable will generally be informed by further risk assessment;
    - there are some risks from certain activities, processes or practice which are not tolerable whatever the benefits, i.e. they are unacceptable. Any activity, process or practice giving rise to risks falling in that region would be ruled out unless the activity, process etc can be modified to reduce the degree of risk so that it becomes tolerable;
    - as control measures are introduced, the residual risks may fall so low that additional measures to reduce them further are likely to be grossly disproportionate to the risk reduction achieved, though the control measures should still be monitored in case the risks change over time;
  - HSE has proposed numerical criteria for informing decisions on the tolerability of risks only for very limited categories of risk, for example, those entailing fatalities either individually or in multiple fatality accidents.

Appendix 1

Sets out some of the conventions adopted for undertaking risk assessment. It points out that:

- more often than not, a risk assessment is done in relation to a hypothetical person (a hypothetical type of individual who is deliberately assumed to have some fixed relation to the hazard under consideration);
- the procedures adopted for handling uncertainty are in line with the precautionary principle and ensure that a lack of certainty is not a reason for not taking preventive action.

Appendix 2

Sets out:

- the architecture of health and safety law;
- the constraints that must be taken into account when introducing health and safety legislation;
- the procedures adopted for identifying the hierarchy of options for new regulatory measures.

Appendix 3

Examines some issues relevant to assessing risk reduction options, including:

- the implication of case law on 'reasonable practicability';
- the protocols and procedures adopted for conducting a cost benefit analysis and for ensuring consistency when comparing costs against benefits.

Appendix 4

Gives some statistics for comparing risks from different hazards.

Part 1

Overview of risk and risk management issues

Purpose of this document

1 Work activities give rise to many hazards which present risks to workers and the public. The HSC/E are responsible for regulating such risks. The aim of this document is to explain the basis for HSE's decisions regarding the degree and form of regulatory control of risk from occupational hazards, and in particular to:

- open to scrutiny our approach (eg when advising the HSC) to the assessment, management and regulation of risk and the philosophy underpinning it;
- make transparent the factors that inform our decisions on risks and show how these shape the form and content of our regulations and guidance. For example, how account is taken of the scientific knowledge of the risks concerned, the technology available for controlling them, public attitudes towards the risks, the benefits engendered by allowing the processes, events etc giving rise to the risk to take place;
- help reassure the public that risks to people from work activities are properly addressed, taking due account of the benefits of the activities giving rise to the risks. In particular to satisfy the public that industry, in taking advantage of technological advances and in responding to economic pressures, will not be allowed to impose intolerable risks on people;
- let other regulators, whose responsibilities may overlap with those of HSC/E, know the basis for the management of health and safety risks arising from work activities and thereby help to promote consistency of decision-making amongst regulators.

2 The central purpose throughout has, therefore, been on opening up our decision-making process rather than providing guidance to duty holders. The document is thus aimed at showing how our approach to the assessment and management of risk shapes the form and content of our regulations and guidance, and informs our compliance activities. The difference in emphasis is important. For example, as we point out in paragraphs 80-81 the boundaries that HSE applies in assessing and regulating risks are generally much broader than those we would expect duty holders to undertake in complying with the relevant statutory provisions.

Hazard and risk

Hazard and risk are used interchangeably in everyday vocabulary. Nevertheless, it has proved useful to HSE to make a conceptual distinction between a 'hazard' and a 'risk' *by describing a hazard as the potential for harm arising from an intrinsic property or disposition of something to cause detriment, and risk as the chance that someone or something that is valued will be adversely affected in a stipulated way by the hazard. HSE – as far as the health, safety and welfare of people is concerned – frequently makes use of the above conceptual distinction in its guidance by requiring that hazards be identified, the risks they give rise to are assessed and appropriate control measures introduced to address the risks. This reflects the fact that in most cases it makes sense to take account of the circumstances in which people and management systems interact with a hazard.*

It is often possible to regard any hazard as having more remote causes which themselves represent the 'true hazard'. For example, when considering the risk of explosion from the storage of a flammable substance, it can be argued that it is not the storage per se which is the hazard but the intrinsic properties of the substance stored. Nevertheless, it makes sense to consider the storage as the basis for the estimation of risk since this approach will be the most productive one in identifying the practical control measures necessary for managing the risks, such as not storing the substance in the first place, using less of it or a safer substance, or if there is no alternative to storing the substance, using better means of storing it.

The term 'hazard' is absent in the HSW Act.[1] However, the Courts have ruled that as, far as section 3 of the Act is concerned, 'risk' means 'possibility of danger' rather than 'actual danger' (see paragraphs 41-42). Conceptually, HSE will therefore regard anything presenting the 'possibility of danger' as a 'hazard'. Moreover, since in any given workplace there would be a large number of hazards which duty holders could address, requiring duty holders formally to address them all would place an excessive and largely useless burden on them. So as not to impose unnecessary burdens on duty-holders, HSE will not expect them to take account of hazards other than those which are a reasonably foreseeable cause of harm, taking account of reasonably foreseeable events and behaviour. Whether a reasonably foreseeable, but unlikely, event – such as an earthquake – should be considered depends on the consequences for health and safety of such an event.

Why the need to explain decisions on the management of risk?

3 The risk of suffering harm is an inescapable aspect of living. Nevertheless, there has been tremendous progress in improving many aspects of the quality of our lives. We now live longer than at any time in history; products for use at home and at work are safer and more reliable than ever before. Although accidents at work still occur, the trend averaged over the years has been downwards and we have recently published our targets for reducing these further.[4]

4 This progress in the quality of our lives is readily acknowledged but, paradoxically, it has been accompanied by an increased expectation for a society free of involuntary risks. The

rapid technological developments of recent years have introduced new hazards but also enhanced the scope for controlling existing hazards. Though people accept that we should continue to take advantage of advances in science and technology, this is moderated by expectations that:

- those responsible for the hazards should ensure that adequate measures are taken to protect people from the harmful consequences that may arise from such hazards;
- the State should be proactive in ensuring that its arrangements for securing the protection of people from risks are adequate and up to date as distinct from reacting to events, and that those arrangements should address, as necessary, the concerns the hazards give rise to.

5 Such expectations are complemented in a free market economy by an underlying presumption that industry should be able to take advantage of new technologies, unfettered by undue State intervention.

6 It was such conflicting pressures that led the Government, in an initiative supported by all parties in the political spectrum, to undertake in the early seventies a fundamental review, under the Chairmanship of the late Lord Robens, of the way occupational risks are regulated and managed.[5] The result is that risks to health and safety arising from workplace activity in Great Britain are regulated through a single legal framework – the relevant statutory provisions which include the HSW Act – and by a single set of institutions – the Health and Safety Commission (HSC) and the Health and Safety Executive (HSE), (see the second paragraph of the Preface).

7 A fundamental principle underpinning the HSW Act is that those who create risks from work activity are responsible for protecting workers and the public from the consequences. Thus, the HSW Act places specific responsibilities on employers, the self-employed, employees, designers, manufacturers, importers, suppliers and people in charge of premises. Associated legislation places additional duties on owners, occupiers, licensees and managers.

8 Regulations have also been introduced clarifying these duties, requiring people such as employers and the self-employed to assess risks and to base their control measures on the results of the assessments. Where hazards entailing severe consequences are involved, the trend in recent years has been to amplify the duties for generic risk assessments to require the production of safety cases. These require duty holders to write down and submit to HSE the measures they have in place, or intend to introduce, to meet their legal obligations and ensure safe and healthy systems of work and the proper management of health and safety. This enables duty holders to demonstrate that they understand the hazards associated with work activities and how to control them.

9 In short, since 1974 the trend for managing risk at work has been to merge and centralise the authorities responsible for occupational health and safety and to clarify responsibilities in criminal law for managing risks in particular circumstances through the establishment of regulatory regimes whereby broad general duties are explicitly put on those who are best placed to do something about preventing or controlling the risks. The broad duties are supplemented by specific regulations. Many of these regulations place absolute duties

on duty holders. Others, however, like the broad general duties are qualified by expressions such as 'so far as is reasonably practicable' (SFAIRP) in order to avoid the imposition of duties that no one can fulfil – because absolute safety cannot be guaranteed – and in order to ensure that preventive and protective actions are commensurate with the risks. It is useful to note that SFAIRP is not the only qualification. There are other similar qualifications such as 'as low as reasonably practicable' (ALARP); 'as low as reasonably achievable' (ALARA).

10 The general approach is to set out the objectives to be achieved and to give considerable choice to duty holders as to the measures they should put in place to meet these objectives. However, this is not universal. As explained later in this document, there are circumstances where the enabling powers of the HSW Act have been used to enshrine in regulations specific measures for ensuring that the risks from certain hazards are properly controlled – extending in certain circumstances to proscriptions or to the establishment of a licensing or permissioning regime for certain activities.

11 A similar trend towards centralisation of regulatory authorities and the adoption of non-prescriptive regimes is found in other areas, eg the environment.

12 For a non-prescriptive regime to work, duty holders must have a clear understanding of what they must do to comply with their legal obligations. It is therefore not surprising that HSE, as the regulator responsible for implementing the law on health and safety, is being pressed with increasing frequency for explanations of how risk issues are addressed, both in general and in particular circumstances, so that the risks are regarded as tolerable. In this context 'tolerable' does not mean 'acceptable'. It refers instead to a willingness by society as a whole to live with a risk so as to secure certain benefits and in the confidence that the risk is one that is worth taking and that it is being properly controlled. However, it does not imply that the risk will be acceptable to everyone, ie that everyone would agree without reservation to take the risk or have it imposed on them.

13 Providing such an exposition of the risk decision-making process is not an easy task. The process is inherently complex, with a variety of inputs. It has to be workable whilst allowing the use of judgement by the regulator and flexibility for duty holders. At the same time, it must reflect the values of society at large on what risks are unacceptable, tolerable or broadly acceptable. Any informed discussion quickly raises ethical, social, economic and scientific considerations, for example:

- whether certain hazards should be entertained at all;
- how to maximise benefits to society through taking account of advances in scientific knowledge and technology while ensuring that undue burdens with adverse economic and social impact or consequences are not imposed on the regulated;
- how to achieve the necessary trade-offs between benefits to society and ensuring that individuals are adequately protected;
- the need to avoid the imposition of unnecessary restrictions on the freedom of the individual.

14 The reform of the law relating to health and safety at work, set in train by the HSW Act itself, has proceeded over the past 25 years or so by taking such considerations into account. The approach has evolved – and is still evolving – through the formulation of regulations, Approved Codes of Practice and guidance spanning an enormous variety of industrial activity (see Appendix 2 for a fuller discussion of these regulatory tools). The evolution has taken place under many influences which need to be reviewed in order to set the approach in its full context. This review is the subject of Part 2 following, which leads on to a description in Part 3 of the approach to regulation designed to ensure that risks that are taken are tolerable in the sense already described.

Part **2**

Review of developments that have influenced our decision-making approach

Developments and influences

15 The Robens Committee's diagnosis of the issues at stake when regulating for health and safety still holds good, namely that:

- health, safety and welfare at work could not be ensured by an ever-expanding body of legal regulations enforced by an ever-increasing army of inspectors;
- primary responsibility for ensuring health and safety should lie with those who create risks and those who work with them;
- the law should provide a statement of principles and definitions of duties of general application, with regulations setting more specific goals and standards.

16 Though the above diagnosis still underpins our approach for reaching decisions on the management and regulation of risks, the approach has also evolved to take into account developments that have arisen over the past 25 years. There is nowadays a better understanding of how people view risks. Changes have also taken place in the regulatory environment and on the industrial scene. Finally, within a generation, there have been some marked shifts in the preferences, values and expectations of our society. This review examines some of these developments – particularly those which have influenced the decision-making process and criteria described in Part 3.

Advances in knowledge on how people view risks

17 How people view risks and apply value judgements is perhaps the most challenging factor to take into account when developing an approach to the regulation of risk – not least because these views and value judgements are not static but change according to circumstances. Recent studies have shown that as mankind has evolved to cope with the dangers and uncertainty of life, we have all been provided with inbuilt mechanisms for dealing with risk – mechanisms that reflect our personal preferences and the values of the society in which we live.

18 We all recognise that, as an inescapable fact of life, we are surrounded by hazards – all with a potential to give rise to unwanted consequences. Less apparent is that whatever we do, however we occupy our time or even if we 'do nothing', we are taking some kind of risk. Even at home there are myriad risks – we could get hurt, for example, in a house fire or when doing DIY jobs. If we did something else, we would be taking other kinds of risks. Some of the risks we face may be from naturally occurring hazards while others may arise from our lifestyle and are risks we take willingly to secure some wanted benefits, eg flying to go on holiday.

19 Moreover, everyday, consciously or unconsciously, we all view hazards and evaluate their risks to determine which ones we choose to notice, ignore or perhaps do something about. We may take the consequences of some risks for granted and, for others, consider that our own chances of being harmed may be either more or less than the average, depending on the apparent degree of control we have for taking or limiting the risks, eg whether we are more nimble, younger, have better sight and so on.

20 In short, the way we all treat risks depends on our perception of how they relate to us and things we value. It is only fairly recently that social scientists have examined in detail what factors affect people's perception of risk. They have found that there is a wide range of factors. Particularly important for man-made hazards are 'how well the process (giving rise to the hazard) is understood, how equitably the danger is distributed and how well individuals can control their exposure and whether risk is assumed voluntarily'.[6]

21 Other studies on perception of risk have led to a theory which considers that it may be simplistic to believe that it will be possible to derive a quantifiable physical reality that most people will agree represents the 'true' risk from a hazard. This theory argues that the concept of risk is strongly shaped by human minds and cultures. Though it may include the prospect of physical harm, it may include other factors as well, such as ethical and social considerations, and even the degree of trust in the ability of those creating the risk (or in the regulator) in ensuring that adequate preventive and protective measures are in place for controlling the risks. The logical conclusion drawn from the theory is that it is human judgement and values that determine which factors should be defined in terms of risk and actually made subject to analysis.[7,8,9,10]

22 The theory has been used to explain why, for many new hazards, high quality risk assessments by leaders in the field often fail to reassure people. Even using all available data and best science and technology, many risk assessments cannot be undertaken without making a number of assumptions such as the relative values of risks and benefits or even the scope of the study. Parties who do not share the judgmental values implicit in those assumptions may well see the outcome of the exercise as invalid, illegitimate or even not pertinent to the problem – as exemplified by the controversy surrounding the proposal to dispose of the Brent Spar oil platform in the middle of the ocean.

23 Social scientists have also proposed another theory for explaining why risks that are minor in quantitative terms at times produce massive reactions while major risks are often ignored.[11] Their social amplification of risk model suggests that the impact of a particular risk begins with the initial victims and diffuses outward to society at large. In that process, public response to the risk can be amplified or attenuated depending on how the reporting of the risk interacts with psychological, social, cultural, and institutional processes.

24 For example, awareness of the risk of air travel following an airline crash can be amplified by a large volume of information, scientific experts challenging one another, dramatisation of the issue and use by the media of value-laden terminology and images. This perception can then be further amplified or attenuated depending on the effects of such media exposure on the community and society as a whole.

25 These and other studies have established that hazards give rise to concerns which can be put into two broad categories:

- **Individual concerns** or how individuals see the risk from a particular hazard affecting them and things they value personally. This is not surprising since one of the most important questions for individuals incurring a risk is how it affects them, their family and things they value. Though they may be prepared to engage voluntarily in activities that often involve high risks, as a rule they are far less tolerant of risks imposed on them and over which they have little control, unless they consider the risks as negligible. Moreover, though they may be willing to live with a risk that they do not regard as negligible, if it secures them or society certain benefits, they would want such risks to be kept low and clearly controlled.

- **Societal concerns** or the risks or threats from hazards which impact on society and which, if realised, could have adverse repercussions for the institutions responsible for putting in place the provisions and arrangements for protecting people, eg Parliament or the Government of the day. This type of concern is often associated with hazards that give rise to risks which, were they to materialise, could provoke a socio-political response, eg risk of events causing widespread or large scale detriment or the occurrence of multiple fatalities in a single event. Typical examples relate to nuclear power generation, railway travel, or the genetic modification of organisms. Societal concerns due to the occurrence of multiple fatalities in a single event is known as **societal risk**. Societal risk is therefore a subset of societal concerns.

26 Hazards giving rise to societal concerns share a number of common features. They often give rise to risks which could cause multiple fatalities; where it is difficult for people to estimate intuitively the actual threat; where exposure involves vulnerable groups, eg children; where the risks and benefits tend to be unevenly distributed – for example between groups of people with the result that some people bear more of the risks and others less, or through time so that less risk may be borne now and more by some future generation. People are more averse to those risks and in such cases are therefore more likely to insist on stringent Government regulation. The opposite is true for hazards that are familiar, often taken voluntarily for a benefit, and individual in their impact. These do not as a rule give rise to societal concerns. Nevertheless, activities giving rise to such hazards (for example, Bungee jumping) are often regulated to ensure that people are not needlessly put at risk.

27 In addition to the direct societal concerns about the impact of the hazards on those affected, there is also, and importantly, a concern that, in the wake of an event giving rise to such concerns, confidence in the provisions and arrangements in place for protecting people against risks to health and safety, and the institutions responsible for setting out and enforcing these provisions and arrangements, would be undermined, however remote was the chance of the event happening in the first place. The result would be a consequential loss of trust by the public not only in the duty holders with the primary responsibility for

reducing the risk, but also in the regulator and Government – even if current provisions and arrangements were very good. Consideration of how regulation should approach hazards of this kind to safeguard against such undesirable outcomes is intensely political and usually described on a case-by-case basis. A prime consideration is the amount of resources (time, money, etc) that should be devoted to introduce measures to control the hazard, relative to the total detriment suffered by society in the event of the hazard being realised.

Changes in the regulatory environment

28 We explore below some of the marked changes that have taken place in the regulatory environment since Robens.

The internationalisation of regulation

29 The regulation of risk is nowadays increasingly being undertaken at European or international level in the form of legally binding instruments on Member States – such as directives, treaties and conventions adopted in the wake of the creation of new global markets and new technologies. For some of the new risks, like those arising as a result of the release of genetically modified organisms, action will clearly have to be taken at international level to have any effect. Moreover, in other areas the technology is moving so fast that de facto international standards or practices are evolving all the time, eg in ensuring the safe use of computerised systems for controlling plant and machinery. Regulators, industry and pressure groups in many countries are calling for such technologies to be regulated at international level as the only effective way to prescribe appropriate standards.

30 The pressure towards the internationalisation of regulation requires innovative forms of regulatory co-operation which must take into account a host of other factors such as agreements for regulatory harmonisation, mutual recognition of standards and removal of barriers to trade – such co-operation is essential since the legal instruments used for that purpose (eg directives) take precedence over national legislation.

Increased complexity in the regulation of risk

31 Throughout the long history of legislation introduced to eliminate or minimise risks, the first areas to be regulated have always been the most obvious, often requiring little scientific insight for identifying the problem and possible solutions. For example, it was not difficult to realise that controlling airborne dust would reduce the risk of silicosis in miners and that making it mandatory to guard moving parts of machinery would prevent workers from being killed or maimed. In short, dramatic progress towards tackling such problems could be (and was) made without unduly taxing existing scientific knowledge or the state of available technology.

32 However, as the most obvious risks have been tackled, new and less visible hazards have emerged and gained prominence. Typical examples include those arising from technologies such as biotechnology, and processes emitting gases which contribute to global warming

and ozone depletion. One frequent characteristic of these new hazards is that it can be very difficult to define precisely the risks they may give rise to, even when scientific knowledge is pushed to the limit. The processes that may give rise to risks are only partially understood with the result that regulatory decisions must frequently be based on limited data and considerable scientific and technological uncertainties. The control measures required by regulation should reflect the nature of the uncertainties and err on the side of health and safety.

33 Moreover, whereas in the past, agreement about the action necessary could usually be reached on the basis of the degree of risk posed by a particular hazard as assessed by applying theories from natural sciences, engineering, logic and mathematics, this is no longer the case. This approach is no longer sufficient to counter the growing demand that regulation of some risks should take account of the quality (or attributes) of the hazard as distinct from objective assessment of the quantity of risk.

34 It has become a matter of course to request, for example, that taking into account undesirable consequences should include consideration of matters such as distributional or economic equity or ethical considerations[12,13,14] or, for those occupational risks that are often accompanied by secondary environmental risks, whether it is morally right to adopt policies without considering their effects on natural phenomena like the survival of species and the maintenance of ecosystems.[15] In short, the evaluation and management of hazards are evolving to include values that cannot readily be verified by traditional scientific methods. Techniques being produced for taking these values into account are at an early stage of development.

35 This has led to disagreements about the role that risk assessment should play in the regulation of risk – complicating matters still further. It has become a recent fashion by some to campaign against the use of risk assessment in the decision-making process, particularly for risks with widespread consequences. Many of the criticisms voiced about the role of risk assessments are based on mistaken beliefs about how such assessments are undertaken and applied. For example, it is often argued that an approach based on assessment of the risks:

- often underestimates the true impact of a problem overall. For example, a risk assessment is always undertaken for a specific purpose and with a specific population in mind and may therefore ignore risks to another population;
- is used capriciously to legitimise decisions, for example, to allow an unpopular development in one area but not in another;
- can be misused to present a particular problem as being primarily one of risk and could thereby undermine the adoption of a precautionary approach based on anticipating and averting harm;
- is inadequate since it often reduces the characteristics of what is in many instances a complex issue to a single number and is therefore weak in taking into account societal concerns or other important factors such as the degree of trust between regulators and their stakeholders (see paragraph 21).

36 However, the counter view – which we hold – is that there is overwhelming evidence that, properly used, the results of a risk assessment often provide an essential ingredient in reaching decisions on the management of hazards. Depending on the issue, the results of a risk assessment may be expressed in qualitative or quantitative terms, or both. The proper use of risk assessment also requires inter alia that:

- the risk problem is properly framed;
- the nature and limitations of the risk assessment are clearly set out and understood; and
- the results of the risk assessment are used to inform rather than to dictate decisions and are only one of the many factors taken into account in reaching a decision.

Clarification by the Courts on the meaning of risk

37 Arguments on the meaning that duty holders should attach to the concepts of 'hazard' and 'risk' when complying with their legal duties to ensure the health, safety and welfare may have contributed to the disagreements on the role that risk assessment should play in the decision-making process.

38 The concepts of hazard and risk are enshrined in our everyday vocabulary. When people say that they are prepared to take a risk they mean that in taking a particular decision they are willing to incur a chance of adverse consequences happening in the expectation of a probable benefit (ie a positive consequence). Intrinsic in that definition is that 'risk' should reflect both the likelihood that some form of harm may occur and a measure of the consequence. In everyday life though, we are more likely to pay attention to one than the other.

Regina vs Board of Trustees of the Science Museum, 1993

In the above judgement, the Court of Appeal ruled that as far as the use of risk in the HSW Act, section 3 was concerned, this should be interpreted as conveying the 'idea of a possibility of danger'.

'The starting point must be the ordinary meaning of the language of section 3(1). In our judgment the interpretation of the prosecution fits in best with the language of section 3(1). In the context the word 'risks' conveys the idea of the possibility of danger. Indeed, a degree of verbal manipulation is needed to introduce the idea of actual danger which the defendants put forward. The ordinary meaning of the word 'risks' therefore supports the prosecution's interpretation and there is nothing in the language of section 3 or indeed in the context of the Act, which supports a narrowing down of the ordinary meaning. On the contrary the preventive aim of sections 3, 20, 21 and 22 reinforces the construction put forward by the prosecution and adopted by the judge. The adoption of the restrictive interpretations argued for by the defence would make enforcement of section 3(1) and to some extent also of sections 20, 21 and 22 more difficult and would in our judgment result in a substantial emasculation of an essential part of the Act of 1974. The interpretation which renders those statutory provisions effective in their role of protecting public health and safety is to be preferred.

We have not lost sight of the defence submission that we ought to concentrate on the word 'exposed' rather than 'risks' in section 3(1). If the word 'risks' has the meaning which we consider it has, the point disappears. In that event exposure to a possibility of danger is sufficient. The word 'exposed' simply makes clear that the section is concerned with persons potentially affected by the risk... But the word 'exposed' cannot change the meaning of 'risks' from a possibility of danger to actual danger. On the principal points in this case the argument for the defence is really a red herring.'[16]

39 Nevertheless, it has proved useful to HSE to make a conceptual distinction between a hazard and a risk by describing a hazard as the potential for harm arising from an intrinsic property or disposition of something to cause detriment, and risk as the chance that someone or something that is valued will be adversely affected in a stipulated way by the hazard. HSE – as far as the health, safety and welfare of people is concerned – frequently makes use of the above conceptual distinction in its guidance by requiring that hazards be identified, the risks they give rise to are assessed and appropriate control measures introduced to address the risks. This reflects the fact that in most cases it makes sense to take account of the circumstances in which people and management systems interact with the hazard.

40 However, depending on the situation and degree of knowledge, the relative importance of likelihood and consequence in determining control measures may vary. HSE, for example, might attach a different weighting to the likelihood that harm will occur from the weighting attached to the consequences. In some circumstances, particularly where the consequences are particular serious or knowledge of the likelihood is very uncertain, we may choose to concentrate solely on the consequences so that, in effect, we are concerned only with the hazard.

41 However, the use of the latter approach by HSE has been challenged by some – perhaps because the HSW Act[1] makes reference to 'risks' but not 'hazards'. In that respect, a clarification by the Courts on the meaning of 'risks' in the context of the HSW Act is very relevant. The Court of Appeal in Regina vs Board of Trustees of the Science Museum, 1993,[16] ruled that, as far as the use of 'risks' in the HSW Act,1 section 3 was concerned, this word should be interpreted as conveying 'the idea of a possibility of danger'. We would interpret the use of 'risk' in other sections of the Act in the same way.

42 *The implication of this interpretation is that successful management of risk in the workplace must satisfy the premise that anything present in an undertaking which 'presents the possibility of danger' is properly addressed*. Conceptually, HSE will regard anything presenting the possibility of danger as a 'hazard'. As we shall see later, the processes and criteria described in Part 3, which include the use of risk assessment to determine the required control measures, meet this important condition. For example, they ensure that for hazards surmised to have consequences that may be irreversible and deleterious, there is an overriding need to introduce control measures to address the hazards. This is true when, or perhaps especially when, there is considerable uncertainty about the nature of the hazards and the likelihood of them causing harm.

Changes on the industrial scene

Changes in patterns of employment

43 The regulatory environment now has to cope with the increasing trend in industry and elsewhere to outsource work and hence risks, with changes in patterns of employment and with the fragmentation of large companies into autonomous organisations working closely together. For example, there have been dramatic increases in self-employment and home-working; small and medium size firms are now a major force in creating jobs. Moreover, many monolithic organisations have become a series of separate companies, eg the railways now operate as separate companies with different responsibilities for operating the track, the rolling stock and the networks.

Polarisation of approaches between large and small firms

44 Some of these changes have blurred legal responsibilities for occupational health and safety, traditionally placed on those who create the risks or on those best situated to take steps to control the risks. In certain industries it is often no longer easy to determine who may be in such a position. Though case law has in many instances clarified the situation, the fact remains that for many sectors the above factors make it more difficult to co-ordinate the adoption of measures for controlling risks. Many more players are involved, some with little access to expertise. There has in consequence been a growing demand by small firms for a reversion to prescriptive regulation, running counter to the self-regulatory approach – a demand resisted by large firms because they do not face the same problems and are comfortable with the self-regulatory approach. This has resulted in greater emphasis being placed on the need for clarity of the status and content of the guidance element of the architecture of regulation (see Appendix 2).

Changes in the preferences, values and expectations of society

45 The preferences, values and expectations of society have never been static. Current shifts are linked in part to:

- the rapid rise in information technology which nowadays plays an important role in shaping perceptions by making it easier for people to have information on the risks that may affect them and the society (or indeed the planet) in which they live. This explosion in information technology has, for example, resulted in greater awareness of issues such as the Chernobyl accident, the toll of asbestos-related deaths, and the threats to the ozone layer. Unfortunately information about risks is frequently passed on in isolated bits by the mass media and without any critical examination or peer review – often resulting in the public getting confused or in some risks being amplified while others are attenuated;

- the increased pace in exploiting advances in scientific and technological knowledge, which has led to an increased focus on technological risks;
- greater affluence in society. The majority of people in industrialised countries no longer have to struggle at subsistence level. As a consequence, the acceptance of industrial activity to gain increased standards of living is no longer as readily given as when the fight against hunger and poverty overshadowed everything else.

46 These shifts in preferences and values result in:

A growing perception that risks imposed on people should be justified

47 There is a growing propensity to scrutinise benefits brought about by industrial activity against potential undesirable side effects such as the risk of being maimed or killed or of environmental pollution. This is particularly true for risks:

- which could lead to catastrophic consequences;
- where the consequences may be irreversible, eg the release of genetically modified organisms;
- which lead to inequalities because they affect some people more than others, such as those arising from the siting of a chemical plant or a waste disposal facility;
- which could pose a threat to future generations, such as toxic waste.

48 This has already resulted in industry having less discretion on matters on which they previously had considerable freedom to decide which course of action to adopt, eg plans for modifying their plant within their own boundaries, what raw materials and processes they should use, or how the waste generated (or the plant itself at the end of its useful life) should be disposed of.

An increasing reliance by the public on regulators that they trust

49 A heightened perception of risk has been accompanied by a recognition that modern society has evolved in such a way that it is virtually no longer possible for many of its individual members to:

- avoid risks that they would have preferred not to incur. For example, a person who does not want to travel by car or plane may find their employment or promotion opportunities severely restricted. A person wanting to avoid processed food because of their fear of additives would be able to do so only at great expense or by having a restricted way of life;
- assess for themselves the risks posed by many of the newer hazards arising from industrialisation. This often may be because the risk is not immediately obvious, eg the risks from new hazardous substances which do not cause immediate acute

effects and for which there might be long delays between first exposure and the manifestation of undesirable symptoms. People must rely instead on the opinion of experts. However, the trust placed in expert opinion as a source of reassurance is being continually eroded, particularly for those issues where the mass media seek to expose controversies surrounding such opinions or where the experts have had to frequently reassess the risks arising from certain hazards to take account of new knowledge etc.

50 The net result is that, increasingly, people are having to rely on authoritative bodies such as HSC/E as a source of reassurance about the arrangements in place for protecting people and the impartiality of those arrangements. These bodies for their part are acutely aware that they would not be able to provide reassurance unless they are trusted and that trust will not be bestowed but will have to be earned.

51 This is far from easy. There is often considerable pressure on regulators (and industry) to act quickly and decisively in a climate heavily influenced by perceptions of harm often based on graphic imagery. Regulating slavishly on such occasions is not the answer. Regulating to address concerns, which with hindsight turn out to be no more than transitory shifts in value preferences, carries heavy penalties.

Calls for greater openness and involvement in the decision-making processes

52 Perhaps the most dramatic shift in value preferences of society has been the pressure on regulators for greater clarity and explanation of their approaches to the regulation of risk. This is reflected in the broadly stated principles of good regulation published by the Better Regulation Task Force.[17] These require:

- the targeting of action: focusing on the most serious risks or where the hazards need greater controls;
- consistency: adopting a similar approach in similar circumstances to achieve similar ends;
- proportionality: requiring action that is commensurate to the risks;
- transparency: being open on how decisions were arrived at and what their implications are; and
- accountability: making clear, for all to see, who are accountable when things go wrong.

53 This need for clarity and explanation is entirely consistent with the Robens Committee's conclusion that real progress on health and safety is not possible without the agreement of those affected and the co-operation and commitment of those playing a role in implementing decisions.

54 Though all the developments described in this part have influenced our approach, the following have been particularly important:

- the need for the meaning of 'risk' to encompass more than physical harm by taking into account other factors such as ethical, economic and social considerations (paragraphs 17-27);
- clarification by the Courts on the meaning of 'risk' in the HSW Act which implies that approaches for managing risks must ensure that hazards present are properly addressed (paragraphs 37-42); and
- the need to explain how we apply the principles at paragraph 52 above.

55 The rest of this document sets out how we have taken these developments on board, building on our previous approach.

Part 3

Approach to reaching decisions on risk

System for informing and reaching decisions

56 In this part we build upon the developments described in the review in Part 2 to explain the approach that HSE adopts for reaching decisions on the degree and form of regulatory control of risk from occupational hazards. This includes both the system used for informing and reaching decisions and the criteria and philosophy adopted for deciding on what risks are unacceptable, tolerable or broadly acceptable.

57 Many systems have been developed for informing and reaching decisions, and some particularly pertinent to health and safety have been described.[18] The stages below characterise the system, governed by the principles set out in paragraph 52, that has evolved in HSE in the course of undertaking its own statutory responsibilities and in advising and assisting HSC, for example in implementing policies on modernising health and safety legislation.

58 The stages are:

- Stage 1: Deciding whether the issue is primarily one for HSC/E;
- Stage 2: Defining and characterising the issue;
- Stage 3: Examining the options available for addressing the issue, and their merits;
- Stage 4: Adopting a particular course of action for addressing the issue efficiently and in good time, informed by the findings of the second and third points above and in the expectation that as far as possible it will be supported by stakeholders;
- Stage 5: Implementing the decisions;
- Stage 6: Evaluating the effectiveness of actions taken and revisiting the decisions and their implementation if necessary.

59 However, it is worth emphasising four points. First, though the stages as listed above give the impression that they are distinct and independent of each other, in practice the boundaries between them are not clear-cut. We usually gather valuable information or perspectives while progressing from one stage to another, often requiring early stages of the process to be revisited. In short we find that going through the stages is an iterative process.

60 Secondly, we involve stakeholders at all stages in the above process with the aim of reaching a wider consensus. However, we are conscious that HSC must take, or propose to

Ministers, final decisions where consensus is not possible, for example, because different stakeholders hold opposite views based on deep-rooted beliefs.

61 Thirdly, as a corollary to the first point, how we proceed through the above stages will not be found in a single document because the process is reflected, for example, in the way we assist HSC and its Advisory Committees to go about their business, the research we commission to better understand the issue, the consultative documents that we publish, the responses to such consultation, and discussions that take place with our stakeholders, both formal and informal.

62 Finally, the system describes our current arrangements but some caution is necessary for those looking for their universal application in our past, present and future decisions. Because the system was developed over time, previous regulatory decisions may not be in full accord with them. Moreover, there are often many constraints which prevent the system from being applied fully. For example, as explained in Appendix 2, most health and safety at work legislation originates from the EC in the form of directives and their transposition may require, for example, regulations where otherwise we would use an Approved Code of Practice. Furthermore, the arrangements are also applied proportionately and with discretion. There may be times when the need to act quickly may circumvent some of the stages, and there may not be any need to go through all the stages if information and knowledge from past decisions can be transposed to inform new decisions.

63 We examine, in further detail below, what is involved at each stage.

Stage 1: Deciding whether the issue is one for HSC/E

64 The scope of the HSW Act is very wide and it will usually be self-evident that an issue or subject of concern is primarily one of occupational health, safety and welfare. These issues or subjects of concern can arise through many ways. The most important are:

- intelligence on new hazards for example from new technologies, or inadequacies in existing arrangements to cope with change, for example, in the pattern of employment;
- pressure of events and experience in terms of statistics of accidents and ill health and reports of investigations into particular incidents;
- public perceptions that there is a problem to be addressed;
- feedback that existing arrangements are not fit for purpose, for example in imposing unnecessary burdens on duty holders;
- political moves in Europe or internationally to which we have to respond.

65 It must always be borne in mind that the objectives of the HSW Act include not only the securing of the health, safety and welfare of people at work but also the protection of people not at work against risks to their health and safety arising out of work activities. The wide scope of the Act, together with its wide-ranging enabling powers to make regulations, often result in pressure on HSC/E to take the lead in protecting the public, because of the workability and effectiveness of the arrangements that can be put in place under health and safety legislation and/or its enforcement. Moreover, similar pressure may arise from the practical consideration that other institutions with relevant powers may not exist within the Government machine.

66 Such considerations have arisen particularly in the case of activities with minimal involvement of employees but with the potential to cause harm to the public and where the relevance of health and safety 'at work' legislation may not be obvious. Typical examples include golf courses, horse-riding establishments and pop concerts.

67 The wide scope of the HSW Act and its considerable enabling powers to make regulations have resulted in two other effects. Firstly, many of its provisions and regulations made under the Act overlap with other legislation which is the responsibility of other Government Departments. As a general rule, HSC/E wish to avoid duplication with other enforcing authorities and, where policy areas overlap, there are often demarcation agreements between HSE and other Departments on respective responsibilities covering many areas of potential risks to the public. In many areas of overlap, agreement has been reached that HSE should not attempt generally to enforce the requirements of sections 2 and 3 of the HSW Act, because public safety will be adequately guaranteed by the enforcement of the other legislation covering the risk in question.

68 Secondly, pressure on HSC/E is at times targeted at issues where health, safety and welfare is not a prime consideration but might be seen as a means of objecting to inequity between those who reap the benefits and those who are put at a detriment of some sort that may include a health and safety component, eg the loss of a visual amenity in the vicinity of a scenic spot or a fall in property values as a result of allowing a major installation, such as an airport, to be developed. In these circumstances, we may advise HSC:

- that public debate and discussion on the distribution and balancing of the benefits and detriments involved should take place in a wider context, and that it would therefore be better for the issue to be addressed and/or regulated through a more appropriate avenue in the political and democratic system; or

- to consider the issue but only with respect to the matters which are within its powers to consider ie the health, safety and welfare aspects entailed in the particular context. That is, to look at the appropriateness of the measures in place to protect workers and the public from the risks arising from the activity but leave wider aspects – such as whether the activity should be entertained in the first place – to be considered by the political and democratic system as per the first point above. For example, HSE has made it clear that in its consideration of the tolerability of risks from nuclear power stations, it has limited its analysis to the consideration of the safeguards that should be in place and the way they should be exercised, and has left it for Parliament to weigh the benefits of nuclear power against the risks entailed.[2,19]

69 A quite different issue arises when a European directive is enacted under Article 137, the health and safety article of the EC Treaty. It is not always the case that matters covered by an Article 137 directive are interpreted as health and safety matters in Great Britain. Such a question arose when we had to advise HSC on whether the enabling powers of the HSW Act should be used to introduce regulations to implement an EC health and safety directive on working time. We (and HSC) were not convinced that all elements of the directive (eg paid annual leave) were primarily occupational health, safety and welfare issue and agreement was reached with Ministers that the enabling powers of the HSW Act should not be used to implement them.

70 In short, if an issue ends up being regulated under health and safety legislation, it should always be the result of careful consideration of all the factors involved, such as those described above.

Stage 2: Defining and characterising the issue

Defining the issue

71 In this stage we consider how the issue can be framed or described in terms of problems to be tackled and the means for tackling them.

72 For example, the rate of replacement of older rolling stock on the railways is an issue with two quite different dimensions:

- transport policy, regarding the public's willingness to use the system; and
- public safety policy, regarding the safety benefits of modern rolling stock.

The issue could be framed either way, giving rise to quite different problems to be tackled by different arms of the Government regulatory machine.

73 In framing an issue we shall therefore pay particular attention to whether:

- the action to be taken can be efficiently delivered by HSC/E acting within their powers and arrangements as discussed in paragraphs 64-70 above; and
- society at large will regard as valid the whole process that was adopted for reaching the decision on the most appropriate course of action for addressing the issue. This is because, as we have already seen, the way an issue is framed can have a considerable influence on judgements about whether risk is actually the crux of the issue and, if so, the effectiveness of the measures that should be put in place for addressing the risk.

74 Areas of particular contention arise when there is a divergence between public perceptions that there is an issue to be addressed and objective analysis of the associated problems in health and safety terms. There may then be a need for iteration between this stage and the first stage described earlier (paragraphs 64-70). We sometimes issue discussion documents as a means of seeking convergence towards a workable option.

Characterising the issue in terms of risk

75 The framing of the issue may point to it being one where a decision on proportionality of action requires information on the risks. In such cases, we need to characterise the risk quantitatively and qualitatively, to describe how it arises and how it impacts on those affected and society at large. Such information is needed in order to inform later consideration of options for risk reduction.

76 We usually undertake an assessment of the risks to achieve this. Assessing risks involves identifying the hazards associated with the risk issue, ie what in a particular situation could cause harm or damage, and then assessing the likelihood that harm will actually be experienced by a specified population and what the consequences would be.

77 The process of gathering and refining information on risks is underpinned by a great deal of research and the engagement of expertise both within and outside HSE. The systems devoted to establishing sound information and intelligence on risk account for around 25% of HSE's total resources notwithstanding the intelligence gathered by inspectors as part of day-to-day inspection/investigation activities. External expertise is engaged through research, often carried out collaboratively, and through the system of HSC Advisory Committees. The science underpinning HSC/E policies and practices is extensively exposed to the normal scientific process of peer review. There is, in addition, provision in our research commissioning arrangements for ideas generated independently to be considered for funding in order to bring fresh perspectives to bear. All told, the arrangements in place for incorporating science into the characterisation of risk require much deliberative activity between HSE and the science community at large.

78 We would be interested in assessing at this stage the individual risks and then identifying the associated societal concerns generated by the hazards and other issues such as whether a hazard should be entertained at all or should be regulated in particular way. But the extent to which each of these issues is considered in our assessment will depend on the nature and attributes of the hazard as well as the context of our intervention.

79 For example, many hazards in the workplace are well known, familiar, easy for people to gauge the actual threat they give rise to, have no stigma attached to them and would not cause society any significant concern if realised. We are likely in those cases to pay more attention to the level of residual individual risks after measures have been introduced rather than the societal concerns (if any) that they might engender. On the other hand, gauging the extent of the societal concerns caused by a hazard is likely to be a major consideration when considering whether regulations should be introduced for addressing a hazard that is new, unfamiliar and where its realisation would generate a socio-political response.

80 Moreover, in our role as a regulator and with powers of discretion, the assessment of risk that we undertake – for example when we propose options to the HSC for draft regulations – may, according to circumstances, be much broader than the one that we would generally expect a duty holder to undertake in complying with their duty to assess risks, for example, as required under the Management of Health and Safety at Work Regulations 1999.[3] The risk assessment performed under those Regulations would be confined in scope to the conduct of the undertaking and would usually concentrate on:

- looking at the prospect of harm to individuals and in some cases to society but, as far as the latter is concerned, limited to the extent to which HSC/E has stated in regulations, guidance etc how this should be undertaken;
- identifying, in the light of good practice, what needs to be done to comply with the law.

81 On the other hand, the assessments we carry out (at a much earlier stage):

- more often than not, have to probe in depth in order to develop standards of good practice for future application. In this way, good practice established by HSE is based on the risk assessment by HSE, and compliance with that good practice implicitly conforms to a risk-based approach to control;
- could go beyond the confines of the undertaking and look at the impact of our proposed action on society;
- would not necessarily be limited to the identification of control measures but could cover any matter which could be the subject of health and safety regulations as specified in section 15 of, and Schedule 3 to, the HSW Act;
- would in scope cover both individual risks and societal concerns as already mentioned at paragraphs 78-79 above (see also Appendix 3, paragraph 7).

82 Thus, we use a risk assessment essentially as a tool to inform our decisions by assisting in our understanding of the nature and degree of risk and for extrapolating, from available data, our experience of harm, or for representing a large amount of scientific information and judgement as an estimate of the risks. The policy process then couples the scientifically-based judgements about risks with policy considerations about the approach to their control. The latter (sometimes separately described as risk evaluation) includes such considerations as the relative weightings to be attached to likelihood and consequence as discussed in paragraphs 38-40, and the way that public perceptions of the risk should be taken into account.

83 For example, the risk assessment may show that the risks are such that individuals may not be unduly concerned because of the familiarity of the risks etc (see paragraph 79) and/or that the expectation of harm to any one individual is low. Nevertheless, the activity giving rise to the risks may need to be regulated further because of the numbers of people individually affected, and other possible detriments. For example, regulations have been introduced to make the wearing of hard hats compulsory on construction sites.

84 The proper characterisation of the risk is important to the effective application of the preferred risk control hierarchy promoted by HSC/E and the EU. The hierarchy actually covers controls on hazards as well as the resulting risks. At the top of the hierarchy, and consistent with the general duty to secure health and safety, is the consideration of measures or alternatives that will avoid the hazard in the first place. This might involve substitution or the adoption of processes that conform with principles aimed at ensuring that a design is inherently safer. Lower down the hierarchy is the consideration of measures that will reduce the risks, given that there are no viable alternatives to accepting the hazard.

85 An implicit presumption underlying the hierarchy is that it is not the case that any activity can be pursued simply because measures are available to control the risks it entails. This would be particularly true for activities where there are considerable uncertainties in the estimates of the risks attached to them. Indeed, in line with our earlier discussion on the meaning of risk at paragraphs 37-42, the regulation of health and safety is replete with examples where the potential severity of the consequences, rather than the probability of them occurring, is the dominant consideration. This is particularly true for hazards where there is considerable uncertainty on the nature and scale of the risks they give rise to, eg the release of genetically modified organisms. We therefore need to look at uncertainty in more detail.

Inherently safer design

Adoption of the principles of inherently safer design is particularly important where the consequences of plant or system failure are high. HSE will press for the incorporation of inherently safer design features, where these are possible, to reduce the reliance on engineered safety systems or operational procedures, to control risk.

For example, the concept of 'defence in depth', redundancy, diversity and segregation, the provision of multiple barriers and other good practices, as set out in HSE's safety assessment principles for nuclear plant[20], are fundamental to ensuring safety. These apply against a requirement to: firstly, avoid the hazard and maintain safe conditions through inherent and, where appropriate, passive design features; and, secondly, to minimise the sensitivity of the plant to potential faults as far as can be reasonably be achieved, by ensuring the plant response to a fault is as near the top of a hierarchy of: (i) produces no operational response or a move to a safer condition; (ii) passive or engineered safeguards, continuously available, make the plant safe; (iii) active engineered safeguards, brought into service in response to the fault, render the plant safe.

The RBMK type of reactor used at Chernobyl, for example, would not be licensed by HSE's Nuclear Installations Inspectorate for operation in Great Britain. The design of this type of reactor does not satisfy HSE's requirements because, under certain conditions, a change in the condition of the water coolant in the reactor core from liquid to steam could lead to a significant increase in the rate of nuclear fission. Such a change in coolant condition could occur either as a result of a mismatch between the rates of heat generation in the core and heat removal by the coolant, or as a result of a fall in coolant pressure. The increase in nuclear fission would exacerbate the situation, as the resulting rise in reactor power would increase the mismatch between the rates of heat generation and removal, leading to a runaway nuclear reaction. This *inherently unsafe aspect of the design was one of the main factors that led to the infamous accident at Chernobyl in 1986.*

Handling uncertainty

86 The process of assessing risks needs to take account of the possibility of uncertainty. For example the science underpinning the assessment may be complex, ambiguous or incomplete and/or the necessary data may not be available.

87 We must first distinguish between uncertainty and ignorance. The latter refers to a lack of awareness of factors influencing the issue. This is a well-recognised weakness in risk assessment – that the identification of hazards may be incomplete. The measures needed to counteract ignorance are a wide engagement of different disciplines and communities of interest in the characterisation of the issue. Paragraph 77 describes the very broad base of expertise called into play by HSE in undertaking that task. A further measure is to practise openness to the greatest degree possible so that thinking can be exposed to alternative views at an early stage. This is a principal requirement in the guidelines issued by the Office of Science and Technology.[21]

88 Uncertainty itself is a state of knowledge in which, although the factors influencing the issue are identified, the likelihood of any adverse effects or the effects themselves cannot be precisely described. Uncertainty has many manifestations and they affect the approach to its handling. In summary:

- **Knowledge uncertainty** – This arises when knowledge is represented by data based on sparse statistics or subject to random errors in experiments. There are established techniques for representing this kind of uncertainty, for example confidence limits. The effect on a risk assessment is estimated by sensitivity analysis. This provides information relating to the importance of different sources of uncertainty which can then be used to prioritise further research and action, which is the only feasible way to address the uncertainty, though in some cases research may not be technically possible or cost-effective.

- **Modelling uncertainty** – This concerns the validity of the way chosen to represent in mathematical terms, or in an analogue fashion, the process giving rise to the risks. An example is the growth of a crack in the wall of a pressure vessel. The model would postulate the way the growth rate is affected by factors such as the material properties and the stress history to which the vessel is exposed in service. The model will provide prediction of failure in terms of time and the nature of the failure. It will inform intervention strategies such as the material specification, in-service monitoring and mitigation measures. All these factors may be modelled in many ways with the assumptions for each one open to question. The rigour of the peer review process and openness to alternative hypotheses are the main safeguards. However, the most intractable problems arise when it is not practical or physically possible to subject the alternative hypotheses to rigorous testing. In such cases, the exercise of expert judgement is paramount and confidence depends on the procedures adopted for selection of the experts and the management of bias (or appearance of bias).

- **Limited predictability or unpredictability** – There are limits to the predictability of phenomena when the outcomes are very sensitive to the assumed initial conditions. Systems that begin in the same nominal state do not end up in the same final state. Any inaccuracy in determining the actual initial state will limit our ability to predict the future and in some cases the system behaviour will become unpredictable.

Precaution in the face of uncertainty

89 However, our risk assessment and risk management procedures have a number of safeguards to ensure that our approach is inherently precautionary and in line with the precautionary principle. Included though not defined in the EC Treaty, the precautionary principle has been defined, for example, by the United Nations Conference on the Environment and Development (UNCED) in 1992 as: ***'where there are threats of serious or irreversible environmental damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent degradation.'***

90 Thus, the precautionary principle describes the philosophy that should be adopted for addressing hazards subject to high scientific uncertainty, and rules out lack of scientific certainty as a reason for not taking preventive action. Although originally formulated in the context of environmental protection, particularly in connection with 'global' environmental issues (eg climate change, ozone depletion), the precautionary principle has been applied more widely.

91 Our policy is that the precautionary principle should be invoked where:

- there is good reason, based on empirical evidence or plausible causal hypothesis, to believe that serious harm might occur, even if the likelihood of harm is remote; and

- the scientific information gathered at this stage of consequences and likelihood reveals such uncertainty that it is impossible to evaluate the conjectured outcomes with sufficient confidence to move to the next stages of the risk assessment process.

92 Good reason to believe that serious harm might occur could be demonstrated by showing that an activity, product or situation is similar to others which are known to carry a substantial adverse risk; or by adducing a sound theoretical explanation (tested as necessary by peer review) as to how harm might be caused.

An example of a qualitative assessment of risks

Crowd Safety at Pinner Fair

Estimates of risk are often qualitative rather than quantitative, and are frequently based on systematic observation. An example is the assessment of crowd safety risks at an annual fair in Pinner on the north-west outskirts of London.

Pinner Fair was established by Royal Charter in 1337. Each year it attracts about 50 000 people to the central streets of Pinner, where the restricted space contrasts with the increasing size and complexity of modern fairground rides.

In a study in 1993 by HSE, observation of the setting up, running and dismantling of the fair, together with an analysis of the safety management, formed the basis for hazard identification and risk assessment. The hazards included overcrowding during the fair and dismantling rides while crowds were still present. Comparisons were made with standards in codes of practice and guidance, and with good practice for comparable events. Opinions voiced by local residents, the local authority and the police were also taken into account. It was shown that straightforward changes in the organisation and layout of the fair could eliminate some hazards and substantially reduce the risks from others. To prioritise the improvements needed the risks were ranked qualitatively using a five point scale from 'very low' to 'very high'.

The findings of the risk assessment were discussed with interested parties, including the local authority, the emergency services and the Showmen's Guild of Great Britain, who decided to adopt a series of measures to improve crowd safety. HSE evaluated the effectiveness of the action taken in a follow up study in 1994 when significant improvements were already apparent.

Further information: Fairgrounds and amusement parks: guidance on safe practice.[22]

93 Though the precautionary principle is invoked for hazards where, because of the uncertainty involved, it is not possible to apply the conventional techniques of risk assessment to assess the risks involved whatever the circumstances, it is possible in practice, to use such techniques for operationalising the principle. Uncertainty is overcome by constructing credible scenarios on how the hazards could be realised and thereby making assumptions about consequences and likelihood. The credible scenarios can range from a 'most likely' worst case to a 'worst case possible' depending on the degree of uncertainty. For example, by assuming that exposure to a putative carcinogenic chemical will cause cancer the chemical becomes subject to a very stringent control regime. Though such risk assessments made on scenarios are inevitably narrower in scope than a full blown risk assessment, this may not be a serious limitation if the scenarios are carefully chosen to reflect what could happen in reality.

Quantitative risk assessment

As indicated in a previous example, estimates of the likelihood that a hazard will be realised are often qualitative rather than quantitative, and in general duty holders under occupational health and safety legislation adopt authoritative good practice to address the significant hazards arising from their work activities.

Some sectors of industry, however, have used the tool of quantitative risk assessment (QRA) as part of their consideration of the safety of plant and operations. QRA is a powerful tool in showing the relationship between different subsystems and the dependencies within the overall system. QRA is frequently used to estimate the risk from plant, as designed and operated. However, care needs to be taken to avoid numerous pitfalls that can trap the unwary. For example, in estimating the likelihood of an event by looking back at historical accident or incident data, care needs to be taken in selecting:

- *the accident/incident sample – too small a sample or too narrow a scope can mislead; too wide a scope may result in the inclusion of accidents/incidents that developed differently from the event in question;*

- *the time period – too short a period may lead to the omission of representative accidents/incidents; too long a period may again result in the inclusion of accidents/incidents that developed differently from the event in question. Whatever time period is chosen, the assumption of a constant relationship between accident/incidents and time needs to be questioned in the light of changes in technology and in public expectations;*

- *the statistical method – historical accident/incident data may not include the cause, and selective use of data and/or choice of model can result in numerical figures that do not properly reflect actual history.*

The process of undertaking a QRA can lead to a better understanding of the important features contributing to risk and weaknesses in the systems as well as allowing a numerical estimate of the residual risk to be derived. The quality of the modelling and the data will affect the robustness of the numerical estimate, and the uncertainties in it must always be borne in mind when using the estimate in risk management decisions. The use of numerical estimates of risk by themselves can, for several reasons including those above, be misleading and lead to decisions which do not meet adequate levels of safety. In general, qualitative learning and numerical risk estimates from QRA should be combined with other information from engineering and operational analyses in making an overall decision.

94 In addition to invoking the precautionary principle as above there are many other ways in which our approach is inherently precautionary. For example our risk assessment procedures:

- do not take 'absence of evidence of risk' as 'evidence of absence of risk', although they recognise that persistent absence of evidence of risk, notwithstanding appropriate and thorough efforts to find it, may be indicative;

- require that the effects of the assumptions made to cover gaps in knowledge be tested through recognised methods, eg sensitivity analysis;

- build safety factors into the assessment process where appropriate, eg in assessing toxic substances, safety factors are used depending on the quality of data, severity of effect, and whether data from animals or *in vitro* experiments are being extrapolated to humans;

- attach more weight to consequences where a hazard has attributes which makes it likely that it will give rise to societal concerns, such as the potential to affect future generations, or the potential for severe detriment, eg a major explosion in a built-up area;

- make use of comparative risk assessment for novel hazards that bear a similarity with existing hazards, requiring a stringent control regime for reducing risks to tolerable levels.

95 All the above show that assessing risks is far from being a straightforward exercise. At times the risk assessment will be a simple process based on observation and judgement, while at the other extreme it can also require the use of complex techniques such as quantified risk assessment. In practice it cannot be carried out without adopting certain conventions or protocols. We examine some of these at Appendix 1.

Stage 3: Examining the options available and their merits

Identifying options

96 Once the problem has been characterised we then identify the options available for managing the risks. These can range from doing nothing to introducing measures (whether non-regulatory or regulatory) to get rid of the cause of the problem altogether, or to reduce it to one which people are prepared to live with so as to secure certain benefits and in the confidence that the risk is one that is worth taking and that it is being properly controlled.

97 The courses of action available are similarly many and varied, for example:

- providing more information and guidance to duty holders to enable them to fulfil their responsibilities;
- publicity campaigns to create awareness, for example the 'Good Health is Good Business' campaign and the publicity given to the poor maintenance of domestic gas heating installations;
- engaging the assistance of intermediaries in the health and safety system (eg safety representatives, consultants);
- stronger enforcement of existing legal provisions;
- exerting pressure for heavier penalties on transgressors;
- developing the line to be taken in negotiation of European directives to reflect the issue as it manifests itself in Great Britain;
- targeting action on those who should be controlling the risks;
- improving the available knowledge base through research; and
- proposing new measures that are commensurate with the risks to be addressed, eg new law.

98 For example, the following illustrates some of the options that are available for preventing or controlling exposure to a particular substance:

- banning the use of the substance altogether;
- requiring the use of technology to prevent the substance being released into the workplace or the environment;
- introducing new law, eg licensing regimes to limit the exposure of people to the substance while ensuring that they use best practice to prevent accidental exposure to the substance;
- educating/informing the public on the steps they can take to prevent exposure (eg on the need to service gas appliances to prevent carbon monoxide poisoning); or
- doing nothing because the substance does not pose a significant risk at the level at which it is present.

Adopting decisions: setting occupational exposure limits

Occupational exposure limits (OELs) are important risk management tools that regulate the extent of personal exposure (via inhalation) to substances hazardous to health. The procedures for setting OELs illustrate the involvement of the stakeholders in consensus decision-making in an area where risk assessment is complex and where account has to be taken of uncertainty and socio-economic factors. The procedures also illustrate the use of dose as a necessary surrogate for risk and the importance of openness.

Under the framework in the Control of Substances Hazardous to Health Regulations (COSHH), there are two types of OEL – an occupational exposure standard (OES) and a maximum exposure limit (MEL). Both are expressed as airborne concentrations of a hazardous substance averaged over a period of time.

An OES is set at a level at which, based on current scientific knowledge, it is judged that there is minimal risk to the health of the workforce if exposed via inhalation to the substance day after day. MELs are normally set for substances which may cause health effects such as cancer or occupational asthma where it is not possible to identify reliably a threshold of exposure on which to base an OES. MELs are also set for substances for which 'safe' thresholds may be identifiable, but control to these levels is not reasonably practicable.

OESs and MELs are set on the recommendations of the HSC's Advisory Committee on Toxic Substances (ACTS) and its Working Group on the Assessment of Toxic Chemicals (WATCH). The role of WATCH is to consider all the scientific evidence; the role of ACTS is more to take into account socio-economic factors in balancing risks to health against the cost and effort of reducing exposure. Both groups comprise appropriate representatives of the stakeholders, eg employers and employees, together with scientific experts.

The process starts in WATCH which decides for each substance whether an OES can be established, and if so at what level it should be set, using assessment or uncertainty factors to reflect, eg the quality of the data, the nature of the toxic effect and the need to extrapolate from animal data to effects on people. If, however, WATCH decides that a MEL is appropriate, consideration of the level passes to ACTS. ACTS makes recommendations on the basis of the level that can be achieved by application of good occupational hygiene practice, taking into account socio-economic factors (in practice WATCH or ACTS may recommend separate levels for 8 hour time-weighted average and 15 minute reference periods). If the recommendations are endorsed by the Commission, proposals are published for public consultation, together with criteria documents summarising for each substance the toxic effects, typical exposure levels, measurement levels and the basis for the proposed exposure limit – including for a MEL, a cost benefit assessment.

After public consultation the Commission may approve a new OES or a new MEL.

Further information: Health and Safety Executive guidance booklets EH40, Occupational exposure limits[23] *and EH64,* Summary criteria for occupational exposure limits, *both published annually.*[24]

Fairhurst S, '*The uncertainty factor in the setting of occupational exposure standards*'.[25]

99 We can often build on our experience to identify options that are likely to work in certain circumstances. For example, we identify at Appendix 2 the options that should be considered when introducing new regulations or guidance and the order in which they should be examined.

100 In looking at options, we would be particularly interested in examining:

- **possible good practice** for addressing the hazards identified, and evaluating whether it is relevant and sufficient. If specific good practice is not available we would also examine the merits of good practice that applies in comparable circumstances if we believe that this is directly transferable or can be suitably modified to address the hazard;

- **possible constraints attached to a particular option**; for example whether the option is technically feasible; or whether there are legal constraints on its adoption. As shown in Appendix 2, the general principle is that the option adopted will improve or at least maintain standards of health, safety and welfare;

- **any adverse consequences associated with a particular option**. Very often adopting an option for reducing one particular risk of concern may create or increase another type of risk. For example: banning a particular solvent may increase the use of a more hazardous one; reducing airborne concentration of substances in the workplace by exhaust ventilation may increase risk in the community or vice versa. Therefore for each option having adverse consequences we examine the trade-off between reducing the target risk and the increase in other risks. Appendix 3 gives an indication of how far and how deeply this exercise is carried out;

- **how much uncertainty is attached to the issue under consideration** and as a consequence **the precautionary approach** that should be adopted to ensure that decisions reached are in line with the precautionary principle (see paragraphs 89-94). As we shall see later, though HSE adopts a framework (see paragraph 121-127) for reaching decisions which intrinsically ensures that the treatment of uncertainty is biased towards health and safety to take account of uncertainty, this bias reflects a proper judgement of the degree of caution needed in the circumstances of the decision. The framework achieves this by ensuring that, as the degree of uncertainty increases, and depending on certain other characteristics attached to a particular hazard (eg whether the risk, if realised, could result in consequences that are irreversible or could detrimentally affect future generations), there is an increasing shift towards requiring more stringent measures to mitigate the risks. Moreover, in cases where the benefits cannot justify the risks, the framework requires that consideration is given to banning the activity, process or practice giving rise to the hazard;

- **how far certain options should be constrained** so that the problem remains within the boundaries that we have set in Stage one. For example, when considering options for improving health and safety on the railways and in particular whether a railway operator should introduce investments, we cannot consider the question whether the resources could be better spent on the National Health Service as this would be an issue for the Government to address;

- **how far the options succeed in improving (or at least maintaining) standards** in line with section 1(2) of the HSW Act. Though there is a duty on the HSC to adopt this principle when proposing the modernising of legislation predating the HSW Act, the same principle permeates HSC/E's policies and approach to the regulation and management of risks;

- **the costs and benefits** attached to each option by looking at what is required to implement each option and the degree of risk reduction it is likely to achieve. Since this is one of the factors taken into account to inform decisions (the next stage in the process), it is examined in greater detail below;

- **what is the most appropriate regulatory instrument** in the range available to HSC/E (see Appendix 2) for achieving its objectives for managing the risks in question.

Assessment of risk reduction action

101 We sometimes need to carry out formal analyses of costs and risk reduction to help with judgements on the benefits of each option and the costs involved in reducing the risks. These analyses may be of varying sophistication and complexity, and might in some cases include a cost benefit analysis (CBA). CBA is often a useful tool for judging the balance between the benefits of each option and the costs incurred in implementing it. CBA aims to express all relevant costs and benefits in a common currency, usually money. This in principle requires the explicit valuation of the benefit of reducing the risk. However, such a valuation may not always be possible or practicable – in these circumstances we rely on qualitative estimates. And, in any case, we apply common sense when reviewing the results. Moreover, explicit valuations may not always be necessary because:

- as we shall see later, most safety provision for day to day hazards is in terms of the adoption of good practice or the voluntary pursuit of best practice, taking advantage of technological advances; and

- it may be possible to compare the difference in costs from switching from one option to another against the gains so achieved in terms of avoidance of harm.

102 Nevertheless, we do carry out explicit valuations in support of policy proposals that would require duty holders to make major investments in safety measures, or when introducing new regulations.

103 When an option produces the benefit of preventing fatalities, this requires putting a monetary value on achieving a reduction in the risk of death. For example, for the purpose of conducting CBAs, we currently take as a benchmark that the value for preventing a fatality (VPF) is about £1 000 000 (2001 figure). As is made clear in Appendix 3, VPF is **not** the value that society, or the courts, might put on the life of a real person or the compensation appropriate to its loss. This figure derives from the value used by the Department of Transport, Local Government and the Regions (DTLR) for the appraisal of new road schemes. However, we regard higher values as being appropriate for risks for which people appear to have a high aversion (the practical use of the VPF is discussed in Appendix 3).

104 There will of course be many options where potential benefits are not concerned with a reduction in the risk of death, for example avoiding deafness or dermatitis or a major injury. Very often in these cases, we place monetary values on the risk reduction by comparing how society rates the risks of harms such as a major injury relative to the risk of death. In addition, there may be non-monetary benefits of a regulatory option such as improvement in the sense of well-being or security. There may also be potential benefits in terms of not having to take measures, such as food bans, evacuations etc, which otherwise would be needed to reduce the effects on health and safety following an incident.

105 Expected costs for an option may also be non-monetary as well as monetary. Typical examples of monetary costs include those associated with the development and application of technology, training, clean-up etc. Non-monetary costs include loss of things that people value, such as convenience or a reduction in choice for consumers and businesses, for example if a product or process is banned.

106 We give further information on our approach for appraising options at Appendix 3, including the use of the results of CBA for assessing the cost-effectiveness of the options identified. However, as will be clear from the next stage, cost-benefit analysis is only one of a number of factors that are taken into account in deciding whether to pursue any particular course of action.

107 This approach means that the cost for preventing a fatality (CPF) of a particular measure adopted might reasonably be very different from the value of preventing a fatality (VPF) used for the purpose of conducting a cost-benefit analysis (see Appendix 3 for a fuller discussion).

108 Eventually we reach a point where we have to make a judgement about whether enough information has been collected and analysed to enable us to proceed to the next stage. This avoids us falling into a mode known as 'paralysis by analysis' where the need for additional information is used as an excuse to avoid or postpone the adoption of a decision.

Stage 4: Adopting decisions

109 This is the stage where we review all the information gathered in the previous stage with a view to selecting the most appropriate option for managing the risks. The key to success depends to a large extent on ensuring as far as possible that interested parties are content with the process for reaching decisions and, hopefully, also with the decisions themselves. They will have to be satisfied, for example, about:

- the way uncertainty has been addressed, the plausibility of the assumptions made; and
- how other relevant factors such as economic, technological and political considerations have been integrated in the decision-making process.

110 Meeting these conditions is not always easy to achieve, particularly when parties have opposing opinions based on differences in fundamental values or confine themselves to a single issue. Nevertheless, we tackle the first condition by:

- finding out and focusing on the uncertainties that matter;
- explaining why a particular method was chosen, in preference to others, for estimating the risks; and finally
- being open on the science, assumptions and other critical inputs that have contributed to the value or judgement obtained from the risk assessment exercise.

111 Addressing the second condition above (ie how economic, technological and political considerations have been integrated in the decision-making process) is more difficult. Success lies in adopting decisions which most accurately reflect the ethical and value preferences of society at large on what risks are unacceptable, tolerable or broadly acceptable, and how far we have been successful in involving stakeholders in the decision-making process. At times, to take account of uncertainty and the need to adopt a precautionary approach, this might require focusing more on the consequences of harm occurring from a hazard than on the likelihood that the hazard will be realised (see paragraphs 37-42).

The importance of societal concerns: Adventure activities

The regulatory controls put in place on adventure activities (eg certain caving, watersport or climbing activities) show how societal factors can sometimes dominate considerations of individual risk and cost benefit.

In 1993 four young people lost their lives in a canoeing tragedy at Lyme Bay. At the request of Ministers, the Health and Safety Commission published a consultative *document (CD) seeking views on proposed new regulations to license commercial providers of certain adventure activities. The proposed controls took the form of a statutory licensing system even though (as the CD noted):*

- *the historic risk of fatalities was low;*
- *formal licensing systems are normally reserved for activities which, if not properly managed, would pose high risks to large numbers of people (eg manufacture and storage of explosives, operation of nuclear installations, or certain work with asbestos).*

Public consultation confirmed the desire for new controls along the lines proposed – a reflection of societal concerns. Such concerns might perhaps be summarised in the view that society expects a very high standard of care of organisations which provide activities that aim to develop young people by enabling them to experience a sense of achievement in overcoming challenges they would not otherwise meet. The Adventure Activities Licensing Regulations came into force in April 1996.[26]

Note: Although made under the Activity Centres (Young Persons' Safety) Act 1995,[27] *the requirements of the 1996 Regulations are enforceable as if they were relevant statutory provisions under the Health and Safety at Work etc Act 1974,*[1] *and the licensing authority has to report annually to the Health and Safety Commission.*

112 We shall examine in more detail later how the criteria that we have developed on the tolerability of risks address these issues.

Stage 5: Implementing the decisions

113 When we have reached a decision on the degree to which a risk should be controlled, we have to decide how the decision can be implemented in practice using the regulatory tools at our disposal, eg recommending new legislation, inviting new guidance or taking enforcement action (see Appendix 2 for a fuller discussion of this process). As explained in paragraphs 7-8, the responsibility for measures for controlling a risk will usually fall on the person who creates it or who is in a position to do something about preventing or minimising it.

114 When constructing the regulatory tool we apply, our approach:

- is exposed to the checks and balances inherent in HSC's arrangements for dealing with occupational health and safety matters, thus ensuring fundamental principles (eg the strategy and targets set out in the 'Revitalising Health and Safety' programme agreed by the Government and HSC) are not compromised and that societal concerns are taken into account properly;
- involves consulting our stakeholders, and requires communicating effectively the outcome to stakeholders;
- takes place in the context of legal requirements which include the Management of

health and safety at work Regulations (MHSWR)[3,28,29] and so requires those who have to introduce measures for managing risks to:

✦ enlist the co-operation and involvement of those affected and those able to assist, such as safety representatives, by pointing out that this is crucial for the proper management of health and safety. For example, the involvement of safety representatives in health and safety management can help duty holders considerably to fulfil their legal obligations and achieve high standards of health and safety. Moreover, employers are unlikely to achieve the proper control of risks in their workplace without the help of their employees;

✦ introduce procedures that foster a culture disposing everyone involved to give of their best. For example, in the workplace this may mean getting a commitment, at every level of the organisation, to adopt high health and safety standards and work to them. It also calls for the establishment of well-considered and articulated safety policies where responsibilities are properly defined and allocated and organisational arrangements set out to ensure control and promote co-operation, communication and competence;

✦ have a plan for taking action by looking ahead and setting priorities for ensuring that risks requiring most attention are tackled first, based on the risk assessment which they are legally required to undertake under the MHSWR[30] and other specific legislation;

✦ set up a system for monitoring and evaluating progress, eg by identifying potential indicators for evaluating how far the control measures introduced have been successful in addressing the problem;

✦ comply with well-established principles on the hierarchy of measures for the prevention of risks, e.g. eliminating risks, combating the risk at source, generally applying sound engineering practice such as inherently safer design and applying collective protective measures rather than individual protective measures;

- takes account that employees also have duties imposed on them (eg by virtue of section 7 of the HSW Act[1] and Regulation 14 of MHSWR[30]) to:

  ✦ take reasonable care of their own health and safety and of other persons who may be affected by the employees' acts or omissions at work;

  ✦ cooperate with their employers as necessary to enable the latter to comply with their statutory health and safety responsibilities.

Stage 6: Evaluating the effectiveness of action taken

115 Finally, our process for ensuring that risks are properly managed would not be complete without procedures to review our decisions after a suitable interval to establish:

- whether the actions taken to ensure that the risks are adequately controlled resulted in what was intended;

- whether decisions previously reached need to be modified and, if so, how; for example, because levels of protection that were considered at the time to be good practice may no longer be regarded as such as a result of new knowledge, advances in technology or changes in the level of societal concerns;

- how appropriate was the information gathered in the first two stages of the decision-making process to assist decisions for action, eg the methodologies used for the risk assessment and the cost benefit analysis (if prepared), or the assumptions made;
- whether improved knowledge and data would have helped to reach better decisions;
- what lessons could be learned to guide future regulatory decisions, improve the decision-making process and create greater trust between regulators, operators and those affected by, or having an interest in, the risk problem.

116 We regard such evaluations as an ongoing process which we need to plan carefully to ensure, for example, that we can tap the data that we have encouraged risk managers to obtain by suggesting they set up a system for monitoring and evaluating progress (paragraph 114). Since there might be some time before the full impact of risk reduction measures can be monitored, we might first focus on the extent of our success in getting risk managers to introduce appropriate measures before concentrating on the success of the decisions as a whole.

117 The importance of the evaluation stage should not be underestimated. For example, we shall see later that the criteria we adopt for deciding the degree to which risk should be controlled rely heavily on good practice being adopted or alternatively the introduction of measures achieving a similar or better level of protection. Evaluation provides a good opportunity to assess whether such 'established standards of good practice' are out of date. New developments such as better knowledge of the risks involved and advances in technology may indicate that a higher standard would be more appropriate to control the risk.

Criteria for reaching decisions

118 Though all six stages of the decision management system just described are important, getting Stage 4 right (the one concerned with reaching decisions) is crucial. Achieving this will not only help to reach decisions that are likely to be supported and implemented but, because of the iterative process inherent in the health and safety management system, it will also help to get the other stages right as well. Getting it right depends to a large extent on the criteria adopted for deciding whether a risk is unacceptable, tolerable or broadly acceptable. It is, therefore, not surprising that a lot of effort has been spent in developing such criteria.

119 Research analysing the criteria used by regulators in the health, safety and environmental field has shown that, in general, the criteria can be classified according to three 'pure' criteria. Regulators have either used these 'pure' criteria on their own or have used them as building blocks to create new criteria. They are:

- an **equity-based** criterion, which starts with the premise that all individuals have unconditional rights to certain levels of protection. This leads to standards, applicable to all, held to be usually acceptable in normal life, or which refer to some other premise held to establish an expectation of protection. In practice, this often converts into fixing a limit to represent the maximum level of risk above which no individual can be exposed. If the risk estimate derived from the risk assessment is above the limit and further control measures cannot be introduced to reduce the risk, the risk is held to be unacceptable whatever the benefits;

- a **utility-based** criterion which applies to the comparison between the incremental benefits of the measures to prevent the risk of injury or detriment, and the cost of the measures. In other words, the utility-based criterion compares in monetary terms the relevant benefits (eg statistical lives saved, life-years extended) obtained by the adoption of a particular risk prevention measure with the net cost of introducing it, and requires that a particular balance be struck between the two. This balance can be deliberately skewed towards benefits by ensuring that there is gross disproportion between the costs and the benefits;

- a **technology-based** criterion which essentially reflects the idea that a satisfactory level of risk prevention is attained when 'state of the art' control measures (technological, managerial, organisational) are employed to control risks whatever the circumstances.

120 Though there are many circumstances where these criteria work well on their own, their universal application has been found wanting. For example, it has been argued that:

- an equity-based criterion may often, in practice, require taking decisions on worst case scenarios bearing little resemblance to reality. In such cases, the decisions reached are inevitably based on procedures which systematically overestimate risks, causing undue alarm and despondency among the public or resulting in benefits achieved at disproportionate costs;

- a utility-based criterion tends to ignore that there are ethical and other considerations than just achieving a balance between costs and benefits. For example, some people believe that certain hazards should not be entertained at all because they are morally unacceptable. At the other extreme, utility-based criteria do not impose an upper bound on risk, whereas we believe that there are risks that society regards as unacceptable because they entail too high a likelihood that harm will actually occur to those exposed or the consequences are too extreme, however small the likelihood of the risk being realised, to countenance exposure to the hazard;

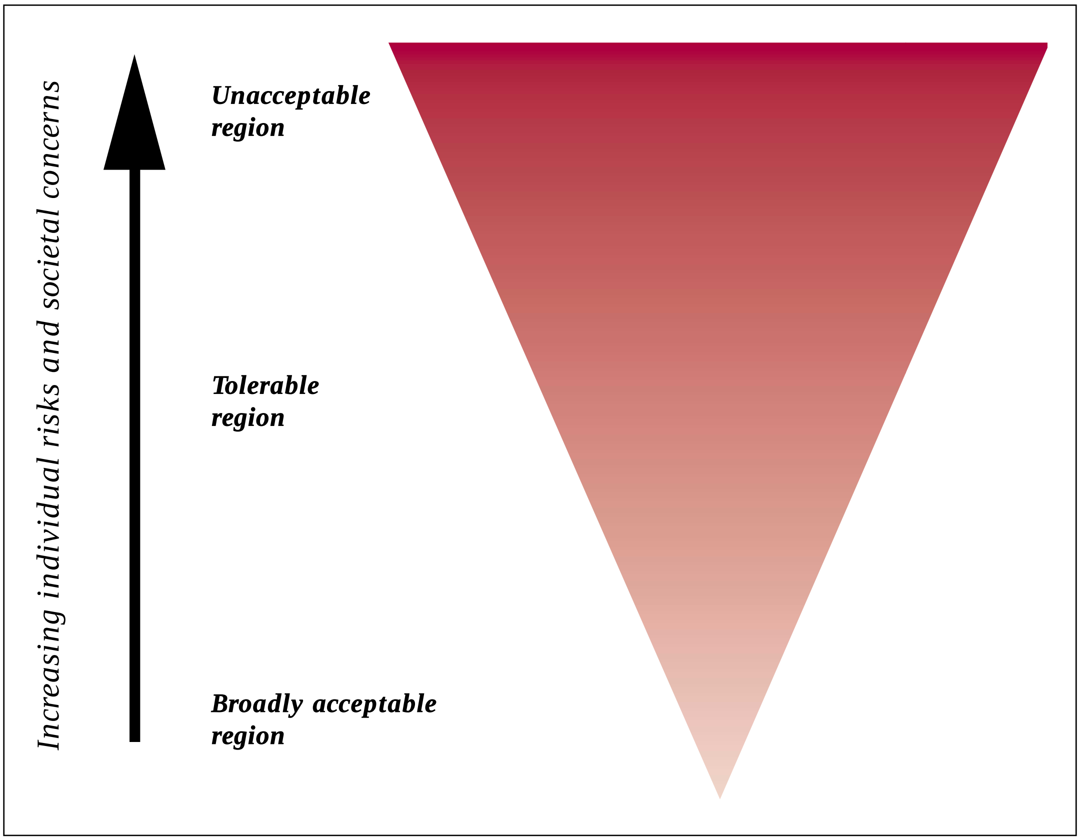
- technology-based criteria often ignore the balance between costs and benefits. They would, for example, require wood furniture manufacturers to adopt the state-of-the-art technology developed for keeping, clinically clean, factories, manufacturing medicines – hardly a realistic proposition.

121 However, as already mentioned above, there is of course no reason why the above three pure criteria should be regarded as mutually exclusive. Indeed, the criteria that HSE has adopted in the form of a framework, known as the tolerability of risk (TOR), accommodate all three criteria. The strength of the framework lies in:

- its ability to capitalise on the advantages of each of the above 'pure criteria' whilst avoiding their disadvantages; and

- the fact that the main tests that are applied under it for reaching decisions on what action needs to be taken are very similar to those people apply in everyday life. As already mentioned, in everyday life there are some risks that people choose to ignore and others that they are not prepared to entertain. But there are also many risks that people are prepared to take by operating a trade-off between the benefits of taking the risks and the precautions we all have to take to mitigate their undesirable effects.

Figure 1: HSE framework for the tolerability of risk



122 The framework is illustrated in Figure 1. The triangle represents increasing level of 'risk' for a particular hazardous activity (measured by the individual risk and societal concerns it engenders) as we move from the bottom of the triangle towards the top. The dark zone at the top represents an unacceptable region. For practical purposes, a particular risk falling into that region is regarded as unacceptable whatever the level of benefits associated with the activity. Any activity or practice giving rise to risks falling in that region would, as a matter of principle, be ruled out unless the activity or practice can be modified to reduce the degree of risk so that it falls in one of the regions below, or there are exceptional reasons for the activity or practice to be retained.

123 The light zone at the bottom, on the other hand, represents a broadly acceptable region. Risks falling into this region are generally regarded as insignificant and adequately controlled. We, as regulators, would not usually require further action to reduce risks unless reasonably practicable measures are available. The levels of risk characterising this region are comparable to those that people regard as insignificant or trivial in their daily lives. They are typical of the risk from activities that are inherently not very hazardous or from hazardous activities that can be, and are, readily controlled to produce very low risks. Nonetheless, we would take into account that duty holders must reduce risks wherever it is reasonably practicable to do so or where the law so requires it.

124 The zone between the unacceptable and broadly acceptable regions is the tolerable region. Risks in that region are typical of the risks from activities that people are prepared to tolerate in order to secure benefits, in the expectation that:

- the nature and level of the risks are properly assessed and the results used properly to determine control measures. The assessment of the risks needs to be based on the best available scientific evidence and, where evidence is lacking, on the best available scientific advice;
- the residual risks are not unduly high and kept as low as reasonably practicable (the ALARP principle – see Appendix 3); and
- the risks are periodically reviewed to ensure that they still meet the ALARP criteria, for example, by ascertaining whether further or new control measures need to be introduced to take into account changes over time, such as new knowledge about the risk or the availability of new techniques for reducing or eliminating risks.

125 Benefits for which people generally tolerate risks typically include employment, lower cost of production, personal convenience or the maintenance of general social infrastructure such as the production of electricity or the maintenance of food or water supplies.

126 As such the framework can be seen as essentially applying an equity-based criterion for risks falling in the upper region, while a utility-based criterion predominates for risks falling in the middle and lower regions and technology-based criteria complement the other criteria in all three regions.

127 It must be stressed that Figure 1 is a conceptual model. Moreover, the factors and processes that ultimately decide whether a risk is unacceptable, tolerable or broadly acceptable are dynamic in nature and are sometimes governed by the particular circumstances, time and environment in which the activity giving rise to the risk takes place. For example, standards change, public expectations change with time, what is unacceptable in one society may be tolerable in another, and what is tolerable may differ in peace or war. Nevertheless, the protocols, procedures and criteria described in this document should ensure that in practice, risks are controlled to such a degree that the residual risk is driven down the tolerable range so that it falls either in the broadly acceptable region or is near the bottom of the tolerable region, in keeping with the duty to ensure health, safety and welfare so far as is reasonable practicable.

Tolerability limits

128 The TOR framework just described can in principle be applied to all hazards. When determining reasonably practicable measures for any particular hazard, whether the option we have chosen to control the risk is good enough or not depends in part on where the boundaries are set between the unacceptable, tolerable or broadly acceptable regions in Figure 1. As will be clear from earlier discussions, the choice will be the outcome of much deliberation and negotiation in the course of policy development, reflecting the value preferences of stakeholders and the practicability of possible solutions.

Tolerability limits for risks entailing fatalities

In practice the actual fatality rate for workers in even the most hazardous industries is normally well below the upper limit of a risk of death to any individual of 1 in 1000 per annum for workers and of 1 in 10 000 per annum for the public who have a risk imposed on them 'in the wider interest of society' (see paragraphs 131-132).

For example, in 1999/00 the annual fatality rates for agriculture, hunting, forestry and fishing (but not sea fishing); construction; and mining and quarrying (including offshore oil and gas) were 1 in 12 984, 1 in 21 438, and 1 in 14 564 respectively. In traditionally less hazardous industries the annual risk of death for workers is lower still; for example in the service sector in 1999/00 it was 1 in 388 565.

Similarly the actual risk of death per annum for the public from work activities is usually very much lower than the figure of 1 in 10 000. For example, during the period 1994/5-1998/9 the annual risk of death to the public from the use of gas (fire, explosion or carbon monoxide poisoning), averaged over the entire population of Great Britain, was 1 in 1 510 000 – in other words below the limit of what is often regarded as broadly acceptable. Gas incidents, however, continue to give rise to societal concern, particularly where the incidents occur because unscrupulous landlords seek to avoid the cost of simple safety checks on their gas heating systems and so put those who rent the accommodation (often young people) at greater risk. In effect such societal concerns override averaged numerical considerations. HSE has responded by firm enforcement action where appropriate, and by targeted publicity emphasising the importance of annual safety checks on gas appliances.

Further Information: Appendix 4 gives other examples of the magnitude of different risks. Further information is available in Health and Safety Statistics *published annually by the Health and Safety Commission.*

129 As a result what is unacceptable, tolerable or broadly acceptable in specific circumstances is often spelled out or implied in legislation, ACOPs, guidance, etc or reflected in what constitutes good practice ie there is no need to set explicit TOR boundaries. However, HSE on the basis of its wealth of experience accumulated over the years in engaging its stakeholders subscribes as a matter of policy to the following indicative criteria, as to where these boundaries lie, for risks in a limited category, namely those entailing the risk of individual or multiple deaths. We must also stress that these criteria are merely guidelines to be interpreted with commonsense and are not intended to be rigid benchmarks to be complied with in all circumstances. They may, for example, need to be adapted to take account of societal concerns or preferences.

Example of good practice enshrined in law

Substances hazardous to health and genetically modified micro-organisms

Some basic principles of good occupational hygiene practice are enshrined in the Control of Substances Hazardous to Health Regulations (COSHH). Control of exposure to substances hazardous to health, for example, must be achieved by:

- *prevention (eg by avoiding use altogether, or by substituting a less hazardous substance), or where this is not reasonably practicable;*
- *control measures (eg engineering controls such as containment or local exhaust ventilation), or where this is not reasonably practicable;*
- *personal protective equipment.*

Sometimes application of good practice is made a specific requirement in law. For example, in setting down standards of human health and environmental safety the Genetically Modified Organisms (Contained Use) Regulations 2000[31]** require application of 'the general principles of good microbiological practice and of good occupational safety and hygiene' (14 well accepted principles are then listed). Societal concerns over the risks from genetically modified micro-organisms are reflected in a high standard of control and, in the developing area of micro-biological safety, a legal requirement which demands application of accepted good practice in step with evolving scientific knowledge and technological developments.*

**These Regulations implement Directive 90/219/EEC, as amended, on the contained use of genetically modified micro-organisms, which includes the same wording.*

Boundary between the 'broadly acceptable' and 'tolerable' regions for risk entailing fatalities

130 HSE believes that an individual risk of death of one in a million per annum for both workers and the public corresponds to a very low level of risk and should be used as a guideline for the boundary between the broadly acceptable and tolerable regions. As is very apparent from Tables 1-4 at Appendix 4, we live in an environment of appreciable risks of various kinds which contribute to a background level of risk – typically a risk of death of one in a hundred per year averaged over a lifetime. A residual risk of one in a million per year is extremely small when compared to this background level of risk. Indeed many activities which people are prepared to accept in their daily lives for the benefits they bring, for example, using gas and electricity, or engaging in air travel, entail or exceed such levels of residual risk.

131 Moreover, many of the activities entailing such a low level of residual risk also bring benefits that contribute to lowering the background level of risks. For example, though electricity kills a number of people every year and entails an individual risk of death in the region of one in a million per annum, it also saves many more lives, eg by providing homes with light and heat, operating lifts, life support machines and through a myriad of other uses. Indeed, it is the combined effect of many activities involving such low levels of residual risks that contributes to the wealth of the nation and leads to improvements in health and longevity.

Boundary between the 'tolerable' and 'unacceptable' regions for risk entailing fatalities

132 We do not have, for this boundary, a criterion for individual risk as widely applicable as the one mentioned above for the boundary between the broadly acceptable and tolerable regions. This is because risks may be unacceptable on grounds of a high level of risk to an exposed individual or because of the repercussions of an activity or event on wider society. Indeed, it would be quite unusual for high levels of individual risk not to engender societal concerns, on equity grounds, for example, as we have already argued. The converse is not, however, true – society can be seized by hazards that pose, on average, quite low levels of risk to any individual but could impact unfairly on vulnerable groups, such as the young or the elderly or particularly susceptible individuals. Furthermore, exposure to an activity may result in a low level of average risk to any one individual but the totality of such risks across the affected population would not be acceptable as judged by the socio-political response to a particular event such as a railway disaster. Nevertheless, in our document on the tolerability of risks in nuclear power stations, we suggested that an individual risk of death of one in a thousand per annum should on its own represent the dividing line between what could be just tolerable for any substantial category of workers for any large part of a working life, and what is unacceptable for any but fairly exceptional groups. For members of the public who have a risk imposed on them 'in the wider interest of society' this limit is judged to be an order of magnitude lower – at 1 in 10 000 per annum.

133 However, these limits rarely bite. As we have already pointed out, hazards that give rise to such levels of individual risks also give rise to societal concerns and the latter often play a far greater role in deciding whether a risk is unacceptable or not. Secondly, these limits were derived for activities most difficult to control and reflect agreements reached at international level. In practice most industries in the UK do much better than that.

Risks giving rise to societal concerns

134 Developing criteria on tolerability of risks for hazards giving rise to societal concerns is difficult. Hazards giving rise to such concerns often involve a wide range of events with a range of possible outcomes. The summing or integration of such risks, or their mutual comparison, may call for the attribution of weighting factors for which, at present, no generally agreed values exist as, for example, the death of a child as opposed to an elderly person, dying from a dreaded cause, eg cancer, or the fear of affecting future generations in an irreversible way.

135 Nevertheless, HSE has adopted the criteria below (some of which are currently under review) for addressing societal concerns arising when there is a risk of multiple fatalities occurring in one single event. These were developed through the use of so-called FN-curves (obtained by plotting the frequency at which such events might kill N or more people, against N). The technique provides a useful means of comparing the impact profiles of man-made accidents with the equivalent profiles for natural disasters with which society has to live. The method is not without its drawbacks but in the absence of much else it has proved a helpful tool if used sensibly.[32] Moreover, the criteria are based on an examination of the levels of risk that society was prepared to tolerate from a major accident affecting the population surrounding the industrial installations at Canvey Island on the Thames. Reports on the risk from the installations at Canvey Island were discussed in Parliament, and (after improvements) the risk was deemed by Ministers to be just tolerable. The limit was subsequently endorsed by the HSC's Advisory Committee on Dangerous Substances in the context of major hazards transport.[33] These criteria are, however, directly applicable only to risks from major industrial installations and may not be valid for very different types of risk such as flooding from a burst dam or crushing from crowds in sports stadia.

136 Thus, where societal concerns arise because of the risk of multiple fatalities occurring in one event from a single major industrial activity*, HSE proposes the following basic criterion for the limit of tolerability, particularly for accidents where there is some choice whether to accept the hazard or not, eg the risk of such an event happening from a major chemical site or complex continuing to operate next to a housing estate. In such circumstances, HSE proposes that the risk of an accident causing the death of 50 people or more in a single event should be regarded as intolerable if the frequency is estimated to be more than one in five thousand per annum. See reference 32 for a discussion of techniques available for extrapolating this criterion to other numbers of casualties and their frequency.

* Here a single major industrial activity means an industrial activity from which risk is assessed as a whole, such as all chemical manufacturing and storage units within the control of one company in one location or within a site boundary, a cross-country pipeline, or a railway line along which dangerous goods are transported.

137 A different situation arises altogether when giving advice to planning authorities in connection with proposed developments in the vicinity of major hazard chemical plants. Since the developments have not yet received planning permission, not allowing them because of the putative societal risks to which would-be occupants would have been exposed by living next to a chemical plant, is relatively inexpensive when compared to the costs entailed in requiring existing developments with similar risks to introduce remedial measures. HSE's criteria for advising against a development because of the societal risks that it may engender are based in the first instance on the level of individual risk per year calculated for a hypothetical person (see Appendix 1) receiving a dangerous dose, or worse, together with certain characteristics of the development.

Occupational exposure limits for substances hazardous to health and the TOR framework

In a previous example we explained that occupational exposure limits (OELs) determine the extent of exposure (by inhalation) of people at work to substances hazardous to health; an OEL can be of two types – an occupational exposure standard (OES) or a maximum exposure limit (MEL).

In principle an OEL ought to be set using data on all the effects on health produced by the substance at different levels of occupational exposure. In practice, however, absence of data and lack of a clear understanding of the biological processes involved means it can be difficult to relate occupational exposure over time to a probability of *specific harm, particularly for chronic effects such as cancer, occupational asthma or dermatitis. (One exception is chrysotile asbestos, for which the relationship between the risk of death from lung cancer and occupational exposure has been estimated.) Alternative approaches are, therefore, normally adopted. Nevertheless, the general TOR framework (Figure 1) still applies, and illustrates the application of the different types of OEL, the role of legislation in sometimes setting out what is intolerable, and the use of good practice in setting limits.*

The conventional approach is to decide whether or not the hazardous properties of the substance have a threshold, and if so to seek to derive from the available data an overall no observed adverse effect level (NOAEL). Using suitable assessment or uncertainty factors (see Example Box on page 37) the NOAEL is then translated into an OES – a level of exposure at which, based on current scientific knowledge, it is judged that there is minimal risk to the health of the workforce. An OES is, however, only set if the level can be met by the application of good practice, and foreseeable excursions above this level are not associated with serious health effects.

In contrast, MELs are normally set for substances for which it is judged that there is no identifiable threshold of exposure and the health effects produced are of serious concern. (A MEL may also be set for substances for which it may be possible to identify a 'no-effect' level, but control to the corresponding exposure level is not reasonably practicable.) A MEL is set at the level which is reasonably practicable to achieve for the work activity where control of exposure is most difficult.

Under the Control of Substances Hazardous to Health Regulations (COSHH), exposure must not exceed the MEL and must be reduced to a level which is as low as is reasonably practicable below the MEL in accordance with good practice. In effect, MELs are at the boundary between the unacceptable and tolerable regions of exposure (Figure 1); exposure above the MEL is deemed intolerable.

On the other hand, control of exposure to an OES represents a level of risk that is close to or even within the broadly acceptable region. The permitted excursions are in the tolerable region provided exposure is restored to the OES as soon as is reasonable practicable (as required by COSHH).

Note: however, that whilst MELs and OESs fit within the framework of Figure 1, the levels at which they are set do not correspond with the numerical limits of risk in paragraphs 129-131. (OELs are, of course, set substance by substance; they do not usually relate to end points of death; and they are not expressed in terms of probability of harm.)

Further Information: The role of occupational exposure limits in the control of workplace exposure to chemicals.[34]

138 Thus in the case of most housing developments, for example, HSE advises against granting planning permission for any significant development where individual risk of death for the hypothetical person is more than 10 in a million per year, and does not advise against granting planning permission on safety grounds for developments where such individual risk is less than 1 in a million per year. (Somewhat different criteria are applied to sensitive developments where those exposed to the risk are more vulnerable, e.g. schools, hospitals or old people's homes, or to industrial or leisure developments, reflecting the different characteristics of the hypothetical person used to assess individual risk).

139 Cases of proposed housing development where the individual risk of death per annum is between 1 and 10 in a million per year are scrutinised more closely, taking into account a more detailed assessment of the individual risk, the area of the development, the number of people involved, their vulnerability and how long they are exposed to the risk. Further information is available on the risk criteria presently applied by HSE in land use planning, including the criteria applied for different categories of development, for developments in the vicinity of major chemical plants, and for development of new plants.[35]

Applying the (generalised) TOR framework

140 Our general thrust in applying the framework is aimed at ensuring that our approach for addressing hazards is inherently precautionary and leads to control regimes that improve or at least maintain standards, while retaining the principles of proportionality, consistency, etc as mentioned in paragraph 52.

141 Thus when we apply the framework to policy formulation, regulatory development and enforcement activities, we:

- take into account that societal concerns are often absent for a wide range of hazards, for example, this is often the case for those hazards that are familiar or where the risks they give rise to are generally accepted as being well controlled. As we have pointed out in paragraph 26, hazards giving rise to societal concerns have a number of well known features and such concerns are often absent for many routinely encountered occupational hazards. This means that when determining where the hazard falls on the TOR triangle (as described in paragraph 122) we can, as a general rule, for most occupational hazards, focus on the individual risks (generally assessed in relation to a hypothetical person using conventional risk assessment techniques – see Appendix 1). We would weigh up the extent (if any) to which societal concerns are taken into account according to the degree that they are pertinent to the circumstances under consideration;

- decide, from the information gathered in going through the decision-making process, how precautionary our approach will be when determining where the individual risk and societal concerns ie on the TOR geometry;

- concentrate on ensuring that duty holders must have in place suitable controls to address all significant hazards arising from their undertakings;

- start with the expectation that those controls should, as a minimum, implement authoritative good practice precautions (or achieve similar standards of prevention/ protection), irrespective of specific risk estimates.

142 In this context we would:

- regard a hazard as significant unless past experience, or going through the decision-making process described earlier, shows the risk from it to be extremely low or negligible when compared to the background level of risk to which people are exposed, and the hazard does not give rise to societal concerns;

- consider as authoritative sources of relevant good practice those enshrined in prescriptive legislation, Approved Codes of Practice and guidance produced by Government. We would also consider including as other sources of good practice, standards produced by Standards-making organisations (eg BS, CEN, CENELEC, ISO, IEC, ICRP) and guidance agreed by a body representing an industrial or occupational sector (eg trade federation, professional institution, sports governing body). Such considerations would take into account that HSE is a repository of information concerning good engineering, managerial and organisational practice, and would also include an assessment of the extent to which these sources had gained general acceptance within the safety movement.

143 The next stage is to distil from the information gathered at Stages 2 (characterising the problem) and 3 (examining options and their merits) on individual risks and societal concerns and, by applying the tests at Appendix 3 and the criteria in paragraphs 118-139 above, decide whether adoption of authoritative good practice precautions is an adequate response to the hazards. Our experience suggests that in most cases adopting good practice ensures that the risks are effectively controlled.

144 One consequence of linking the required control regime to relevant good practice (or measures affording similar levels of protection) is that the control measures so derived apply regardless of the length of exposure. In most circumstances, we would expect control measures to be in place at all times. For example, if good practice requires that accidental contact with the moving parts of a machine should be prevented through the fitting of a guard, the guard will need to be in place, however short the period the machine is being used.

145 There will be, however, cases where existing good practice:

- was not identified as an option at Stage 3. This will be particularly true for hazards that are new or not well studied, or where the circumstances in which people interface with the hazard are untypical or exceptional;

- is found to result in inadequate control of risks.

146 In these circumstances we have to examine (again by adopting the procedure set out at paragraph 58 above) whether any of the other options identified at Stages 2 and 3 would reduce the risks to the degree HSE considers appropriate. If one is found we would advocate its adoption. However, as we go through this iterative process of examining options, there will be occasions when we may find that no option is available for reducing the risks to a tolerable level. This will be the case for risks from activities:

- that are so high and their control inherently so difficult that it is not possible to find reasonable control measures that one could feel confident would work in practice; or

- where it is not possible to allay the societal concerns about the risk. For example, though experts may regard available control measures as adequate for controlling a particular risk, that view may not be shared by society as a whole, as established through existing democratic processes and regulatory mechanisms, either because the majority of people believe that the measures will not always be observed or that they have doubts that the risks should be entertained at all.

Intolerable risks: I

There are relatively few examples in health and safety legislation of processes or activities that have been banned because the risks they entail are so high and their control inherently so difficult that it is not possible to find any control measure that one could feel confident would work in practice (paragraph 146(i)).

The examples below are historical and reflect judgements on the risks from two particularly hazardous substances. The bans, however, have been continued into modern legislation because the risks are still real and, notwithstanding modern control measures, the judgement of the Health and Safety Commission (confirmed in public consultation) remains that, in the light of accepted good practice in using alternatives, the effort required to control the risk would be disproportionate.

The manufacture and use for any purpose of 2-naphthylamine and its salts was banned under the Carcinogenic Substances Regulations 1967[36] *because its combination of physical (sublimation) and chemical (potent carcinogen) properties means that control of exposure is very difficult and the potential ill-health effects severe. The ban was continued under an EC Directive now implemented by the Control of Substances Hazardous to Health Regulations 1999 (COSHH).*[37]

The Control of Lead at Work Regulations 1998 (CLAW)[38] *continue a prohibition on the use of certain glazes in pottery manufacture first introduced more than 40 years ago. The requirement bans any glaze unless it is 'leadless' or 'low solubility' (terms which are defined).*

Historically the use in pottery manufacture of glazes containing raw lead compounds resulted in unacceptably high levels of lead poisoning. The problem was resolved by the development of glazes containing reduced amounts of lead, or by 'fritting' the lead compounds (ie fusing and quenching to form a glass, and then granulating) to produce glazes with much reduced lead bioavailability. Adoption of these glazes became accepted good practice and their use was made a legal requirement.

Levels of exposure of workers to lead in the pottery industry are now relatively low, and there are very few cases where workers have to be suspended from work with lead because their blood lead levels are above prescribed limits.

Intolerable risks: II

Presently there are very few examples in health and safety at work legislation of processes or activities that have been banned outright on the basis of societal concerns (paragraph 146(ii)). One concerns the employment of young people (under 18 years) in certain work activities where there is potential for exposure to high levels of lead.

The Control of Lead at Work Regulations 1998 (CLAW)[36] rationalise and continue certain historical restrictions on the employment of young persons and women of reproductive capacity in specific activities where there is potential for high exposure to lead. Historically these restrictions were imposed mainly on the basis of ethical considerations. The provisions of CLAW expressly provide for a high level of protection for women of reproductive capacity, as the foetus is now known to be at greater risk from exposure to lead than adults. Nevertheless, public consultation on CLAW when still in draft form confirmed that there were continuing societal concerns over the employment of youngsters in such work activities, and the Regulations expressly ban the employment of young persons, as well as women of reproductive capacity, in a list of specified activities involving work in lead smelting and refining, and in lead-acid battery manufacture.

147 We would conclude in such circumstances that we are dealing with activities located in the upper, 'unacceptable' region of the framework. In our experience, activities or processes where the above conditions apply are relatively rare. There may be several reasons for this. First, as noted above, advances in technology mean that most risks can now be controlled. Secondly, we are aware that as regulators we can often allay societal concerns by giving reassurance that risks are being properly controlled through the introduction of progressively more stringent regulatory instruments, such as the use of guidance, ACOPs, or prescriptive legislation, culminating if necessary in the introduction of process regulations such as notification or licensing systems (see Appendix 2).

148 Nevertheless, in situations where Intolerable risks I and II are found to apply, we shall give consideration to banning these activities or processes. For existing risks where banning would be an incomplete solution because the hazard is already widespread, remedial action of some kind has to be undertaken – removal of asbestos prior to demolition of buildings is a case in point.

149 We must stress that we use the above criteria and framework flexibly and with commonsense. For example, addressing certain hazards from existing situations may require that certain activities be undertaken which would fall into the intolerable region for a short period of time, eg when the emergency services are engaged in saving life. Our decision-making process provides the necessary flexibility. Thus in the above example of the emergency services, as we go through the iterative stages of the decision-making process, we should be able to gauge the best option overall for ensuring that measures are introduced so that health and safety standards are not compromised.

Appendix 1

Some of the conventions adopted for undertaking risk assessments

Actual and hypothetical persons

1 Though a risk assessment can be done (and is sometimes done) to assess the risk to an actual person – ie the risk to an individual taking full account of the nature, extent and circumstances in which the exposure arises – there are three problems which limit the usefulness of such an approach for managing risks generally. First, the implications of the case law mentioned in paragraph 41, means that we do not need to wait for people to be actually exposed to a hazard before taking decisions about whether the risk they entail should be incurred at all or the degree to which it should be controlled. Secondly, the approach could be very resource intensive. Exposure to most hazards is seldom confined to one person. It would be necessary to carry out a risk assessment for each person exposed since individuals are affected by risk differently depending, amongst other things, on their physical make up, abilities, age, and the circumstances giving rise to their exposure. Thirdly, it would be very difficult to extract and distil useful information from all the individual assessments.

2 In practice therefore, assessment of the risks to an actual person has rather limited uses such as checking whether a generic measure introduced is suitable for a particular person. What is done instead is to perform the assessment in relation to an hypothetical person. An hypothetical person describes an individual who is in some fixed relation to the hazard, eg the person most exposed to it, or a person living at some fixed point or with some assumed pattern of life. For example, occupational exposure to chemicals, entailing adverse consequences after repeated exposure for long periods, is often controlled by considering the exposure of an hypothetical person who is in good health and works exactly forty hours a week.

3 To ensure that all significant risks for a particular hazard are adequately covered, there will usually have to be a number of hypothetical persons constructed. For example, for each population exposed to the hazard, there will usually be an hypothetical person specifically constructed for determining the control measures necessary to protect that population.

4 Relating assessments to an hypothetical person has several advantages. Persons actually exposed to the risks can compare their own circumstances to those associated with the measures deemed necessary to control the risks found for the hypothetical person, and decide whether they or their family incur a greater or lesser risk and therefore whether the measures in place are adequate in their circumstances. Furthermore, those who have a duty to assess risk and introduce appropriate measures can also reach similar conclusions in respect of those they have to protect. Moreover, the approach allows all relevant factors to be taken into account in the assessment of the risks, for example, human factors where relevant.

5 In addition the concept of hypothetical person has the considerable advantage that it allows the risk of a certain process, activity, situation etc to be assessed meaningfully and independently of

the exposure of persons actually exposed to the risks. This is because in applying the concept, it is assumed that exposure to the hazard is for the time period that was fixed when the credible scenario for the exposure of the hypothetical person was agreed upon.

6 Accordingly, its use:

- limits claims that, in particular circumstances, it is not necessary to introduce control measures for addressing a hazard entailing a significant probability of adverse consequences because the exposure to persons exposed to the hazard is actually low as they interface with the hazard for a short time. Attempts to justify such a claim could be made if, for example, persons interfacing with the hazard were periodically dismissed and replaced with others, thereby ensuring that exposure of any person to the hazard is short;

- deals elegantly with the phenomenon that exposure to many hazards is not uniform but comes in peaks and troughs. This, if present, must be factored in when determining the exposure of any exposed population by creating as necessary one or more hypothetical person to take this into account. For example, the period of exposure of the hypothetical person could be time-weighted and/or more than one hypothetical person could be constructed to deal with the various attributes of the exposure to the hazard.

- helps to improve (or at least maintain) standards by encouraging risks to be assessed (and therefore controlled) in an integrated manner by taking account of the way people interface with the hazard giving rise to the risk. A particular hazard might pose a risk of immediate traumatic injury and/or long-term health effects and affect the various population exposed differently, (eg pregnant women as opposed to male workers). A particular work activity might give rise to a number of hazards which could occur at different stages of the activity. Hazards might arise as a direct consequence of the work activity or incidentally to it (eg traffic at road works). The same hazard may be found in the different locations of a duty-holder's undertaking (eg hazards occurring on the railway system). There will usually be a need for more than one hypothetical person to be constructed to capture all these factors when assessing risks.

Hypothetical persons in the assessment of risk from nuclear plants

The procedures for assessing risks from nuclear plants illustrate how careful use of the concept of 'hypothetical persons' can reduce uncertainty and increase confidence in the outcome of the assessment.

When establishing the radiation risk to those outside a nuclear site three different hypothetical persons are used to ensure that the control measures built into the plant and incorporated in its operational procedures cater both for normal operation and for all reasonably foreseeable faults and accidents. To ensure that any calculations do not underestimate the risk, these hypothetical persons are assumed to have lifestyles that would result in the highest realistically conceivable doses from exposure to:

- *direct radiation from normal operation of the plant itself;*

- *routine emissions to air, water, etc;*

- *direct radiation and intakes of radioactivity in the event of a fault or accident.*

The definition of each hypothetical person would have to be justified in the light of the nature and environment of the plant. For the points above respective examples might be:

- *a child present continuously in the nearest dwelling to the site*
- *someone whose diet includes regular consumption of the greatest plausible quantity of a locally produced food likely to be most affected by the maximum allowable discharges from the plant (see note);*
- *someone who remains at the position of highest dose for the duration of a release of radioactive material occurring in weather conditions that resulted in the greatest exposure.*

Further information: Health and Safety Executive Safety assessment principles for nuclear plants.[39]

Note: In England and Wales discharges to the environment are regulated by the Environment Agency (in Scotland the Scottish Environment Protection Agency); food safety is the responsibility of the Food Standards Agency.

7 Our approach is to provide a 'full picture' of the risks generated by a hazard by creating enough hypothetical persons to enable control measures to be put in place to protect all those exposed from all the undesirable consequences of the hazard, taking account of the different populations exposed and the circumstances of their exposure (see paragraph 3). This technique has the merit of preventing risk being underestimated by making clear whether a generic assessment of the risks on its own is adequate, or whether it should be supplemented by other assessments pertaining to:

- particular groups of persons interacting with the hazard in a certain way or who are particularly vulnerable to it;
- a slice of time;
- particular locations.

8 In practice, when assessing compliance, it will also be necessary to check whether actual persons exposed to the risks fall within the profile of the hypothetical person(s) adopted for the assessment of the risk. If the preventive measures adopted for controlling risks to the hypothetical person are found not to be adequate to protect actual persons, more stringent measures may need to be introduced.

Standards

9 The results of assessments done in relation to hypothetical persons are also used for the adoption of standards. Standards can be regarded as generic control measures that must be applied to eliminate or reduce the risks for a particular hazard. The scope of the standard is set by specifying the circumstances in which the hazards give rise to the risk. One feature of using standards is that once adopted they may be regarded as applying to the hazard rather than to the risk in the sense that they are applied to control risks whatever the circumstances, for example, however short the actual exposure to the hazard.

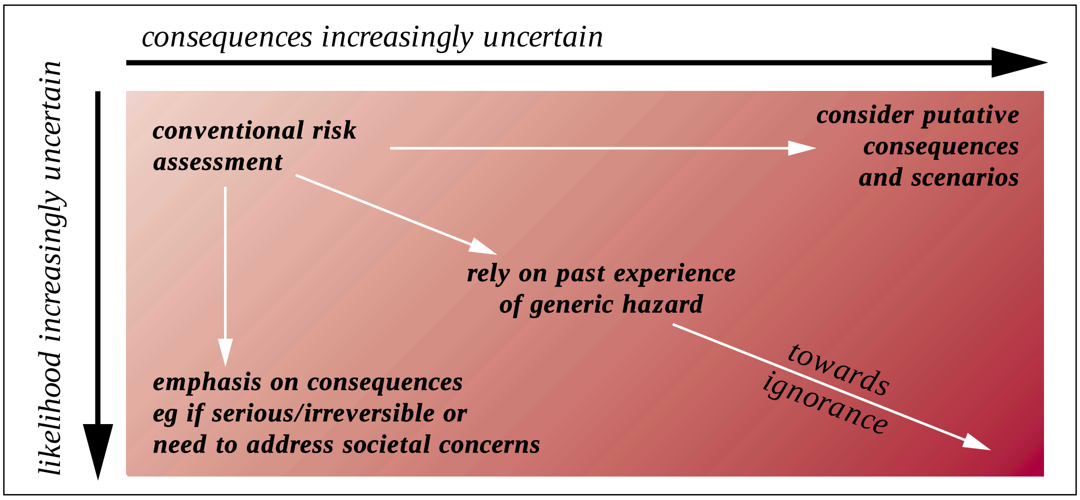
Procedures for handling uncertainty

10 The procedures adopted for handling uncertainty are illustrated in Figure 2. The vertical axis represents increasing uncertainty in the likelihood that the harmful consequences of a particular event will be realised, while the horizontal axis represents increasing uncertainty in the consequences attached to the particular event.

11 At the upper left hand corner, a risk assessment can be undertaken with assumptions whose robustness can be tested by a variety of methods. However, as one moves along the axes increasingly assumptions are made that are precautionary in nature and which cannot be tested.

12 For example, at the bottom of the vertical axis where there is a high degree of uncertainty about likelihood, it is assumed that the event will be realised by focusing solely on the consequences, while on the far right of the horizontal axis, where there is a high degree of uncertainty surrounding the consequences, putative consequences are deliberately assigned to the hazard.

Figure 2: Procedures for tackling uncertainty when assessing risks



13 It is also worth noting that though more information frequently leads to a decrease in uncertainty, it does not necessarily change the probability of an event. For example, though frequent inspections of a critical component may reduce the uncertainty regarding the probability of the component failing within a period of time, the inspections do not reduce the probability of the component failing unless action is taken to remedy the situation.

Appendix 2

Identifying and considering options for new regulations, Approved Codes of Practice and guidance

1 When considering a specific risk problem, HSC/E are often confronted with the question as to how they should use the powers conferred on them by the HSW Act to clarify how duty holders should comply with their legal duties under the Act, or to extend those duties in particular cases. In these circumstances, in our role in advising HSC, we need to decide whether the new measure is really necessary and, if it is, what form this should take so that the decisions reached take due account of the framework in Part 3 of this document, the architecture of our health and safety law, and the fact that there may be constraints in pursuing certain options. How we tackle this question is explored below.

Architecture of health and safety law

2 The HSW Act puts a range of regulatory instruments at HSC's disposal in its role as guardian of occupational health, safety and welfare. These include making proposals to the Secretary of State for new legislation, and issuing Approved Codes of Practice (ACOPs) and guidance. The Act also allows for modernising health and safety law according to a particular architecture. Our policy is to ensure that regulations, like the Act itself, should, so far as possible, express general duties, principles and goals with subordinate detail set out in ACOPs and guidance. As such the architecture is designed to keep the need for intervention by the regulator to a minimum.

3 The architecture takes the following form:

- **the general duties** on employers, self-employed persons and others in the HSW Act. They amount to a statutory (criminal law) enactment of common law duties of care. They are comprehensive in coverage – of people, places, activities and other sources of hazard. They are qualified by 'so far as is reasonably practicable' (SFAIRP). An exception is Section 7, under which employees have a duty to 'take reasonable care' of their own and others health and safety;

- **regulations**, some of which clarify particular aspects of the general duties and are mandatory; others may introduce particular requirements for specific hazards, sectors etc. They do not add to the scope of the general duties, but regulations may impose a higher standard of duty ('practicable' or absolute requirements). Of special mention is the Management of Health and Safety at Work Regulations 1999 (MHSWR).[32] These require employers and self-employed people to assess the risks in their undertakings so as to identify the measures they need to have in place to comply with their duties under health and safety law. As such, the assessment provisions of

MHSWR permeate all other workplace health and safety legislation including the general duties in the HSW Act;

- **ACOPs**, which clarify particular aspects of the general duties and regulations, and are HSC's way of spelling out their implications. ACOPs have a special guidance status. If employers are prosecuted for a breach of health and safety law, and it is proved that they have not followed the relevant provisions of the Approved Code of Practice, a court can find them at fault unless they can show that they have complied with the law in some other way. Accordingly, the HSC agreed in 1996, following consultation, that it would limit the use of guidance having the status of an ACOP to cases where four conditions were met. These are when:
  - there is clear evidence of a significant or widespread problem;
  - the overall approach being taken to an area of risk is by amplifying general duties in the HSW Act or preparing goal-setting regulations (see paragraph 4);
  - there is a strong presumption in favour of a particular method or particular methods that can be amplified in an ACOP in support of the general duties or goal setting regulations to give authoritative practical guidance;
  - the alternative is likely to be more prescriptive regulation;

- **guidance**, which is not law but gives advice on measures available and what is good practice.

4 Regulations broadly take three forms:

- **'process' regulations** concerned with what has to be done to manage the control of risks. These include requirements to assess risks, set out management approaches, draw up safety cases, notify hazards, keep records etc. and may include some form of permissioning, eg licensing. Many of the requirements are derived directly from what is implicit in the general duties, eg the need to assess risks. They deal with matters where there is a need to demonstrate that risk is subject to careful, explicit control;

- **goal-setting regulations** which set out the objectives to be achieved but leave considerable freedom on how these objectives are to be met. Goals or targets to be met in such regulations are often qualified by 'reasonable practicability' and thus demand from both regulator and duty holders some matching of response to risk and of cost to benefit;

- **standard-setting regulations** which prescribe what constitutes an appropriate response to a hazard.

5 These forms are not mutually exclusive, ie a set of regulations could contain all three.

Constraints

6 The regulation of health and safety risks from work activities is subject to certain constraints, some voluntary and others which we must take into account. In the latter

category we would include:

- the fact that most health and safety legislation these days originates from the European Union, mainly in the form of European Community directives (some legislation may originate in International Conventions). Once adopted, the UK has to transpose the provisions of the directive into national legislation. Though the framework described in Part 3 of this document will be most useful to inform the line that should be taken in negotiation of directives, compromises reached during the negotiations may result in measures for managing risks which do not fit completely in either the framework or the above architecture. If the enabling provisions of the HSW Act (as is often the case) are subsequently used to implement the directives into UK law, these 'misfits' will inevitably be reflected in the implementing legislation;

- the need, when modernising legislation preceding the HSW Act, to maintain or improve standards of health, safety and welfare.

7 Voluntary constraints include:

- adhering to the general principle that standards of health, safety and welfare should be maintained, even when this is not mandatory, for example, when replacing legislation or guidance introduced after the Act;

- ensuring that, wherever possible, regulatory measures adopted domestically fit as far as possible with the architecture described above.

Hierarchy of options

8 Based on our wealth of experience in applying the framework and while taking account of the above constraints, the following procedure has evolved for identifying options most likely to work for new regulatory measures and the order in which they should be considered:

- reliance on the general duties and the Management of Health and Safety at Work Regulations. These would be judged as sufficient unless:
  - past experience shows enforcement of the above duties does not succeed;
  - there is a high level of uncertainty about what is required;
  - EC Directives (or International Conventions) require more specific or different legislation to be introduced domestically;
  - societal concerns require that some explicit form of action is needed (politically or to allay public fears).

- use of guidance. This may help to deal with some of the above, but could be insufficient if:
  - EC Directives (or International Conventions) require more;
  - the need to address societal concerns requires more;
  - the current compliance record suggests guidance will not be effective, or will leave

too large a gap between average and poor compliance;
✦ statutory regulation is required to ensure a level playing field for the risk creators;
✦ the general view of stakeholders is that guidance alone leaves too much discretion to duty holders and/or HSW Act inspectors, eg in interpreting 'reasonable practicability' and measures necessary to reduce risk 'as low as reasonably practicable' (ALARP).

- ACOPs. These may help to overcome some of the above, whilst still allowing scope for alternative, equally good, ways of controlling hazards and reducing risks. They would be considered particularly effective if:
✦ there is rapidly developing technology offering new ways of achieving good practice;
✦ there is high diversity of circumstance best dealt with by allowing different approaches;
✦ the industry is highly organised, homogeneous and capable of a fair degree of self-regulation;
✦ the ACOP can be used, in effect, to define reasonable practicability (or other legal standard, as appropriate) and hence prevent over-response by industry, over-enthusiasm by enforcers and over-selling by intermediaries – and the converse (under-response etc).

- But an ACOP is likely to be regarded as insufficient if:
✦ the hazard requires an absolute and/or prescribed duty to deal with it;
✦ EC Directives (or International Conventions) allow no alternative approaches;
✦ there is not a sufficiently strong statutory 'peg' on which to hang requirements in an ACOP (since ACOPs are not to be used to introduce higher duties by the back door);
✦ the need to address societal concerns requires more.

- goal-setting regulations. These may help to amplify general duties in ways which overcome most of the above. But these may still be insufficient if:
✦ EC Directives (or International Conventions) require specificity or prescription;
✦ HSC has decided that adequate control of the risk from a particular hazard requires that specific standards have to be met;
✦ a 'level playing field' requires duty holders to do the same thing as well as to achieve the same results;
✦ uncertainty needs to be reduced to the minimum (including allowing minimum discretion to the regulator);
✦ the need to address societal concerns requires more, such as the introduction of process regulations.

- specific or prescriptive regulations. These may be justified to:
✦ deal with manifest hazards and/or those hazards entailing high risks or societal concerns;
✦ deal with new hazards so as to ensure consistency of action;
✦ secure a step-change in behaviour in known areas of bad practice (including changes that will reduce the 'spread' of performance and bring bad performers up to generally acceptable levels);

- define and eliminate uncertainty by providing a generic assessment of risk and a suitable response which can help cut costs;
- secure standardisation and fair competition;
- meet the requirements of EC Directives (or International Conventions);
- allay worker and public concern by transparent measures and accountability;
- cut down duty holders and/or inspectorial discretion;
- ban a specific activity or process in line with the criteria adopted for stage four of the decision-making process.

9 If specific or prescriptive legislation needs to be introduced then process regulations will generally be used as a last resort because they tend to be resource intensive. Nevertheless, this course of action will be adopted if process regulations are found to be the best way of ensuring that adequate measures are put in place for controlling the particular hazard under consideration. Such regulations could require (in ascending order of stringency) the notification of the hazard; the drawing up of safety cases for demonstrating that the risks from the hazard are adequately controlled; or establishing a licensing system that stipulates specific conditions for ensuring health and safety.

Some issues relevant to assessing risk reduction options

1 When deciding how to regulate hazards and their concomitant risks, HSE can consider a broader range of factors than those which the HSW Act and its relevant statutory provisions require duty-holders to take into account when they manage risks at work (see paragraphs 80-95). However, HSE must operate within the framework provided by the HSW Act and the existing case law – it cannot propose a regulatory regime which places requirements on duty-holders to reduce risks at work which does not fit within this legal framework. The framework though is very wide.

2 The enabling powers of the Act to make regulations (section 15) and the subject matter that may be covered in regulations (see Schedule 3) are very broad in scope. Health and safety legislation made under the Act may be absolute or qualified by expressions such as 'practicable' or 'reasonable practicability'. The latter expressions provide duty holders with a defence against a duty. They are therefore used for instances where HSC/E would like duty holders to have such a defence, for example when the lack of the qualification would result in bad law by imposing duties that cannot be fulfilled because absolute safety cannot be guaranteed. Paragraphs 3-9 are a discussion of the implications of case law when regulating through the imposition of duties qualified by the concept of 'reasonable practicability'. Paragraphs 10-22 discuss the factors taken into account by HSE when comparing risks and costs in the context of undertaking a cost benefit analysis before regulating.

Implications of case law on 'reasonable practicability'

3 Because, ultimately, it is a matter for the courts to decide whether or not duty-holders have complied with such duties, considerable attention must be paid to how the courts have interpreted the above qualification. Case law on duties qualified by 'so far as is reasonably practicable' (SFAIRP) makes it clear that the courts will look at all relevant circumstances, on a case by case basis, when reaching decisions on the appropriateness of action taken by duty-holders in meeting this qualification.

4 Of particular importance in the interpretation of SFAIRP is *Edwards v. The National Coal Board (1949)*.[40] This case established that a computation must be made in which the quantum of risk is placed on one scale and the sacrifice, whether in money, time or trouble, involved in the measures necessary to avert the risk is placed in the other; and that, if it be shown that there is a gross disproportion between them, the risk being insignificant in relation to the sacrifice, the person upon whom the duty is laid discharges the burden of proving that compliance was not reasonably practicable.

5 In seeking to apply this case law, when regulating or producing guidance on compliance with duties qualified by all injunctions embodying the concept of 'reasonable practicability' such as SFAIRP, ALARP (as low as reasonably practicable), ALARA (as low as reasonably achievable), HSE believes that such duties have not been complied with if the regime introduced by duty holders to control risks fails the above 'gross disproportion' test. Moreover, HSE believes that in making this compliance assessment, the starting point for determining whether risk has been reduced as low as reasonably practicable, should be the present situation in the duty holder's undertaking. However, in certain circumstances, it will not be possible to assess options in this way. In such situations, the starting point should be an option which is known to be reasonably practicable (such as one which represents existing good practice). Any other options should be considered against that starting point, to determine whether further risk reduction measures are reasonably practicable.

Risks taken into account in regulating

6 HSE would not normally impose duties on duty-holders which required them to consider risks other than those which:

- arise out of reasonably foreseeable events and behaviour. For example, the risk of a well designed, properly built and well maintained building collapsing would not be regarded as a reasonably foreseeable event (unless signs such as subsidence, cracked walls or falling roof tiles suggest otherwise). This is because the risks were considered and taken care of by the building designers, contractors and maintenance engineers and the building is unlikely to collapse unless it is affected by an external event such as a severe earthquake, itself very unlikely. In contrast, the risk of a building collapse during its demolition would be regarded as reasonably foreseeable. However, in some circumstances, we would consider very unlikely risks (ie 'foreseeable' but not 'reasonably foreseeable') because of the extent of the consequences should those risks be realised. For example, it would be proper to consider the effects of a severe earthquake in the case of major hazard industries because it could trigger an even greater catastrophic event;

- are under the control of the duty-holder. This is in line with the regulatory structure provided by the HSW Act, which for example requires employers to ensure the health and safety of their employees and members of the public who may be affected by the conduct of the employers' undertakings. When determining what is reasonably practicable, HSE will take into account that the risks which an employer needs to consider are limited to those present in the conduct of his undertaking and which he is in a position to eliminate or control.
  ✦ For example, a railway operator would not need to consider whether increasing their fares would put more people at greater or less risk overall because they suspect that some people might be inclined to choose to travel by inherently less safe modes of transport (eg using their own motor cars). What determines such choices is very complex and depends on many elements. Though the operators might be able to control one of those elements (the price of their fares), they have no way of

controlling the other elements. Nor for the same reasons would they in practice be able to reach a view on the impact of their proposed fare increases on the level of risk overall. On the other hand it would be quite proper for Government (as opposed to HSC/E) to consider such matters;

- are not trivial or arising from routine activities associated with life in general, unless the work activity compounds those risks, or there is evidence of significant relevance to the particular work activity.

7 In regulating and assessing risks, HSC/E considers both individual risks and societal concerns, including societal risks. Therefore, where hazards give rise to societal concerns, HSC/E may require duty holders to take these into account. Duty holders action on societal concern is limited to instituting the measures set out by HSC/E in the control regimes which are required by regulations enacted to address the hazard concerned, and in associated guidance.

8 Within these constraints, HSE when regulating attaches great importance to risks being assessed in an integrated manner as described at Appendix 1, paragraph 7. Here again, HSE's approach in deciding the control regime that duty holders should adopt would initially be to require the introduction of generic control measures to eliminate or control the risk for the full range of hypothetical persons identified at the risk assessment stage. However, if these are not sufficient to control the risk, HSE will consider whether it is appropriate to require control measures specifically tailored for risks which may occur at particular locations or in a slice of time, or for particular groups.

9 If, due to unusual circumstances, some actual persons exposed to the risks fall outside the profile adopted for the hypothetical person(s) used for assessing the risks (see Appendix 1, paragraphs 3-8), then HSE will expect that the control measures adopted for protecting the hypothetical person(s) are modified by the duty holder to ensure that the actual persons are protected. For example, control measures may need to be adapted to cater for people with disabilities such as colour blindness, if the need to distinguish between colours is a health and safety requirement, or if the employees lack a particular skill that the hypothetical person is assumed to have, such as the ability to read or understand instructions.

Use of cost benefit analysis in the decision-making process

10 As discussed in paragraphs 101-108 cost benefit analysis (CBA) offers a framework, widely used in Government, for comparing the benefits of reducing risks against the costs incurred for a particular option for managing risks. HSE uses CBA to informs its decisions when regulating and managing risks. It does this by expressing all relevant costs and benefits in a common currency – usually money. It is normally undertaken for options falling within the tolerable region in Figure 1. In practice, a CBA cannot be done without the adoption of certain technical conventions. Those used generally by Government have been published in guidance from HM Treasury.[41]

11 The Treasury rules are meant to cater for a wide range of circumstances and as such are inevitably broad brush. We examine below in more detail (but still in general terms) the policy rules that we consider particularly relevant for assessing the relationship between the cost and benefits of occupational health and safety measures.

Valuation of benefits

12 A suitable and sufficient assessment of cost and risk can often be done without the explicit valuation of the benefits, on the basis of common sense judgements while, in other situations, the benefits of reducing risk will need to be valued explicitly. The latter is far from easy because the health and safety of people and their societal concerns are not things that are bought and sold, and yet a monetary value has to be attributed to matters such as the prevention of death, personal injury, pain, grief and suffering.

13 Where the benefit is the prevention of death, the current convention used by HSE, when conducting a CBA is to adopt a benchmark value of about £1 000 000 (2001 prices) for the value of preventing a fatality (VPF).* This is the VPF adopted by the Department of Transport, Local Government and the Regions for the appraisal of road safety measures. It may well be the case that individuals' willingness to pay for risk reduction – measured in aggregate by the VPF – will vary, depending on the particular hazardous situation. Thus, the particular hazard context will need to be borne in mind when a VPF figure is adopted. Currently, HSE takes the view that it is only in the case where death is caused by cancer that people are prepared to pay a premium for the benefit of preventing a fatality and has accordingly adopted a VPF twice that of the roads benchmark figure. Research is planned to assess the validity of this approach.

* VPF is often misunderstood to mean that a value is being placed on a life. This is not the case. It is simply another way of saying what people are prepared to pay to secure a certain averaged risk reduction. A VPF of £1 000 000 corresponds to a reduction in risk of one in a hundred thousand being worth about £10 to an average individual. VPF therefore, is not to be confused with the value society, or the courts, might put on the life of a real person or the compensation appropriate to its loss.

14 Moreover, it is also important to note that when HSC/E regulate, VPF is not the only factor in balancing costs against risks since a CBA informs, but does not determine, the decisions on measures that should be adopted to control the risk. As already explained, the final decision may take into account wider political and equity considerations as to whether costs are grossly disproportionate to benefits.

15 Once a decision has been adopted on the control regime that should be introduced to control the risk, the cost of the measures required can be assessed to derive a value for the 'cost of preventing a fatality' (CPF), by dividing the total final cost by the (putative) total fatalities prevented. Comparison of CPF with VPF may well reveal a difference between the two values.

Discounting of costs and benefits

16 When preparing formal CBAs, it is customary to discount future costs and benefits to reflect the fact that people, on balance, prefer to have benefits now and pay for them later. Thus they value a benefit in the present more highly than the same benefit received some

time in the future. Similarly, a health and safety measure paid for in the present is considered more costly than if it is paid for at some future date. Conventional economic theory is that such preferences are reflected in the rate of interest paid by borrowers or to savers for capital.

17 For most public policy applications, a real rate of return of 6% a year is used currently to discount costs and benefits. This assumes that all monetary costs and benefits are expressed in real terms (constant prices). The value that individuals place on safety benefits tends to increase as living standards improve, so the future values applied to such benefits should be uprated to allow for the impact on well-being of expected growth in average real income. On the basis of past trends and Treasury guidance, HSE regards an uprating factor of 4% a year as appropriate on the benefits side of the comparison.

18 However, when costs and benefits accrue far into the future, the assumptions underlying these discounting conventions may need to be re-examined. Special considerations may be needed for specific cases.

Costs taken into account in regulating

19 HSE adopts the following principles when it make judgements about costs in assessing possible regulatory options:

- the costs to be considered are those which are incurred unavoidably by duty-holders as a result of instituting a health and safety measure. In other words the costs that should be considered are only those which are necessary and sufficient to implement the measures to reduce risk. Where duty holders incur additional costs for other reasons, these should not be counted. So, for example, extra costs incurred by the duty holders adopting 'deluxe' measures where 'standard' ones would serve just as well should be excluded;

- for any particular measure, it will be proper to include the cost of installation, operation, maintenance and the costs due to any consequent productivity losses resulting directly from the introduction of the measure. In general, these should be estimated on the basis of the value of the economic resources involved. This will usually be the same as the financial costs to the duty-holder, but there may be cases where alternative estimation procedures are necessary.

- monetary gains accrued from the introduction of a health and safety measure should be offset against the costs. This is because measures for managing risk often have the effect of reducing costs. Typical examples are the reduction of losses (eg damage to property, lost production) resulting from decrease in accidents or incidence of ill health, and savings made from any productivity gains resulting directly from the introduction of the measure. However, costs should be offset only against those productivity savings which can actually be realised, ie unit cost reductions. The following should not be offset:
  - potential savings/gains, which may depend upon the state of the market, such as

the profits which would result from selling on the increased production made possible through improved productivity;

- gains which would accrue from an improved commercial reputation;
- indirect savings such as those resulting from reduced insurance premiums* or civil damages.
- the ability of the duty holder to afford a control measure is not a legitimate factor in the assessment of costs. This ensures that duty holders are presented with a level playing field.

* In some cases, insurance companies may link reduced premiums directly with the introduction of health and safety measures, in which case the reduction should be used to offset costs.

Comparison of risk against costs

20 In comparing cost against risks HSE, when regulating, will be governed by the principles that:

- there should be a transparent bias on the side of health and safety. For duty holders, the test of 'gross disproportion' implies that, at least, there is a need to err on the side of safety in the computation of health and safety costs and benefits. HSE adopts the same approach when comparing costs and benefits and moreover, the extent of the bias (ie the relationship between action and risk) has to be argued in the light of all the circumstances applying to the case and the precautionary approach that these circumstances warrant (see paragraphs 89-94);

- whenever possible, standards, should be improved or at least maintained.

21 In practice, as noted in paragraphs 140-141, HSE when regulating will consider that normally risk reduction action can be taken using good practice as a baseline – the working assumption being that the appropriate balance between costs and risks was struck when the good practice was formally adopted and the good practice then adopted is not out of date. However, there will be cases where some form of computation between costs and risks will form part of the decision-making process. Typical examples include major investments in safety measures where good practice is not established.

22 Moreover, HSE may decide that certain hazards would be best regulated through a safety case regime requiring an explicit demonstration in the safety case that control measures introduced conform with the ALARP principle. Though HSE expects that this requirement can often be met by just showing that the control measures adopted represent good practice there will, nevertheless, be certain occasions where HSE will expect duty holders to show (not necessarily by a full cost benefit analysis) the comparisons made between the costs of introducing particular options and the risk reduction thereby achieved.

Some statistics for comparing risks from different hazards

1 Comparing the degree and probability of the various risks we run is not an easy task. Different kinds of risks have to be compared in different ways. Some kinds of risk, such as being killed by lightning or in a road accident or by some other violent cause, are borne by large numbers of people or even by all of us all the time, so it is reasonable to give the chance per million per annum, even though some of us would have a better chance than others.

2 However, some kinds of risk need to be compared in a way that takes account of the extent to which the risk is being run. For example, to compare the risks of death from travelling by air, road or rail we need to express it as a proportion of the number of kilometres or the number of journeys travelled.

3 Estimating the annual chance of certain major events occurring also presents difficulties. In Great Britain, estimates of this kind can sometimes be based on direct or historical experience. We know for example how many major fires occur each year and we can expect the same trend to continue, more or less. Sometimes, however, these estimates represent no more than a complex set of expert judgements based on a variety of factors such as the known rate of failure of engineering components. Some others, such as estimating the chance of an aircraft crash represent a scaling down of world experience. As a result, all of them are subject to large margins of error, particularly in translating the probability of accidents occurring in developing countries to more industrialised ones. Moreover, some statistics will be overstated, eg those that depend on engineering judgement because of the caution and pessimism that it is customary to build into such estimates. Others will be understated because, for many hazards, they compare only the chance of immediate death, ignoring that the hazards also carry with them a risk of injury or ill health or of delayed death.

4 Notwithstanding these important reservations, the tables below give some idea of how the different risks we run compare with each other in size and probability.

Examples of large numbers taken from everyday life

- 2 litre bottles of water in a 3 metre-deep, 50 by 20 metre swimming pool (1 500 000).
- Grains in a 500 gram bag of sugar (1 000 000).
- Teaspoons (5 millilitres) of water in a standard bath (0.5 cubic meters) (100 000).

Examples of low probability taken from everyday life

- The probability that the temperature below 500 metres in Great Britain will fall below a certain minimum value in a certain month, based on measurements from 1875 to 1990 (Tornado and Storm Research Organisation, 1996). For example:
  - On any day in September, a minimum temperature of -6 C or lower has occurred on a total of five occasions in five separate years (1942, 1948, 1974, 1975, and 1979), representing an annual probability of 1 in 23.

- The probability of a high-scoring draw at a football match. The statistics reported below are based on data from 10,148 matches from all English League Divisions, for the four seasons in the period 1990-95.
  - A 3-3 draw occurred 118 times, representing a probability of about 1 in 100.
  - A 4-4 draw occurred 11 times, representing a probability of about 1 in 1 000.
  - A 5-5 draw occurred only once, representing a probability of about 1 in 10 000.

- The probability of winning the National Lottery is reported by Camelot in terms of a single lottery ticket matching the main numbers and/or the bonus ball:
  - Match 6 of 6 main numbers (winning the jackpot): 1 in 14 000 000.
  - Match 5 of 6 main numbers and the bonus ball: 1 in 2 300 000.

Average annual risk of death/injury from various causes:

Table 1: Annual risk of death for various United Kingdom age groups based on deaths in 1999 (Annual Abstract of Statistics, 2001/Health Statistics Quarterly – Summer 2001).

Population group	Risk as annual experience	Risk as annual experience per million
Entire population	1 in 97	10 309
Men aged 65-74	1 in 36	27 777
Women aged 65-74	1 in 51	19 607
Men aged 35-44	1 in 637	1 569
Women aged 35-44	1 in 988	1 012
Boys aged 5-14	1 in 6 907	145
Girls aged 5-14	1 in 8 696	115

Table 2: Annual risk of death for various causes averaged over the entire population.

Cause of death	Annual risk	Basis of risk and source
Cancer	1 in 387	England and Wales 1999 (1)
Injury and poisoning	1 in 3 137	UK 1999 (1)
All types of accidents and all other external causes	1 in 4 064	UK 1999 (1)
All forms of road accident	1 in 16 800	UK 1999 (1)
Lung cancer caused by radon in dwellings	1 in 29 000	England 1996 (2)
Gas incident (fire, explosion or carbon monoxide poisoning)	1 in 1 510 000	GB 1994/95-1998/99 (3)
Lightning	1 in 18 700 000	England and Wales 1995-99(4)

(1) Annual Abstracts of Statistics (2001)
(2) National Radiological Protection Board (1996)
(3) Health and Safety Executive (2000)
(4) Office of National Statistics (2001)

Table 3: Annual risk of death from industrial accidents to employees for various industry sectors (Health and Safety Commission, 2001).

Industry sector	Annual risk	Annual risk per million	Basis of risk and source
Fatalities to employees	1 in 125 000	8	GB 1996/97 to 2000/01*
Fatalities to the self-employed	1 in 50 000	20	GB 1996/97 to 2000/01*
Mining and quarrying of energy producing materials	1 in 9 200	109	GB 1996/97 to 2000/01*
Construction	1 in 17 000	59	GB 1996/97 to 2000/01*
Extractive and utility supply industries	1 in 20 000	50	GB 1996/97 to 2000/01*
Agriculture, hunting, forestry and fishing (not sea fishing)	1 in 17 200	58	GB 1996/97 to 2000/01*
Manufacture of basic metals and fabricated metal products	1 in 34 000	29	GB 1996/97 to 2000/01*
Manufacturing industry	1 in 77 000	13	GB 1996/97 to 2000/01*
Manufacture of electrical and optical equipment	1 in 500 000	2	GB 1996/97 to 2000/01*
Service industry	1 in 333 000	3	GB 1996/97 to 2000/01*

Health and Safety Commission, Health & Safety Statistics (1996/97, 1997/98, 1998/99 & 1999/2000) published by HSE Books. Figures used for 2000/2001 are provisional.

Table 4: Average annual risk of injury as a consequence of an activity.

Type of accident	Risk	Basis of risk and source
Fairground accidents	1 in 2 326 000 rides	UK 1996/7-1999/00 (1)
Road accidents	1 in 1 432 000 kilometres travelled	GB 1995/99 (2)
Rail travel accidents	1 in 1 533 000 passenger journeys	GB 1996/97-1999/00 (3)
Burn or scald in the home	1 in 610	UK 1995-99 (4)

(1) Tilson and Butler (2001)
(2) Department of Environment, Transport and the Regions – Transport Statistics (2000)
(3) Health and Safety Executive (2001)
(4) Department of Trade and Industry and Office of National Statistics (2001)

Table 5: Average annual risk of death as a consequence of an activity.

Activity associated with death	Risk	Basis of risk and source
Maternal death in pregnancy (direct or indirect causes)	1 in 8 200 maternities	UK 1994-96 (1)
Surgical anaesthesia	1 in 185 000 operations	GB 1987 (2)
Scuba diving	1 in 200 000 dives	UK 2000/01 (3)
Fairground rides	1 in 834 000 000 rides	UK 1989/90-2000/01 (4)
Rock climbing	1 in 320 000 climbs	England and Wales 1995-2000 (5)
Canoeing	1 in 750 000 outings	UK 1996-99 (6)
Hang-gliding	1 in 116 000 flights	England and Wales 1997-2000 (7)
Rail travel accidents	1 in 43 000 000 passenger journeys	GB 1996/97-1999/00 (8)
Aircraft accidents	1 in 125 000 000 passenger journeys	UK 1991-2000 (9)

(1) NHS Executive (1998)
(2) Lunn and Devlin (1987)
(3) Based on assumption of 3 million dives per year. British Sub-Aqua Club (2001)
(4) Based on estimated 1 billion rides per year. Tilson and Butler (2001)
(5) Based on the assumption that there is a total of 45,000 climbers making an average of 20 climbs per year each. Mountain Rescue Council (2001)
(6) Based on the assumption that there are 100,000 whitewater canoeists making an average of 30 outings per year each. Drownings in the UK, RoSPA (1999)
(7) Based on the assumption that each member makes an average of 50 flights per year. British Hang-gliding and Paragliding Association (2001)
(8) Health and Safety Executive (2001)
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While every effort has been made to ensure the accuracy of the references listed in this publication, their future availability cannot be guaranteed

Glossary of acronyms

ACOP	Approved Code of Practice
ACTS	Advisory Committee on Toxic Substances
ALARA	As Low as Reasonably Achievable
ALARP	As Low as Reasonably Practicable
CBA	Cost Benefit Analysis
CD	Consultative Document
CEN	Comité Européen de Normalisation
CENELEC	Comité Européen de Normalisation Electrotechnique
CLAW	Control of Lead at Work Regulations
COSHH	Control of Substances Hazardous to Health Regulations
CPF	Cost of Preventing a Fatality
EC	European Communities
EU	European Union
HSC	Health and Safety Commission
HSE	Health and Safety Executive
the HSW Act	The Health and Safety at Work etc Act
ICRP	International Commission on Radiological Protection
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
MEL	Maximum Exposure Limit
MHSWR	Management of Health and Safety at Work Regulations
NOAEL	No Observed Adverse Effect Level
OEL	Occupational Exposure Limit
OES	Occupational Exposure Standard
QRA	Quantitative Risk Assessment
RBMK	Reactor Bolshoi Mozjnoct Kanali
SFAIRP	So Far as is Reasonably Practicable
TOR	Tolerability of Risk
VPF	Value for Preventing a Fatality
WATCH	Working Group on the Assessment of Toxic Chemicals

“Reducing Risks, Protecting People”: Index

(Figures in italics refer to boxed examples)

Index to Regulations

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