The London Resort Development Consent Order

BC080001

Environmental Statement
Volume 1: Main Statement

Chapter 13 – Marine ecology and biodiversity

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Planning Act 2008
The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009
Regulation 5(2)(a)
The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017
Regulation 12(1)

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Chapter Thirteen ◆ Marine Ecology and Biodiversity

INTRODUCTION

13.1 This chapter presents an assessment of the likely significant effects of the London Resort on marine ecology receptors (referred to as the 'Proposed Development'). In particular, consideration is given in the assessment to change to water quality and the sediment transport regime, habitat loss and disturbance, underwater noise and vibration, use of artificial light, collision risk, the potential for spread or introduction of non-native species, and accidental pollution events.

13.2 A full description of the Proposed Development for both construction and operational phases are provided in chapter three: *Project Description* (document reference: 6.1.3).

13.3 This chapter details the legislation and policy in place that are relevant to the assessment of potential effects during the construction and operational phases of the Proposed Development, followed by a description of the assessment methodology applied. Details of consultation undertaken in relation to marine ecology and biodiversity are provided in Appendix 13.1: *Marine Ecology and Biodiversity Consultation* (document reference: 6.2.13.1).

13.4 A summary of baseline data available for water quality and marine ecology in the Thames Estuary, in the vicinity of the Kent and Essex Project Sites is provided here with the full baseline provided in Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2). Data were obtained to inform the assessment via a combination of desk-based study and project-specific survey. Effects were assessed for the aquatic ecology receptors, plankton, benthic species/habitats, fish, marine mammals and designated sites. The full details of project-specific surveys are provided in:

- Appendix 13.3: *Saltmarsh Survey Report* (document reference 6.2.13.3);
- Appendix 13.4: *Intertidal Benthic Ecology Survey Report* (document reference 6.2.13.4);
- Appendix 13.5: *Subtidal Benthic Ecology Survey Report* (document reference 6.2.13.5); and
- Appendix 13.6: *Intertidal Fish Ecology Survey Report* (document reference 6.2.13.6).

13.5 This is followed by an assessment of the likely significant effects of the Proposed Development during site preparation and construction works and then once the Proposed Development is complete and operational. Embedded mitigation that is included as part of the design/methods is considered as part of the initial assessment. For any significant effects identified after consideration of any embedded mitigation design, additional

mitigation measures are identified where appropriate to avoid, reduce or offset any potential significant adverse effects. Taking account of the additional mitigation measures, the nature and significance of the likely residual effects are described. The figures supporting this chapter are as follows:

- Figure 13.1: Location of the order limits for the Project Site in relation to River Thames;
- Figure 13.2: Structures associated with the Proposed Development within the marine environment: Option A;
- Figure 13.3. Structures associated with the Proposed Development within the marine environment: Option B;
- Figure 13.4: Structures associated with the Proposed Development within the marine environment: Option C; and
- Figure 13.5: Structures within the Kent Project Site and interaction with intertidal and subtidal habitats.

13.6 A Shadow Habitat Regulations Assessment (HRA) is provided in Appendix 12.4 (document reference: 6.2.12.4), a Water Framework Directive (WFD) report is provided in Appendix 13.7 (document reference: 6.2.13.7) and a Marine Conservation Zone (MCZ) Assessment is provided in Appendix 13.8 (document reference: 6.2.13.8). A draft Biosecurity Plan is also provided in Appendix 13.9 (document reference: 6.2.13.9).

METHODOLOGY AND DATA SOURCES

EIA scoping

13.7 An EIA scoping report was submitted to the Planning Inspectorate on 15th June 2020. This set out the proposed approach to assessing marine ecology and biodiversity in relation to the Proposed Development. The EIA Scoping Opinion was received in July 2020 from the Planning Inspectorate, and further comments were received in August 2020 from other consultees. All comments received from the Planning Inspectorate have been given thorough consideration and have been addressed in the assessment within this ES chapter.

13.8 The 2020 Scoping Opinion comments and responses are summarised in Table 13.1, the full response table is provided in Appendix 13.1: *Marine Ecology and Biodiversity Consultation* (document reference: 6.2.13.1).

Consultation

13.9 A public consultation was held between July and September 2020 (Planning Act 2008,

s.42), which resulted in responses from various stakeholders. A summary of the responses relevant to marine ecology and biodiversity is summarised in Appendix 13.1: *Marine Ecology and Biodiversity Consultation* (document reference: 6.2.13.1):.

Table 13.1. A Summary of the 2020 SOS Comments for the Proposed Development.

Subject	Summary of Inspectorate's Comments	How the response has been addressed
Impacts to plankton	Impacts to plankton are proposed to be scoped out. The Scoping Report does not provide sufficient evidence to allow the Inspectorate to scope this matter out of the assessment.	Plankton have been assessed within the ES assessment at Para 13.53-13.56, 13.170, 13.174, 13.207-13.209, 13.259 & 13.266.
Thermal plume modelling	The Inspectorate considers that thermal plume modelling should be undertaken, in consultation with appropriate bodies, to inform the assessment and should address impacts to migratory fish, both adult and juvenile, that are sensitive to thermal plumes. Modelling results relevant to the assessment of likely significant effects should be provided with the ES.	The Water Source Heat Pump (WSHP) option has been removed from the project and as such no thermal plume modelling has been undertaken.
Wastewater treatment facility and outfall and site-specific water quality monitoring	No details have been provided for the wastewater treatment facility and outfall. These should be provided in the ES and efforts should be made to agree the approach with the relevant consultation bodies. Additionally, efforts should be made to agree the need for any site- specific water monitoring to inform the assessment with relevant consultation bodies. Which may be necessary to inform a robust assessment resulting from the proposed Wastewater Treatment outfall.	The wastewater treatment facility has been assessed within the ES in terms of potential effects of cofferdam construction. The discharge will meet any water quality consenting requirements. The approach has been agreed with the relevant consultation bodies (see chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17, for details).
Surveys	The baseline is based on a number of previous surveys and upcoming surveys. The details (locations, duration, extent etc.) of these surveys/sampling and their results should be provided with the Application; effort should be made to agree the approach to proposed surveys with the relevant consultation bodies and should include seasonal variations. The use of gap analysis should be considered on any data	A literature review and gap analysis was conducted to determine the need for surveys and to inform survey design. Consultation on survey design has been undertaken with the EA. The EA provided comments on the survey design on 24th June 2020 which set out their

Subject	Summary of Inspectorate's Comments	How the response has been addressed
	obtained to support a robust assessment of the effects.	view of the survey points, indicated that they agreed that water quality sampling was not required as their data is sufficient, indicated that chemical sampling of sediments is required for dredging licence applications and noted that the NVC methods for saltmarsh survey may be similar to the EA method. As part of the application for a Wildlife Licence for the survey, the survey design was sent to the MMO and NE. The survey results are provided in the survey reports in Appendices 13.3 – 13.6 and have been summarised in the ES.
Piling	The ES should include details on the extent, method to be used, information on the pile size, number of piles, expected installation duration and timing of any piling works. The ES should assess any potential impacts from piling on receptors where significant effects are likely to occur.	A Rochdale Envelope approach has been applied to the project for all activities as described in ES chapter one: *Introduction* (document reference: 6.1.1). As requested, information relating to the realistic worst case scenario for piling activities (including the parameters stated) has been provided and forms the basis of the assessment for each effect/receptor pathway.
Dredging	The ES should include details on the proposed methods, timing and duration, volume of material to be dredged/disposed of and the location of the works. The ES should assess any potential impacts from dredging on receptors where significant effects are likely to occur.	A Rochdale Envelope approach has been applied and the realistic worst case scenario for dredging has been assessed. The parameters indicated are provided and form the basis of assessment for each

Subject	Summary of Inspectorate's Comments	How the response has been addressed
		effect/receptor pathway.
Jetty	The ES should include details of the jetty in terms of the likely design and material for its construction, types of vessels used and the draft required for their operation. The assessment should specifically address potential impacts to the tentacled lagoon worm from dredging and propeller wash.	A Rochdale Envelope approach has been applied to the project and the realistic worst case scenario for the jetty has been assessed for each effect/receptor pathway. The parameters indicated are provided as part of the assessment and the potential effects on the tentacled lagoon worm are considered in relation to all aspects of the project including dredging (as Option C) and the effects of propeller wash.
Vessel pollution, wash and wave impacts	Construction and operational vessel movements will increase pollution in the marine environment resulting from increased fumes, anti- fouling paint and vessel waves and wash. The Scoping Report only refers to 'accidental pollution events' with regards to impacts during construction and operation and does not include vessel wash and wave impacts on sediment movement and intertidal habitats. The ES should also include an assessment of impacts from increased fumes, anti-fouling paint and vessel waves and wash where significant effects are likely to occur.	These effect pathways are included within the ES Assessment in Paras 13.195, 13.196 & 13.260-13.264
Mitigation Measures	The Scoping Report proposes a number of mitigation measures during construction and operation that could be employed to address significant effects. An effort should be made to agree the approach and need for mitigation measures with the relevant consultation bodies.	Appropriate mitigation measures have been proposed in the ES (Paras 13.267-13.274). Once appropriate mitigation has been agreed as part of the consenting process, specifics in terms of how it will be implemented will be determined in consultation with the relevant conservation bodies.

Subject	Summary of Inspectorate's Comments	How the response has been addressed
Water Framework Directive (WFD) Assessment	A WFD assessment is proposed and will inform the ES in terms of changes to water quality in Thames Middle Transitional waterbody. This will be informed by hydraulic modelling which is proposed in Chapter 16. The ES should cross-refer where Chapters overlap and/or inform other Chapters to aid understanding of the assessments.	Cross-references to other relevant chapters of the ES have been included within the Marine Ecology Chapter.
Cofferdam	The consultation response from the Environment Agency (EA) identifies the potential need for a cofferdam during construction of the outfall structure. Should this be the case, any impacts from the construction, operation and decommissioning of the cofferdam should be assessed in the ES where significant effects are likely to occur.	The WSHP has been removed from the project. The potential need for a cofferdam during installation of outfalls for the wastewater treatment facility and surface water runoff has been assessed.
Shellfish	The ES should assess impacts to shellfish where significant effects are likely to occur.	The effects on shellfish have been considered within the intertidal and subtidal benthic ecology receptors.
Underwater noise modelling	The ES should assess impacts from increased underwater noise on marine ecological receptors. The assessment should be informed by suitable modelling, as necessary, and effort should be made to agree the approach with the relevant consultation bodies.	The underwater noise and vibration assessment is based on likely noise at source levels (in relation to pile size, material and the type of piling) and best practice effects criteria for fish and marine mammals.

Feedback

1.9.1. The 2020 Scoping Opinion also included several comments from consultees in relation to marine ecology (summarised in Table 13.2).

Table 13.2. Excerpts of consultation responses in relation to Marine Ecology in the 2020 Scoping Opinion from the Planning Inspectorate (from Dartford Borough Council, Kent County Council, Environment Agency, Gravesham Borough Council, Marine Management Organisation, Natural England and the Port of London Authority.

Consultee	Response	How the response has been addressed
Dartford Borough Council / Kent County Council	It is not clear within the Marine chapter if additional surveys will be carried out as part of this submission. The only exception to this statement is saltmarsh as the report states the following: *A site-specific survey will be conducted to map the extent of saltmarsh across the Kent Project Site. The survey will determine the distribution of National Vegetation Classification community types across saltmarsh at the Kent Project Site and obtain species percentage cover data for vegetation in each community type.* KCC biodiversity highlight that there is a need to ensure that the survey data used to assess the impacts of the proposed development is appropriate and sufficient to ensure the determining authority can fully understand the ecological interest of the submitted development.	A detailed marine ecology baseline is provided in Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2) and has been supplemented by further surveys. The findings of these surveys have been incorporated into the ES. Details on these additional surveys are provided within Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2) and are summarised in the *Data acquisition methodology* section. The full field reports on these surveys are provided in Appendices 13.3 – 13.6.
Environment Agency	There would be significant benefit to marine and euryhaline fish species, especially juveniles, from the creation of new, functional, saltmarsh areas, so we would support any opportunities to extend these areas. New saltmarsh creation would have a positive benefit for fish populations if sympathetically design in order to promote their use of it.	Noted. New saltmarsh will be created through managed realignment and details are provided in Appendix 12.3: *Ecological Mitigation and Management Framework* (document reference: 6.2.12.3).

Consultee	Response	How the response has been addressed
	We strongly recommend that the abstraction and discharge points for the Water Source Heat Pump (or CHP) be given early consideration in the project programme. This is because their location could materially affect building locations/jetty designs. Especially, as intake screens that will comply with Eel Regulations will need to located in deep, fast flowing water. We still consider it beneficial for the site to conduct water quality sampling at the proposed outfall points during and post construction. Dependent upon outfall and intake structure locations, it may be necessary to consider if coffer dams are to be used and the potential issues associated with dewatering and fish rescues. The impact of the thermal plume and mixing zone will need to be considered in terms of the likely aquatic communities in the vicinity of the outfall.	The WSHP option has been removed from the project and as such no thermal plume modelling has been undertaken.
	We are anticipating changes in particular to EQS MAC that may come through in the coming months. We would encourage the applicant to maintain a dialogue for further guidance on WFD assessment of the marine environment.	Noted. Consultation with the EA has occurred, in particular in relation to hydrodynamic modelling that was used to inform the WFD assessment.
	The EIA needs to consider vessel wash and the wave energies associated with fast moving ferry services operating from the proposed jetties. This should be assessed in terms of impacts upon sediment movements and intertidal areas. Intertidal mudflats and other areas could be adversely affected by the increased vessel movements and the fast moving, high energy wave generated. This impact could be significant.	Noted. The effects of boatwash have been considered in Paragraphs 13.195 & 13.196.
	The EIA should consider the extent, method, timing and duration of any	The effects of proposed dredging have been considered

Consultee	Response	How the response has been addressed
	proposed dredging operations, potential receptors and propose suitable compensation or mitigation measures.	within Option C for backhoe dredging. As yet, details on timing and duration for dredging have not been determined and so a worst-case approach has been taken for the assessment.
	Migratory species such as salmon, sea trout, smelt and eel will need to be specifically considered when scoping/modelling the potential impact of the thermal plume from the Water Source Heat Pump. The thermal plume will need to be modelled and this used to predict likely receptor fish species and impacts. Typically we would ask for half of the river channel to remain unaffected by the thermal plume to allow migratory salmonids to pass upstream. Any potential impact upon the other migratory fish species present should also be considered.	No plume modelling undertaken due to the removal of the WSHP option from the project. Migratory species have been assessed where relevant throughout the ES assessment.
	The limited information regarding the new jetties – in particular the draft and type of vessels being used, and details around Jerry construction (open or closed structures, materials and density of piles) – makes is difficult to assess whether the survey methodology is appropriate or sufficient. We would especially like to know how the jetty survey design is going to take into account the extreme sensitivity to disturbance of the Tentacled Lagoon Worm, *Alkmaria romijni*, from dredging and 'prop wash'.	Clipper ferries will be used for the shuttle service and details of its draught are provided in paragraph 13.188. Additional information on the jetty construction is provided within the ES assessment in paragraphs 13.66 – 13.68.
	Potential for spread of non-native species should also be considered during the construction phase when plant, vessels and machinery will move on and off the site. Maintenance dredging should also be considered in terms of its	Noted and assessed within the ES assessment in paragraphs 13.168 – 13.172 & 13.252 – 13.257.

Consultee	Response	How the response has been addressed
	frequency, as if it is too regular there will be a permanent adverse impact upon the subtidal areas.	
Gravesham Borough Council	Emphasise that an existing transport corridor is being upgraded along the River Thames and it will be necessary to show whether this has significant effects on the marine environment and the communities that abut the river, noting that there are significant residential developments permitted in Gravesham at both Northfleet Embankment West and East (latter under construction)	Noted and has been assessed in the cumulative impact assessment within this ES chapter (paragraphs 13.279-13.310.
Marine Management Organisation	The MMO agree that future intertidal and subtidal surveys (including a focus on relevant designated species) are necessary and that a HRA and a MCZ will be required.	Noted, the findings of these surveys have been incorporated into the ES for the DCO application. A Shadow HRA (Appendix 12.4, document reference: 6.2.12.4) and MCZ assessment (Appendix 13.8, document reference: 6.2.13.8) have been undertaken to support the application also.
	Chapter 12 goes on to provide a description of the numerous fish species present in the River Thames, then outlines a preliminary assessment of potential effects to marine ecology and provides details of potential avoidance and mitigations measures. The MMO seek clarity as to whether the scoping out of fish as a receptor refers only to the scoping out of potential impacts to freshwater fish and fish ecology at Swanscombe Marshes and Ebbsfleet Stream only, or if the intention is to scope out all freshwater and marine fish receptors.	Scoping out pertains to freshwater fish only.
	Furthermore, the ES should make clear whether the project will scope out freshwater and marine fish for the	Noted, the findings of these surveys, fyke and seine, have

Consultee	Response	How the response has been addressed
	construction and/or operational phases of the development. In Section 11.93 it states that 'no further fish surveys are to be undertaken'. However, Section 12.73 states that a 'site-specific fyke net and seine net survey is proposed to characterise the fish assemblages utilising the margins that could be affected by works in the intertidal zone'. It is recognised in the survey report for the saltmarshes survey around Swanscombe Peninsula (Colclough & Coates 2015 CB/002) that fish movements across vegetated intertidal habitats are extremely dynamic, therefore multiple samples would be required to develop fully robust conclusions on fish assemblages using the site. If further surveys are undertaken to characterise fish assemblages utilising the river margins, then the MMO would recommend that these are carried out periodically throughout the course of year so that seasonal variation in assemblages is captured. The MMO is content that there are adequate resources and data on 'subtidal' fish in the vicinity of the project and that no additional 'subtidal' fisheries surveys are needed to inform the EIA. The MMO note the approach to assessment for potential cumulative and interrelated impacts is discussed in general terms in Chapter 6, but there is no specific information provided within Chapter 12 for fish. The MMO would expect cumulative and inter-related impacts assessment for fish to be included within the ES. The MMO would expect the ES to include suitable robust evidence that	been incorporated into Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2). A cumulative impact assessment has been included within the Cumulative and In-Combination Effects section of this ES chapter. The underwater noise

Consultee	Response	How the response has been addressed
	determines whether or not underwater noise is likely to propagate across the width of the estuary and cause an acoustic 'barrier' to fish movement and migration, and for the applicant to consider the following key points when undertaking the underwater noise impact assessment for fish.	assessment within the ES assessment has considered barriers to fish movement and migration (see paragraphs 13.101-13.132 for construction effects and paragraphs 13.221-13.226 for operational effects.
	The MMO advise the assessment should consider the timing and duration of required piling and dredging works in relation to the sensitive spawning and migration periods of tidal Thames fish.	Noted. The exact time of year when piling and dredging works will take place is not yet known and so a worst-case approach has been taken that these activities could take place at any time of year including sensitive spawning and migration periods for fish in the tidal Thames.
	The MMO recommend that any noise assessment is supported by recent peer reviewed scientific literature. For fish, the Popper et al. (2014) guidelines are currently the most appropriate. For marine mammals the National Oceanic Atmospheric Association, (NOAA), National Marine Fisheries Service 2018 (NMFS), criteria is recommended. There are no noise exposure criteria to assess the potential effects of noise and vibration on marine invertebrates. In this case, the MMO advise that assessment conclusions are supported by the peer-reviewed literature. Relevant source levels may be derived from the scientific literature.	Noted and we have used the Popper *et al*. (2014) guidelines for fish. However, this assessment uses criteria set out by Southall *et al*. (2019) for marine mammals as these criteria have improved on the criteria set out by NMFS (2018).
Natural England	The application is likely to result in direct and indirect impacts to the Swanscombe Marine Conservation Zone (MCZ), as the ferry terminal proposed on the southern side of the Thames is a key site where the tentacled lagoon worm is found.	Noted, an MCZ assessment is provided in Appendix 13.8 (document reference: 6.2.13.8).

Consultee	Response	How the response has been addressed
	Natural England therefore recommends that a full assessment of the potential direct and indirect effects to the MCZ is included within the environmental statement along with details of the avoidance and mitigation measures that will be implemented.	
	We welcome the proposed updated impact assessment which should be based upon robust survey information. The surveys should be based on an assessment on the predicted impacts to receptors that may occur during all stages of the scheme, including the construction and operational phases. For example, there should be a consideration of the impacts resulting from the increased vessel movements and dredging needs along with footprint losses associated with the proposed new/refurbished structures. In addition, the consideration of water quality impacts within the estuary should also be a key component of the environmental assessment.	The surveys were designed based on an assessment of likely effect pathways including proposed footprints resulting in loss of habitat, increased vessel movement and the proposed dredge pocket.
	Records of protected species should be sought from appropriate local biological record centres, nature conservation organisations, groups and individuals; and consideration should be given to the wider context of the site, for example in terms of habitat linkages and protected species populations in the wider area, to assist in the impact assessment.	Noted. Records of protected species were sought from appropriate local biological record centres and nature conservation organisations. The wider context of the site was considered within the assessment.
	The supporting appendices to the Scoping Report highlight that a number of protected species have been recorded across the Kent Site during the previous surveys. Natural England would expect all of the species surveys for the Kent Site to be updated in 2020. In addition,	Noted. Surveys were conducted and field reports are provided in Appendices 13.3 – 13.6. Intertidal and subtidal benthic ecology surveys were conducted at the Kent Project Site. Subtidal surveys were

Consultee	Response	How the response has been addressed
	surveys for the Essex Site should also be undertaken to ensure that a robust baseline is available for the impact assessment on both sides of the Thames.	conducted at the Essex Project Site. No intertidal surveys were conducted at the Essex Project Site as it was considered any effects of the Proposed Development on the intertidal habitats/species would be minimal and available data would be sufficient to inform assessment.
Port of London Authority	In the PLA's experience seals are mostly found on the opposite bank rather than the north of the peninsula, due to the composition of the foreshore, with the feeding birds at the SSSI. Reference is made to water cooling (although it is noted that it is not referenced in the development description) and there is also a reference in Chapter 12 to the waste water plant discharging into the Thames – where it is stated to be into existing infrastructure in the development description. The PLA would like to see climate change impacts and net gain considered in both ecological assessments.	Noted. The WSHP option has been removed from the project and as such no thermal plume modelling has been undertaken. Noted. The effects of climate change are considered within Appendix 13.2 *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2). Net gain considerations are made in chapter 12: *Terrestrial and freshwater ecology and biodiversity* (document reference: 6.1.12) and Appendix 12.3: *Ecological Mitigation and Management Framework* (document reference: 6.2.12.3).

Assessment methodology

13.10 The marine ecology and biodiversity assessment is based on consideration of the Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines for Environmental Impact Assessment (EIA) (CIEEM 2018).

13.11 The assessment approach is based on the conceptual 'source-pathway-receptor' model. This model identifies likely environmental effects resulting from the proposed construction and operation of the Proposed Development. This process provides an easy to follow assessment route between effect sources and potentially sensitive receptors ensuring a transparent impact assessment. The parameters of this model are defined as follows:

- Source: the origin of a potential effect (noting that one source may have several pathways and associated receptors); e.g. a construction activity;
- Pathway: the link or interaction 'pathway' by which the effect of the activity could influence a receptor; and
- Receptor: the element of the receiving environment that is affected.

13.12 Iterative steps involved in the assessment approach included:

- Determination of potential interactions between the Proposed Development and ecological receptors (for construction and operational phases);
- Definition of aquatic environment within the influence of the Proposed Development;
- Assessment of the value and sensitivity of ecological receptors;
- Assessment of the magnitude of impact;
- Assessment of the significance of effects;
- Proposal of mitigation measures to reduce, prevent or where these are not possible,to offset, any adverse significant effects;
- Assessment of the residual effects after any mitigation measures have been considered; and
- Assessment of cumulative effects.

13.13 In some instances the Proposed Development will retain flexibility in terms of the options for methods and approaches to be applied during the construction phase. Where this is the case, for each combination of effect and receptor, the assessment will be based on the

worst case scenario and where this approach has been taken it has been clearly indicated in the ES together with a definition of the worst case scenario for the specific assessment.

Assessment criteria

13.14 Terminology used in this assessment, is based on consideration of activities with associated impacts. It then assesses whether these impacts could have potential effects on habitats/species. A number of aspects are considered when assessing potential impacts/effects including:

- Nature of effect on habitat/species i.e. beneficial / adverse; direct / indirect;
- Extent of the impact (geographical area e.g. site-wide, local, district, regional, and the size of the population affected);
- Likelihood of effect occurring (Table 13.3);
- Value of receptor (Table 13.4);
- Sensitivity of receptor (Table 13.5);
- Magnitude of impact (Table 13.6);
- Duration - temporary or permanent effect. If the effect occurs on all of, or a proportion of, a community/population on a continual basis, or the effect has the potential to always occur due to the Proposed Development even if it is not continual, it can be considered to be permanent (e.g. a continual or intermittent discharge). If it is not on a continual basis or it is known the effect will cease at some point when considering the community/assemblage/population or habitat level it can be described as temporary (e.g. piling during construction); and
- Timing and frequency of impacts in relation to key potential periods of increased sensitivity e.g. migration periods for diadromous fish species.

13.15 The value and sensitivity of each receptor was determined based on consideration of factors outlined in Table 13.4 and Table 13.5 and the magnitude of the potential impact was based on the criteria set out in Table 13.6. Based on the value/sensitivity of the receptor and the predicted magnitude of the potential impact, the significance of effect was then determined as indicated in Table 13.7. Further details are provided below.

Likelihood

Table 13.3. Likelihood of effect occurring and confidence in assessment.

Likelihood	Probability	Definition
Certain	Probability estimated at 95% chance or higher.	Based on consideration of same pressures arising from similar activities, acting on the same type of receptor in comparable areas (i.e. UK). Previous studies indicate consistent magnitude of impact. Scientific evidence and/or construction information is detailed/ extensive.
Likely	Probability estimated above 50% but below 95%	Based on consideration of same pressures arising from similar activities, acting on the same type of receptor in comparable areas (i.e. UK) or similar pressures on receptor/similar receptor in other areas (i.e. outside UK). Previous studies indicate a possible range of magnitude of impact. There may be some limitations to scientific evidence base and/or construction information partially reducing certainty of assessment.
Unlikely	Probability estimated above 5% but less than 50%	Based on consideration of same pressures arising from similar activities, acting on the same type of receptor in comparable areas (i.e. UK) or similar pressures on the receptor / similar receptor in other areas (i.e. outside UK). Previous studies do not indicate consistent effect or range of magnitude.
Extremely unlikely	Probability estimated at less than 5%	Based on consideration of same pressures arising from similar activities, acting on the same type of receptor in comparable areas (i.e. UK) or based on similar pressures on the receptor /similar receptor in other areas (i.e. outside UK). There may be few if any previous studies to indicate any effect on the sensitive receptor.

Value and Sensitivity

Receptor Value

13.16 The value of each receptor was determined based on consideration of factors outlined in Table 13.4. It should be noted that high value and high sensitivity are not necessarily linked within a particular effect. A receptor could be of high value (e.g. an interest feature of a Special Area of Conservation (SAC) or Special Protection Area (SPA)) but have a low or negligible physical/ecological sensitivity to an effect and vice versa.

13.17 Sensitivity has been considered as required when assessing effects and information relating to sensitivity of receptors to impacts has been clearly indicated in the assessment narrative where appropriate.

Table 13.4. Value criteria for marine ecology assessment.

Value	Definition
Very High	• An internationally designated site or candidate site (SPA, pSPA, SAC, cSAC, pSAC, Ramsar site etc.) or an area which the country agency has determined meets the published selection criteria for such designation, irrespective of whether or not it has yet been notified. • Internationally significant and viable areas of a habitat type listed in Annex 1 of the Habitats Directive. • Globally threatened species (i.e. Critically endangered or endangered on IUCN Red list) or species listed on Annex 1 of the Berne Convention. • Regularly occurring populations of internationally important species that are rare or threatened in the UK or of uncertain conservation status. • A regularly occurring, nationally significant population/number of any internationally important species. • Habitat/species are highly regarded for their important biodiversity, social/community value and / or economic value.
High	• A nationally designated site (SSSI, NNR, MNR, MCZ) or a discrete area, which the country conservation agency has determined meets the published selection criteria for national designation (e.g. SSSI selection guidelines) irrespective of whether or not it has yet been notified. • Regularly occurring, globally threatened species (i.e. Vulnerable or lower on IUCN Red list) or species listed on Annex 1 of the Berne Convention. • Previously UKBAP habitats and species; S41 species of NERC Act. • Habitat/species possess important biodiversity, social/community value and / or economic value.
Medium	• Viable areas of key habitat identified in the Regional/County BAP or smaller areas of such habitat which are essential to maintain the viability of a larger whole. • Viable areas of key habitat identified as being of Regional value in the appropriate Natural Area profile. • WFD biological element. • Any regularly occurring significant population that is listed in a Local Red Data Book. • Significant populations of a regionally/county important species. • Habitat/species possess moderate biodiversity, social / community value and / or economic value.
Low	• Areas of habitat identified in a sub-County (District/Borough) BAP or in the relevant Natural Area profile. • District sites that the designating authority has determined meet the published ecological selection criteria for designation, including Local Nature Reserves selected on District/Borough ecological criteria (District sites, where they exist, will often have been identified in local plans).

Value	Definition
	• Sites/features that are scarce within the District/Borough or which appreciably enrich the District/Borough habitat resource. • Species are abundant, common or widely distributed. • Habitat/species possess low biodiversity, social/community value and / or economic value.

Table 13.5. Sensitivity criteria for marine ecology assessment.

Sensitivity	Definition
Very High	• Species/habitats are highly sensitive to changing environments. • Species/habitats are not able to recover or adapt.
High	• Species/habitats are highly sensitive to changing environments. • Species/habitats may have a very low capacity to tolerate the impact with little or slow recovery.
Medium	• Species/habitats are sensitive to changing environments. • Species/habitats may have good capacity to tolerate or recover from the impact.
Low	• Species/habitats are generally adaptable to changing environments. • Species/habitats indicate tolerance of the impact or recover quickly from the impact.
Negligible	• Species are highly tolerant of the effect.

Magnitude

13.18 Magnitude of impact is assessed taking into account property/aspect/features designed into the Proposed Development to avoid or minimise environmental effects (i.e. embedded mitigation) as outlined in ES chapter Three: *Project Description* (document reference: 6.1.3). Guidelines used to assign the magnitude of impact are provided in Table 13.6.

Table 13.6. Magnitude criteria for marine ecology assessment.

Magnitude	Definition
Major	Effect causes extensive changes to all or a large proportion of the habitat at a regional level (assumed to be beyond the area of Thamesmead to Thames Haven for the purposes of assessment), or greater resulting in loss of function of the habitat. Effects extend beyond the Proposed Development and are not reversible through natural processes (permanent effect) or are not reversible for several generations (long-term effect). Effect causes a change to all or a large proportion of the population at a regional level or greater resulting in a decline in the abundance of the population, or other trophic levels, that will not be reversed through natural recruitment for several generations.

Magnitude	Definition
Moderate	Effect causes a change to all or part of the habitat within the local area (assumed to be between the area of Thamesmead to Thames Haven for the purposes of assessment), but does not result in long term effects on the function of the habitat. Effect causes a substantial change in abundance of a species, affecting a population or portion of a population that may last for two to ten generations (medium term), but does not result in long term effects on the population itself or other trophic levels
Minor	Effect causes a change to a small, localised section of habitat within the local area, which is outside the range of natural variation, resulting in no loss of function of the habitat. Effect can be short-term to long-term. Effect causes a change to a small group of localised individuals of a population outside the range of natural variation but does not affect the viability of the population or other trophic levels. Effect can be either for a short period of time (up to two generations) or medium to long term (>two generations).
Negligible	Effects on the habitat/population are undetectable or within the range of natural variation.
No Change	The activity will have no interaction with the receptor.

Impact Significance

13.19 For the purposes of assessment and in line with common practice only effects that are of moderate or major significance have been considered to represent those with the potential to be 'significant' in EIA terms. The overall significance of an effect was determined using the matrix below (Table 13.7).

Table 13.7. Matrix to guide determination of effect significance.

Sensitivity/-Value	Magnitude of Impact				
	Major	**Moderate**	**Minor**	**Negligible**	**No Change**
Very High	Major	Major	Moderate or Major	Negligible or Minor	No effect
High	Major	Moderate or Major	Minor or Moderate	Negligible or Minor	No effect
Medium	Moderate or Major	Minor or Moderate	Minor	Negligible or Minor	No effect
Low	Minor or Moderate	Minor	Negligible or Minor	Negligible	No effect
Negligible	Minor	Negligible or Minor	Negligible	Negligible	No effect

Mitigation Measures

13.20 The likely significance of effects was determined after consideration of embedded mitigation. For any effects considered to be of moderate or higher significance, further mitigation/enhancement measures (beyond embedded measures) are proposed to reduce the significance of effect to minor or lower.

Residual Effects

13.21 Residual effects on marine ecological receptors (i.e. effects following implementation of specific mitigation measures) are then identified and their significance determined.

Mitigation Hierarchy

13.22 The mitigation hierarchy has been followed throughout the assessment. The hierarchy is 'Avoid'; 'Reduce, moderate, minimise'; 'Rescue (relocation, translocation)'; 'Repair, reinstate, restore'; 'Offset'; 'Compensate'. The first step of the mitigation hierarchy is avoid. Numerous alternative sites have been considered and considerations applied when determining the proposed location of the Proposed Development on Swanscombe Peninsula (see ES chapter Four: *Project Development and Alternatives*, document reference: 6.1.4). With the decision to construct the jetty at the proposed location, the next aspect of the mitigation hierarchy is to reduce, moderate and minimise. Efforts have been made to minimise the footprint of infrastructure in the intertidal and subtidal zone while still allow the proposed new ferry terminal and associated structures to operate as effectively as they need to, to service the Proposed Development requirements and meeting building regulations. Other measures are proposed to minimise potential effects of the project on marine ecology receptors. The next step of the mitigation hierarchy is rescue 'relocation/translocation), however, relocation of intertidal mud or tentacled lagoon worm is not considered a feasible option for reasons including the fact populations are predominantly subtidal populations, they are patchily distributed and cannot be targeted, there are strong tidal currents, and tentacled lagoon worm has specific salinity/substate requirements. The proposed habitat creation for saltmarsh in the area (see ES appendix 12.3: *Ecological Mitigation and Management Framework*, document reference: 6.2.12.3) will have aspects of restoring some areas of the saltmarsh, potentially offsetting some loss of intertidal mud and compensating for loss of saltmarsh.

Limitations and Assumptions

13.23 Given this is a Rochdale envelope-based assessment, a precautionary worst-case scenario approach to the assessment has been undertaken where appropriate, including an assumption that construction could be conducted at any time of the year.

13.24 Marine environmental and ecological conditions in the tidal River Thames are subject to change over time, e.g. due to movement of individuals of species into or out of the area, or habitat changes across spatial and temporal scales, which can be influenced by a range of factors. The results of surveys can be influenced by specific conditions at the time of

sampling including tidal state, weather conditions and seasonal trends. Marine ecology surveys have been conducted in 2020 to provide as up-to-date information as possible to inform the ES chapter and these data have also been compared to previous data where available/appropriate.

Data acquisition methodology

Desk Based Review

13.25 An extensive literature review was undertaken to collate background data available for the aquatic environment in the vicinity of the Proposed Development order limits and the wider mid and lower Thames Estuary. The aim of the data review was to identify knowledge gaps and inform Ecological Impact Assessment (EcIA). The literature/data review encompasses plankton (phyto-, zoo-), benthic species/habitats, fish (including ichthyoplankton), marine mammals and designated sites.

13.26 Data were obtained to inform the assessment via a combination of desk-based study, for both the Kent and Essex Project Sites, and project-specific surveys undertaken in 2016 for the Kent Project Site.

Site Characterisation Surveys

13.27 In 2016, the following surveys were completed at the Kent Project Site. No surveys were completed at the Essex Project Site in 2016 as the order limits did not extend into Essex at this time. Subtidal surveys at the Essex Project Site were completed in 2020. There will only be very limited pathways of effect between the Proposed Development and the intertidal habitats at the Essex site it was considered available data were sufficient to assess impacts, therefore no intertidal surveys were conducted at this location. The 2016 surveys included:

- Saltmarsh fish survey;
- Intertidal habitat survey;
- Subtidal habitat survey; and
- Marine mammal survey.

13.28 A summary of the findings of these surveys is provided below. Full data sets and findings from these surveys can be found in Appendices 13.3: *Saltmarsh Survey Report* (document reference 6.2.13.3), 13.4: *Intertidal Benthic Ecology Survey Report* (document reference 6.2.13.4), 13.5: *Subtidal Benthic Ecology Survey Report* (document reference 6.2.13.5), and 13.6: *Intertidal Fish Ecology Survey Report* (document reference 6.2.13.6).

13.29 In 2020, the following programme of surveys were completed at both the Kent and Essex Project Sites. The survey methods are summarised in Table 13.8.

Table 13.8. Surveys carried out at both the Kent and Essex Project Sites in 2020.

Item	Number of Stations	Number of replicates at each station	Survey dates
River Thames (Kent Project Site)			
Subtidal grab sampling (0.01 m^2 Hamon grab)	13	1 for biota, 1 for Particle Size Analysis	August 2020
Intertidal Phase I core and quadrat sampling	16 (8 transects with stations on upper and mid shore*)	3 for biota, 1 for Particle Size Analysis	
Wall scrapes	4	1 for biota	
Swanscombe saltmarsh (Kent Project Site)			
Quadrat samples	Up to 5 stations (i.e. 5 replicate quadrats) per National Vegetation Classification type	1	August 2020
Intertidal fish (Kent Project Site)			
Fyke nets	4	Double fykes at each station (sample ebb and flood)	June 2020 and September 2020
Seine nets	4	2 replicates (seine nets)	
River Thames (Essex Project Site)			
Subtidal grab sampling (0.01 m^2 Hamon grab)	8	1 for biota, 1 for Particle Size Analysis	August 2020
Wall scrapes	3	1 for biota	

Study Area

13.30 The Proposed Development will include the construction of a new ferry terminal west of Swanscombe Peninsula in the Thames Estuary with a floating platform and jetty, potential rebuilding of White's Jetty, renovation of Bell Wharf, a new Roll on - Roll off (Ro-Ro) facility, potential renovation of an existing flood defence (not anticipated to affect the marine environment) and drainage works. These aspects of the Proposed Development are all at the Kent Project Site (see Figure 13.1 to Figure 13.4, and chapter three: *Project description*, document reference: 6.1.3 for further details).

13.31 There are also proposals for structural remedial works to the jetty and a pontoon at the Tilbury Ferry Terminal with a potential mooring area for vessels at the Essex Project Site. This will likely be a floating pontoon but piling of guide piles would be required (see Figure

13.1 to Figure 13.4, and chapter two: *Site description*, document reference 6.1.2, for further details).

RELEVANT LAW, POLICY AND GUIDANCE

Legislation

13.32 There are a number of different legislative instruments that are relevant to the assessment of potential effects of the construction and operational phases of the Proposed Development. The key international legislation that has been considered is set out within Table 13.9.

Table 13.9. A Summary of Legislation and Conventions of Relevance to the Proposed Development.

Title	Summary and Relevance
International	
Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (the 'Habitats Directive')	Provides a framework for the conservation and management of natural habitats, wild fauna (except birds) and flora in Europe. Its aim is to maintain or restore natural habitats and wild species at a favourable conservation status. The relevant provisions of the Directive are the identification and classification of Special Areas of Conservation (SACs) (Article 4) and procedures for the protection of SACs (Article 6). SACs are identified based on the presence of natural habitat types listed in Annex I and populations of the species listed in Annex II. The Directive requires national Governments to establish SACs, and to have in place mechanisms to protect and manage them. SACs are also termed Natura 2000 sites, and those that are covered by tidal water (continuously or intermittently) are also termed 'European Marine Site' (EMS) - although this is not a statutory site designation.
Birds Directive - Council Directive 2009/147/EC on the Conservation of Wild Birds	This Directive provides a framework for the conservation and management of wild birds in Europe. The most relevant provisions of the Directive are the identification and classification of Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex I of the Directive and for all regularly occurring migratory species (required by Article 4). It also establishes a general scheme of protection for all wild birds (required by Article 5). The Directive requires national Governments to establish SPAs and to have in place mechanisms to protect and manage them. The SPA protection procedures originally set out in Article 4 of the Birds Directive have been replaced by the Article 6 provisions of the Habitats Directive.

Title	Summary and Relevance
Ramsar Convention on Wetlands of International Importance (1972)	In accordance with Government advice in both England and Wales, Ramsar sites (internationally important wetlands) must be given the same consideration as European sites, so they are afforded the same protection as those under the Habitats Directive - Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora.
Water Framework Directive (WFD) (2000/60/EC)	The WFD establishes a framework for the management and protection of Europe's water resources. It is implemented in England and Wales through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (the Water Framework Regulations). Central to the WFD is the philosophy to make water bodies better through sustainable development for the joint benefits of aquatic habitats and the human environment. Ecological status is an expression of the quality of the structure and functioning of surface water ecosystems as indicated by the condition of a number of 'quality elements'. These include biological, hydro-morphological and chemical indicators. The development and implementation of strategic long-term River Basin Management Plans (RBMPs) is a key requirement of the WFD. They include a programme of measures outlining the on-going monitoring and management actions required for water bodies to achieve future objectives. Proposed developments or activities that have the potential to affect the water environment require a WFD Assessment. In this context, compliance with the WFD means prevention of deterioration (of ecological status, chemical status and supporting element status) and prevention of ability to achieve future targets. However, WFD Article 4.7 provides legislation for exemption conditions that could allow implementation of schemes that cause deterioration in ecological status, for example for reasons of overriding public interest.
Environmental Quality Standards Directive (EQSD) (2008/105/EC) as amended	This Directive sets out environmental quality standards (EQS) for certain substances or groups of substances identified as priority pollutants on account of the substantial risk they pose to or via the aquatic environment. These substances include the metals cadmium, lead, mercury and nickel, and their compounds, benzene, polyaromatic hydrocarbons (PAHs) and several pesticides. This Directive gives Member States the ability to designate mixing zones in the vicinity of points of discharge.
Priority Substances Directive (2013/39/EU)	Updates the EQS Directive regarding priority substances in the field of water policy.

Title	Summary and Relevance
Marine Strategy Framework Directive (MSFD) (2008/56/EC)	The MSFD aims to achieve Good Environmental Status (GES) in Europe's seas by 2020 and applies beyond 1 nautical mile from the coast in England and Wales. GES involves protecting the marine environment, preventing its deterioration and restoring it where practical, while using marine resources sustainably. The Directive sets out 11 high-level Descriptors of GES which cover all the key aspects of the marine ecosystem and all the main human pressures on them. The European Commission has also produced a Decision document (Commission Decision 2010/477/EU) which provides more detailed criteria and indicators of GES which Member States must use when implementing the Directive. The Directive came into force on 15th July 2008 and was transposed into UK law via the Marine Strategy Regulations 2010.
Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention'), 1992	This is the mechanism by which fifteen governments of the western coasts and catchments of Europe, together with the European Community, cooperate to protect the marine environment of the North-East Atlantic. The Convention included the establishment of a list of threatened and/or declining species and habitats which provides an overview of the species/habitats in need of protection in the North-East Atlantic and is being used by the OSPAR Commission to guide the setting of priorities for further work.
EU Invasive Alien Species Regulation (Regulation No 1143/2014)	Regulation (EU) 1143/2014 on invasive alien species (the IAS Regulation) entered into force on 1 January 2015, fulfilling Action 16 of Target 5 of the EU 2020 Biodiversity Strategy. The regulation is designed to establish a framework for action to prevent, minimise and mitigate the adverse impacts of invasive non-native species on biodiversity and ecosystem services, and focuses on a list of invasive alien species of EU concern, which has been drawn up with Member States using risk assessments and scientific evidence. Selected species are banned from the EU, meaning it will not be possible to import, buy, use, release or sell them. The proposal is for three types of intervention: prevention; early warning and rapid response; and management.
Convention on the Conservation of European Wildlife and Natural Habitats (the 'Berne Convention')	This Convention was adopted in Bern, Switzerland in 1979, and came into force in 1982. The principal aims of the Convention are to ensure conservation and protection of all wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention), to increase co-operation between contracting parties, and to afford special protection to the most vulnerable or threatened species (including migratory species).

Title	Summary and Relevance
Convention on the Conservation of Migratory Species of Wild Animals (the 'Bonn Convention')	This Convention was adopted in Bonn, Germany in 1979 and came into force in 1985. Contracting Parties work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix 1 of the Convention), concluding multilateral agreements for the conservation and management of migratory species which require or would benefit from international co-operation (listed in Appendix 2 of the Convention), and by undertaking co-operative research activities.
Convention on Biological Diversity 1992	The Convention focuses on the conservation of all species and ecosystems and, therefore, provides protection to all biodiversity. The Convention requires the development of national strategies, plans or programmes for the conservation and sustainable use of biodiversity, its sustainable use, and equitable sharing of benefits arising from the utilisation of natural resources (i.e. the Ecosystem Approach). In accordance with this, the UK developed Biodiversity Action Plans (BAPs).
Council Regulation (EC) No. 1100/2007: Establishing measures for the recovery of the stock of European eel	The European Council Regulation sets an objective to enable the recovery of European eel stocks. This objective is to reduce anthropogenic mortality to a level that permits the escapement to the sea of at least 40% of the silver eel biomass, relative to the best estimate of escapement that would have existed with no anthropogenic influence. The Regulation also requires EU member states to develop management plans with the purpose of achieving the objective in the long term.
International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM)	This Convention was adopted on 13th February 2004 and entered into force on 8th September 2017. The BWM Convention aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments. This is supported by Resolution MEPC.279(70) which was adopted on 28th October 2016 and provides *Guidelines for Ballast Water Management Systems (G8)*.
National	
Conservation of Seals Act (1970)	Provide for the protection and conservation of seals in England and Wales and Scotland and in the adjacent territorial waters.
Salmon and Freshwater Fisheries Act 1975	Makes it an offence to discharge effluents which may damage fish, their food or their spawning grounds.

Title	Summary and Relevance
Wildlife and Countryside Act 1981	This Act is the principal mechanism for the legislative protection of wildlife in Britain. It consolidates and amends existing national legislation to implement the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) and Council Directive 79/409/EEC on the conservation of wild birds (Birds Directive) in Great Britain. The Act provides for the designation of Sites of Special Scientific Interest (SSSIs), which are selected as the best national examples of habitat types, sites with notable species and sites of geological importance. Various species of marine animals are also protected from being killed, injured or disturbed under provisions in Schedule 5 of the WCA 1981. It is also the principal UK legislation dealing with non-native species.
The Water Resources Act 1991 (WRA)	The WRA regulates water resources, water quality, pollution and flood defence. The policing of this act is the responsibility of the Environment Agency; under the act is an offence to cause or knowingly permit any poisonous, noxious or polluting material, or any solid waste to enter any controlled water.
National Environment and Rural Communities (NERC) Act 2006	The NERC Act 2006 makes provision for bodies concerned with the natural environment and rural communities, amends protection for some designated wildlife areas, and amends the law relating to rights of way. Section 41 of the Act required the Secretary of State to publish a list of habitats and species of principal importance for the conservation of biodiversity in England. This list (the S41 list) includes habitats and species which have been identified as requiring action in the UK Biodiversity Action Plan (UK BAP), in line with the 1992 Convention on Biological Diversity.
Marine and Coastal Access Act 2009	This Act is the UK interpretation of the MSFD and aims to enable better protection of marine ecosystems, and prevent a decline in marine biodiversity. The Act contains provisions to allow for the designation of Marine Conservation Zones (MCZs) and the creation of a network of Marine Protected Areas (MPAs). MCZs protect a range of nationally important marine wildlife, habitats, geology and geomorphology and can be designated anywhere in English and Welsh inshore and UK offshore waters.
Water Act 2014	Part 3 of the Water Act 2014 focusses on the Environmental Permitting regime in relation to water abstraction and pollution prevention and control (enabling single rather than multiple permit applications).
The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015	Key transposing Directions that set out the environmental standards to be used for the second cycle of river basin plans.

Title	Summary and Relevance
The Eels (England and Wales) Regulations 2009 (SI 2009 No. 3344)	These Regulations transpose Council Regulation (EC) No. 1100/2007: Establishing measures for the recovery of the stock of European eel into law in England and Wales and set out measures for the achievement of the objective in Regulation 1100/2007.
Environmental Permitting (England and Wales) Regulations 2016 (EPR 2016)	The EPR 2016 is an update of EPR 2010 and sets out the permitting regime for discharges to controlled waters. Requirement to regulate 'water discharge activities'; schedule 21 describes 'water discharge activities' such as discharge or entry of poisonous, noxious or polluting material, into inland freshwaters, coastal waters or relevant territorial waters.
The Conservation of Habitats and Species Regulations (2017)	The Conservation of Habitats and Species Regulations 2017 (the 'Habitats Regulations') consolidate the Conservation of Habitats and Species Regulations 2010 with subsequent amendments. The Regulations transpose Council Directive 92/43/EEC, on the conservation of natural habitats and of wild fauna and flora (EC Habitats Directive), into national law. They also transpose elements of the EU Wild Birds Directive in England and Wales, and make provision for the protection and management of sites, including the control of potentially damaging operations that may affect designated sites. The Regulations came into force on 30th November 2017.

Policy

13.33 There are a number of national and local policies that are of relevance to the Proposed Development marine environment assessment process (summarised in Table 13.10).

Table 13.10. Summary of national and local policies of relevance to the Proposed Development.

Title	Summary and Relevance
National	
UK Marine Policy Statement (MPS), 2011	This is the framework for preparing Marine Plans and taking decisions affecting the marine environment. Adopted by the UK Government, the Scottish Government, the Welsh Government and the Northern Ireland Executive, the MPS is intended to help achieve the shared UK vision for clean, healthy, safe, productive and biologically diverse oceans and seas. The MPS aims to enable an appropriate and consistent approach to marine planning across UK waters, and to ensure the sustainable use of marine resources and strategic management of marine activities from renewable energy to nature conservation, fishing, recreation and tourism.
National Policy Statement (NSP) for National Networks (2014)	Whilst there is no NPS for business and commercial nationally significant infrastructure projects (NSIPs), the extent that the Proposed Development includes transport and highways infrastructure means that regard will be had to the NPS on National Networks, including: • Environmental and Social impacts (NPS paragraphs 3.2 to 3.5)

Title	Summary and Relevance
	• Climate Change Adaptation (NPS paragraphs 4.36 to 4.47) • Pollution Control and Other Environmental Protection Regimes (NPS paragraphs 4.48 to 4.56) • Flood Risk (NPS paragraphs 5.90 to 5.115) • Water Quality and Resources (NPS paragraphs 5.129 to 5.231)
National Policy Statement (NSP) for Ports (2012)	Whilst there is no NPS for business and commercial NSIP project, the extent that the Proposed Development includes marine works related to the port means that regard will be had to the NPS on Ports, including: • Habitats Regulations Assessment (NPS paragraph 4.8.1) • Pollution Control and other Environmental Regimes (NPS paragraphs 4.11.1 to 4.11.18) • Climate Change Mitigation (NPS paragraphs 4.12.1 to 4.12.10) • Climate Change Adaptation (NPS paragraphs 4.13.1 to 4.13.15) • Biodiversity and Geological Conservation (NPS paragraphs 5.1.1 to 5.1.25) • Water Quality and Resources (NPS paragraphs 5.6.1 to 5.6.12)
National Planning Policy Framework, 2019	The revised National Planning Policy Framework (NPPF) was published in 2019. The NPPF is a material consideration that must be taken into account in the determination of planning applications. The NPPF requires that an overall approach is taken to sustainable development, incorporating social, economic and environmental dimensions which should not be considered in isolation. A section of the NPPF document addresses 'Conserving and enhancing the natural environment'. Amongst other objectives this section indicates when determining planning applications, that local planning authorities should aim to contribute to and enhance the natural and local environment by applying a number of outlined principles.
UK Post-2010 Biodiversity Framework	The UK Post-2010 Biodiversity Framework has succeeded the UK Biodiversity Action Plan (UK BAP). The Framework demonstrates how the work of the four countries and the UK contributes to achieving the Aichi Biodiversity Targets, and identifies the activities required to complement the country biodiversity strategies in achieving the targets. Although the UK BAP has been superseded, the list of UK BAP priority habitats and species remains a useful reference for local authority decision-makers and forms the basis of the Section 41 list of the NERC Act.
Local	
Marine Plans	The English coastline has been divided into 12 inland and offshore Marine Planning Areas (MPAs). At present, the East Coast Inshore and East Coast Offshore plans have been published following an extensive stakeholder engagement process, and all others are currently in development. The Proposed Development lies within the South East Inshore MPA which currently has a Draft South East Inshore Marine Plan. Consultation on the draft finished on 20th April 2020. The MMO

Title	Summary and Relevance
	are currently reviewing comments made during this consultation period and will redraft the plan prior to its adoption.
Thurrock Council Local Plan	The Thurrock Borough Local Plan 1997 sets out the Council's policies and proposals for the way in which land, buildings and infrastructure should be developed. By law, although the end date of the Borough Local Plan has passed, its policies are a material consideration when deciding planning applications. The Council are in the process of developing a new Local Plan for Thurrock, however, this is in the early stages of development and is not anticipated to be adopted until 2021. The development plan for Thurrock comprises the following documents: Thurrock Core Strategy and Policies for Management of Development and Policies Map, as amended, adopted January 2015 and Thurrock Borough Local Plan Saved Policies, Site Allocations and Annexes, February 2012.
Dartford Borough Local Plan	The Dartford Borough Local Plan 2011 sets out the Council's policies and proposals for the way in which land, buildings and infrastructure should be developed. The development plan for Dartford comprises the following documents: Dartford Core Strategy, adopted September 2011 and Dartford Development Policies Plan, adopted July 2017.
Gravesham Borough Local Plan	The Gravesham Borough Local plan 2014 Plan sets out the Council's policies and proposals for the way in which land, buildings and infrastructure should be developed. The development plan for Gravesham comprises the following documents: Gravesham Local Plan Core Strategy and Local Plan Policies Map, adopted September 2014 and Local Plan Review, undertaken in September 2019. Strategic Objective 16 of the Local Plan Core Strategy is 'Safeguard and enhance the biodiversity of the Borough' and associated with this are Key Policies CS01- Sustainable Development and CS 12 – Green Infrastructure. Policy CS18 Climate Change is also relevant.

Guidance

13.34 The key guidance documents used to inform this assessment were the Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines for Environmental Impact Assessment (EIA) (CIEEM 2018). Other relevant guidance can be found in Table 13.11 below.

Table 13.11. A Summary of Guidance followed for the Proposed Development.

Title	Summary & Relevance
National	
CIEEM guidelines for Ecological Impact Assessment for Terrestrial, Freshwater and Coastal Environments	The Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland (2018) is the primary source guidance for the assessment. The aim of the guidance is to promote good practice for Ecological Impact Assessment (EcIA) relating to terrestrial, freshwater, coastal and marine environments of the UK. It updates CIEEM's Terrestrial EcIA 2006 Guidelines, CIEEM's Marine EcIA Guidelines 2010 and CIEEM's 2016 terrestrial, freshwater and coastal guidelines.
Advice Note 10: Habitats Regulations Assessment relevant to nationally significant infrastructure projects (PINS, 2017)	When preparing applications for NSIPs under the PA2008, Applicants should consider the potential effects of the application on protected habitats. If an NSIP, when taken alone or with existing and known future projects, is likely to affect a European site and/or a European Marine site, the Applicant must provide a report with the application showing the site(s) that may be affected together with sufficient information to enable the competent authority to make an Appropriate Assessment, if required. This Advice Note provides advice for Applicants in relation to the preparation of that report, and the PA2008 processes relating to HRA.
Advice Note 18: The Water Framework Directive (PINS, 2017)	The purpose of this Advice Note is to alert Applicants to the requirements of the WFD and 2017 Regulations, as applicable to NSIPs under the PA2008. This Advice Note explains the information that the Inspectorate considers an Applicant must provide with their NSIP application in order to clearly demonstrate that the WFD and the 2017 Regulations have been appropriately considered.
The IUCN Red list	The International Union for Conservation of Nature (IUCN) has compiled a Red list of threatened species that are facing a high risk of global extinction. The list (IUCN, 2020) includes benthic species that are or may be present in the vicinity of the Kent and Essex Project Sites.
Guidance for survey methodologies	A range of guidance documentation was referred to for the design and completion of project-specific surveys. Relevant guidance will be referred to in the survey reports.
Guidance for supporting Ecological Assessments	Assessment-specific guidance will be referred to when completing the Water Framework Directive Assessment, Habitat Regulations Assessments Report, and Marine Conservation Zone assessment for the DCO application stage.

SUMMARY OF THE BASELINE

13.35 Detailed baseline information for marine ecology receptors is provided in Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2).

13.36 The range of potential key receptors present at the Kent and Essex Project Sites was considered with relevant receptors screened into the assessment. Value categories for receptors screened into the assessment (following criteria in Table 13.5) are summarised in Table 13.12.

Table 13.12. Value of receptors expected to be potentially present within the Kent and Essex Project Sites.

Value	Receptor	Reasoning
Very High	Fish (internationally protected)	The European eel *Anguilla anguilla* is protected under Council Regulation No 1100/2007/EC and listed as Critically Endangered on the IUCN Red List. (This species is also listed under Section 41 of the NERC Act.) Several species are also listed under Annex II of the Habitats Directive including *Alosa alosa*, *Salmo salar*, *Cotus gobio* and *Lampetra fluviatilis*. (*A. alosa* is also listed under Schedule 5 of the Wildlife and Countryside Act and is listed under Section 41 of the NERC Act).
	Marine mammals	A number of marine mammal species are protected by a range of international policy / legislation including the Habitats Directive.
	Designated sites	Thames Estuary and Marshes SPA and Ramsar site are internationally important for bird assemblages and their diverse range of wetland invertebrates and wetland plants. Saltmarshes are listed as A2.5 by the EUNIS habitat classification and are protected under the Berne Convention.
High	Fish (nationally protected)	*Alosa fallax* and *Hippocampus hippocampus* are listed under Schedule 5 of the Wildlife and Countryside Act. Several species listed under Section 41 of the NERC Act and previous UK BAP species including *Lophius piscatorius, Gadus morhua, Scomber scombrus, Salmo salar, Micromesistius poutassou, Salmo trutta, Solea solea, Pleuronectes platessa, Osmerus eperlanus, Clupea harengus, Ammodytes marinus, Lampetra fluviatilis, H. hippocampus, A. fallax* and *Merlangius merlangus*. *S. salar* is listed as Vulnerable on the IUCN Red List.

Value	Receptor	Reasoning
	Intertidal species and habitats	The intertidal area of the Kent Project Site is within the Swanscombe MCZ which has the following designated features: Intertidal mud (Eunis Code A2.2) and tentacled lagoon worm *Alkmaria romijni. A. romijni* is listed on Schedule 5 of the Wildlife and Countryside Act. Several UK Biodiversity Action Plan (BAP) Priority habitats have also been identified at the site. *Scrobicularia plana* is listed as Vulnerable on the IUCN Red List.
	Designated sites	The Swanscombe MCZ is designated for Intertidal mud (Eunis Code: A2.2) and tentacled lagoon worm *A. romijni*. West Thurrock Lagoon and Marshes SSSI is designated for multiple aggregations of non-breeding birds (Dunlin and Redshank) and encompasses mudflats and saline lagoons. The mudflats within the Inner Thames Marshes SSSI support important invertebrate communities which are an important food resource for birds. The South Thames Estuary and Marshes SSSI has been designated largely for its importance as an estuarine habitat and is considered to be almost entirely in favourable condition. The saltmarsh within Mucking Flats and Marshes SSSI. This SSSI has a high invertebrate interest. All are designated at the national level.
Medium	Phytoplankton	Phytoplankton is a WFD biological element.
	Ichthyoplankton	Ichthyoplankton consists for fish larvae and eggs, and fish is a WFD biological element.
	Fish	Several species considered to be commercially important such as *S. solea*, *C. harengus*, *S. sprattus*, *O. eperlanus*, and *Dicentrarchus labrax*. *S. salar* listed as Vulnerable on the IUCN Red List. Fish is a WFD biological element.
	Subtidal species and habitats	Benthic invertebrates are a WFD biological element.

Value	Receptor	Reasoning
Low	Zooplankton	Zooplankton at the Kent and Essex Project Sites are not protected and are expected to be typical of the tidal River Thames. Zooplankton can provide a food resource for other species of conservation and commercial importance, and the larvae of species of conservation and commercial importance form a component of zooplankton.
Negligible	No receptors allocated to this category	Not applicable.

POTENTIAL SIGNIFICANT ENVIRONMENTAL EFFECTS OF THE PROPOSALS

Embedded Mitigation Measures

13.37 The key embedded mitigation measures for the Proposed Development are set out below.

- An area of managed alteration to the flood defences and riverbank profile along sections of the Kent Project Site will be created to provide additional saltmarsh habitat to mitigate the loss of habitat at the Ferry Terminal. This will increase areas of mud flat, salt marsh, small pools, rocks and shingle areas, with reeds, sedges and grasses transitioning into scrub vegetation. This will be undertaken using two different methods: managed retreat of the flood defences in the area south of Bell Wharf and interventions at the shoreline to create an enhanced intertidal zone and encourage saltmarsh habitat to form along the north and northwest coast of the Peninsula. In total it is estimated that approximately 3ha of saltmarsh habitat will be created. Further details on both methods are provided in Appendix 12.3*: Ecological Mitigation and Management Framework* (document reference 6.2.12.3). This mitigation will be secured by a requirement in the DCO.

- Booms or other infrastructure within the designs for the ferry terminal and jetty to prevent erosion caused by boatwash. This mitigation will be secured by a requirement in the DCO.

Proposed Development Activities that Could have an Effect on Marine Ecology Receptors

13.38 A full description of the activities and methods associated with the Proposed Development is provided in ES chapter Two: *Site description*, document reference: 6.1.2 and ES chapter Three: *Scheme description* (document reference: 6.1.3). Activities of key relevance to the Marine Ecology assessment are:

Construction Phase

- Extension of Bell Wharf at Kent Project Site;
- Construction of ferry terminal at Kent Project Site;
- Construction of new passenger jetty at Kent Project Site;
- Extension of jetty at Essex Project Site;
- Wastewater treatment plant outfall at Kent Project Site (see ES chapter 17: *Water Resources and Flood Risk* for details, document reference: 6.1.17). As a worst-case scenario this could involve construction of a cofferdam during outfall construction.
- Surface water outfalls at the Kent and Essex Project Sites (see ES chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17 for details). As a worst-case scenario this could involve construction of a cofferdam during outfall construction.

13.39 In addition, there are currently three options under consideration for the provision of supplies to the Proposed Development. These are:

- Option A: construction of roll on, roll off slipway at Kent Project Site (Figure 13.2);
- Option B: refurbishment of existing White's Jetty (Figure 13.3); and
- Option C: dredge the area between the proposed passenger jetty and the existing White's Jetty to allow all-tide access to Bell Wharf (Figure 13.4). This would only be pursued as an option if Options A and B prove to be unfeasible.

13.40 A backhoe dredger will be used for the capital dredge and the proposed dredge pocket for Option C is shown in Figure 13.4. This is the only option that would require dredging.

Operation Phase

- Deliveries to new ferry terminal at Kent Project Site;
- Use of passenger terminal by London Resort ferry and Thames Clipper at both the Kent and Essex Project Sites;
- Use of Ro-Ro facility;
- Discharge of wastewater from outfall to the estuary at Kent Project Site;
- Discharge of surface water runoff from outfall to the estuary at both the Kent and Essex Project Sites; and

- Maintenance of structures.

- If Option C is chosen, it is the intention that Bell Wharf will only be used during high tide during the operational phase and therefore maintenance dredging will not be conducted. If it was decided that Bell Wharf is to be used at all tides during operation of the proposed development, however, maintenance dredging may be required periodically which would cause disturbance and re-suspension of sediments. If maintenance dredging was required it would be conducted by a backhoe dredger.

13.41 A summary of the key interaction pathways identified for the Proposed Development between construction and operational activities and marine ecology receptors is provided in Table 13.13. It should be noted that Water Quality is not indicated as a receptor in this table as it has been considered as a pathway to potential effects on marine ecology receptors within the assessment. Effects on water quality are discussed in chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17. Water Quality is also assessed with the Water Framework Directive Assessment submitted as part of this DCO application (Appendix 13.7, document reference: 6.2.13.7).

Table 13.13. Interactions matrix indicating the potential pathways of effect of impacts from the Proposed Development on marine ecology receptors.

Receptor	Plankton	Intertidal species & habitats	Saltmarsh	Subtidal species & habitats	Fish	Marine mammals	Designated sites (aquatic ecology receptors only)
Potential development impact							
Construction							
Changes in water quality	✓	✓	✓	✓	✓		✓
Loss of habitat		✓	✓	✓	✓		✓
Physical disturbance and displacement		✓	✓	✓	✓		✓
Visual disturbance						✓	
Increase in underwater noise and vibration		✓		✓	✓	✓	
Use of artificial lighting	✓				✓	✓	
Collision risk with vessels					✓	✓	
Presence of structures in estuary margins					✓	✓	
Introduction and/or spread of invasive non-native species	✓	✓		✓	✓		✓
Physical disturbance and displacement (indirect via food chain)		✓		✓	✓	✓	
Accidental pollution events (e.g. oil spill)	✓	✓	✓	✓	✓	✓	✓
Operation							
Change in hydrodynamics and sediment accretion/erosion		✓	✓	✓	✓		
Changes in water quality	✓	✓	✓	✓	✓		✓
Physical disturbance and displacement				✓			
Visual disturbance						✓	
Increase in underwater noise and vibration		✓		✓	✓	✓	
Introduction of new artificial habitat		✓		✓	✓		
Shading		✓	✓	✓	✓		
Use of artificial lighting	✓				✓	✓	

Receptor	Plankton	Intertidal species & habitats	Saltmarsh	Subtidal species & habitats	Fish	Marine mammals	Designated sites (aquatic ecology receptors only)
Collision risk with vessels					✓	✓	
Presence of structures in estuary margins					✓	✓	
Introduction and/or spread of invasive non-native species	✓	✓	✓	✓	✓		✓
Physical disturbance and displacement (indirect via food chain)		✓		✓	✓	✓	
Vessel pollution		✓		✓			
Accidental pollution events (e.g. oil spill)	✓	✓	✓	✓	✓	✓	✓

Construction

Changes in Water Quality (Suspended Solids and Release of Sediment Chemicals)

Construction Details

13.42 Construction activities that are planned in the intertidal and subtidal estuarine environment have the potential to generate water quality change. The mechanisms through which water quality change may be generated are primarily:

- Increase in suspended sediment concentration at the Kent Project Site via direct disturbance of estuary bed sediment from dredging (if Option C is chosen) and piling for the passenger pier, refurbishment of White's Jetty (if Option B is chosen) at the Kent Project Site and piling to extend the Tilbury Terminal jetty at the Essex Project Site.

- Indirect increase in chemical concentrations within the water column via disturbance and mobilisation of chemicals associated with contaminated sediments.

13.43 Capital dredging will be undertaken by backhoe dredging (open or closed bucket) to attendant barges. Dredging waste disposal will be made (under separate permit) to licensed disposal grounds, of which there are appropriate marine disposal areas in the outer Thames.

13.44 The disturbance and re-suspension of sediments could lead to the release of any contaminants that may be present within them, which may in turn affect compliance with water quality standards. A full characterisation and assessment of sediment

contamination is presented as part of the WFD assessment (Appendix 13.7, document reference: 6.2.13.7) with results summarised here.

13.45 Chemical Action Levels (cALs) as derived by Cefas and Canadian marine Sediment Quality Guidelines (listed in Appendix 13.5: *Subtidal Benthic Ecology Survey,* document reference: 6.2.13.5) were used to characterise the broad contamination status of sediment samples taken during subtidal ecology surveys as detailed in Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2) and Appendix 13.5: *Subtidal Benthic Ecology Survey* (document reference: 6.2.13.5). Concentrations below cAL1 are of no concern, chemical levels between cAL1 and cAL2 generally would indicate further consideration would be required for disposal at sea, while dredged material with chemical levels above cAL2 is generally considered unsuitable for sea disposal (MMO 2015).

13.46 At the Kent Project Site, heavy metal concentrations above cAL1 were recorded at all 14 stations except stations G01 and G11 (see Appendix 13.5: *Subtidal Benthic Ecology Survey,* document reference: 6.2.13.5 for further details). At two stations cAL2 was exceeded for mercury and cAL2 was exceed for zinc at one station. At the Essex Project Site, cAL1 was only exceeded for nickel and that was at one site only (no chemicals at any of the sites exceeded cAL2 concentrations). Polycyclic aromatic hydrocarbon (PAH) levels were high at both Project Sites. No other exceedances were recorded from the subtidal surveys undertaken in 2020.

13.47 There could be dispersal of chemicals as a result of disturbance from construction activities. As assessment of the potential increases in chemical concentrations above background was conducted as set out in Appendix 13.7: *Water Framework Directive Assessment* (document reference 6.2.13.7). The assessment considered disturbance from piling works associated with Options A and B and for dredging with a backhoe dredger for Option C.

13.48 For Options A and B it was assessed that there would be a short-term increase in chemical concentrations across small spatial scales. These short-term increases are considered to be negligible in relation to the tidally influenced changes in the chemical concentrations in the tidal Thames each day and it is not predicted to impact upon the current status of the Thames Middle waterbody. Concentrations of chemicals in the water column were calculated at 100 m from the sources of the piling works. It was predicted that there would be no exceedances of environmental quality standard (EQS) values for any of the metals or TBT. In terms of the PAHs, for benzo(a)pyrene baseline concentrations are already at the EQS level (0.027 µg/l) and at 100 m from the works concentrations could be up to twice as high (0.060 µg/l) while for benzo(b)fluoranthene baseline concentrations are already above the EQS of 0.017 µg/l, and during the works the concentrations could be more than double the EQS value (0.049 µg/l). The situation is similar for benzo(k)fluoranthene with a baseline concentration of 0.0157 µg/l which which is just below the EQS of 0.017 µg/l, and when the works are conducted this could increase to just under double the EQS value (up to 0.032 µg/l).

13.49 The greatest exceedance is evident for benzo(g,h,i)perylene which is largely due to its very low EQS concentration. Baseline concentrations of benzo(g,h,i)perylene (0.0267 µg g/l) are two orders of magnitude greater than the EQS value of 0.00082 µg/l and due to sediment disturbance caused by the works for Options A and B, concentrations could increase up to 0.046 µg/l which is almost double the baseline concentration. It should be noted, however, that these exceedances are anticipated to be at 100 m from the works and increases at any location would be short-term in duration. Sediment fluxes in the tidal Thames are in the region of tens of millions of kilograms per tidal phase and with tidal movements any chemicals in the water column would be very rapidly diluted with increased distance from the source of disturbance.

13.50 For Option C, the potential effects of dredging were considered based on deployment of a backhoe dredger. Metals and TBT were not predicted to exceed EQS concentrations in the vicinity of the dredging although the concentrations relative to baseline levels would be a lot higher than for Options A and B.

13.51 As indicated above baseline levels of benzo(b)fluoranthene and benzo(g,h,i)perylene are already above EQS concentrations. Concentrations of benzo(b)fluoranthene could reach concentrations 100 m from source, which are an order of magnitude above the EQS (0.017 µg/l) and the baseline concentration of 0.0257 µg/l. For benzo(g,h,i)perylene the predicted concentration 100 m from the dredge area is 0.14 µg/l which is many orders of magnitude above the EQS value of 0.00082 µg/l and an order of magnitude above the baseline concentration of 0.0267 µg/l.

13.52 These short-term increases in chemical concentrations are expected to be dispersed rapidly with the natural tidal cycles. As such, changes to water quality as a result of chemical release from disturbed sediments is assessed to be of negligible magnitude and significance of effect is assessed to be negligible.

Plankton

13.53 In terms of water quality, the main potential effect is likely to be associated with changes in suspended sediment levels. Increases in concentrations of suspended sediments can affect light penetration (photic depth) throughout the water column inhibiting photosynthesis and potentially limiting the productivity of phytoplankton. In turn, reduced primary productivity or changes in the phytoplankton assemblage could have an influence on zooplankton assemblages feeding on the phytoplankton, and ichthyoplankton feeding on other plankton groups. Elevated suspended sediment levels can also clog the feeding apparatus of zooplankton and ichthyoplankton.

13.54 Within the Thames Estuary, however, suspended sediment concentrations are naturally very high and planktonic organisms present in the Estuary would be expected to be well adapted to survival in a turbid environment and would be dispersed on each flood and ebb tide.

13.55 A full characterisation and assessment of sediment contamination is presented as part of

Appendix 13.7: *Water Framework Directive Assessment* (document reference: 6.2.13.7). This assessment concludes that effects on water quality will be negligible at the water body scale and no effects on plankton are predicted to occur as a result of changes to water quality.

13.56 Overall, any effects on plankton are assessed to be of **minor adverse significance**.

Intertidal and Subtidal Habitat/Species

13.57 Changes in water quality could potentially impact intertidal species and habitats when submerged and subtidal species and habitats. Resettlement of suspended solids could potentially inhibit breathing and feeding apparatus of some benthic species located on the surface of the sediment. However, organisms present in the intertidal area are expected to be well adapted to naturally high levels of suspended solids.

13.58 Chemicals released through mobilisation of contaminated sediment have the potential to cause toxic effects on intertidal and subtidal species. A full characterisation and assessment of sediment contamination is presented as part of Appendix 13.7: *Water Framework Directive Assessment* (document reference: 6.2.13.7). This assessment concludes that effects on water quality will be negligible.

13.59 Tidal movements would rapidly disperse any chemicals within the water column.

13.60 The magnitude of this impact is assessed to be negligible on these high value receptors. The significance of effect is assessed to be **minor adverse**.

Fish

13.61 Increased turbidity caused by the resuspension of bottom sediments may reduce the visual range of fish, potentially impacting their feeding ability. Physiological effects may also occur such as reduced gill function. Fish are highly mobile species and expected to move away from unfavourable conditions where possible. In addition, the tidal River Thames is naturally turbid and therefore the fish are expected to be adapted to high levels of suspended solids. The effects on water quality of the Proposed Development in relation to baseline levels of chemicals in the water column are assessed to be negligible (see also the Water Framework Directive assessment submitted as part of this DCO application (Appendix 13.7, document reference: 6.2.13.7)) and any potential increased chemical concentrations would likely be short-term with tidal movements rapidly dispersing chemicals in the water column. The effect is assessed to be of **minor adverse significance** for protected species and of **negligible** significance for other fish species.

Designated Sites

13.62 The Kent Project Site is within, and therefore directly interacts with, the Swanscombe MCZ. Potential effects on the MCZ are indicated within the MCZ assessment (Appendix 13.8, document reference: 6.2.13.8). Water Quality was only taken through to MCZ

assessment in terms of changes in suspended solid levels. Based on the outputs of hydrodynamic modelling (The London Resort: Hydrodynamic and sedimentation assessment - ES Appendix 17.4, document reference: 6.2.17.4) and the naturally high and variable turbidity in the Thames Estuary it was concluded that changes in suspended sediment levels would not have a significant effect on the MCZ features (intertidal mud; tentacled lagoon worm *A. romijni*).

13.63 West Thurrock Lagoon & Marshes SSSI is located approximately 1 km west of the Kent Project Site and is designated to protect wintering waders and wildfowl that use the intertidal mudflats. Due to the distance of the site from the works and the extent of potential effects of the works on water chemistry significance of effect is assessed to be **no change**.

Loss of Habitat

Construction Details

13.64 At the Kent Project Site, there will be a loss of habitat within the footprint of the new structures on the seabed. This will include the new passenger pier and part of the new ferry terminal structure as well as: a new Ro-Ro slipway (Option A); or the refurbishment of White's Jetty (Option B); or the removal of sediment within the dredge pocket (Option C). The passenger pier and Option A are likely to be piled with an open structure between piles.

13.65 The Swanscombe ferry terminal itself will extend beyond the existing Bell Wharf and into the intertidal zone. The ferry terminal is piled with a platform overhanging the intertidal zone, however, due to the effects of shading and the fact that the number of piles required has not yet been finalised, for the purposes of this assessment a worst-case scenario has been assumed in terms of the footprint of the ferry terminal representing a loss of habitat. Under this scenario, for all Options the terminal has been assumed to result in a loss of 5,162 sq m of intertidal mud and 5,812 sq m of the adjacent saltmarsh habitat (although with the ferry terminal being raised on piles the actual loss of habitat would be far less than this).

13.66 For all Options, the passenger jetty will be a floating pontoon structure with two 0.9 m piles (with an area of 1.3 sq m in the subtidal) and there will be a gangway to link the jetty with the ferry terminal.

13.67 For Option A, there would also be two 2 m diameter piles for the Ro-Ro guide piles in the subtidal zone (with an area of 6.28 sq m). In addition, there would be four 1 m diameter piles for the gangway prior to the linkspan in the intertidal zone (with an area of 3.14 sq). The linkspan will not require piles or any other footprint in the intertidal.

13.68 For Option B, the only footprint in the subtidal zone would be the two 0.9 m piles for the floating pontoon as indicated above (with an area of 1.3 sq m.).

13.69 For Option C, there will be a loss of habitat within the dredge pocket as the subtidal habitat will be removed. The area of the dredge pocket is 77,430 sq m (with 628 sq m in the intertidal and 76,802 sq m in the subtidal).

13.70 An outfall is required for the wastewater treatment plant and up to five outfalls may be required for surface runoff at the Kent Project Site. As a worst-case scenario, cofferdams may need to be constructed to install the outfalls. For the purposes of assessment it is currently assumed that cofferdam construction could occur along approximately 30 to 50 m of the saltmarsh and approximately 65 to 350 m of the intertidal mud depending on location, with a footprint width of 7 m. These cofferdams would be temporary and at this stage are anticipated to be in place for no more than a few months.

13.71 At the Essex Project Site, there will be a loss of habitat within the footprint of the piles for the extension to the jetty of 5.09 sq m within the subtidal zone.

13.72 A summary of the footprints for the different options is provided in Table 13.14 below (intertidal loss encompasses loss of intertidal soft sediment and saltmarsh due to the ferry terminal and cofferdam construction for outfalls).

Table 13.14. Habitat Loss Estimates.

Site	Area of Intertidal Habitat Loss (m^2)	Area of Subtidal Habitat Loss (m^2)	Total Habitat Loss (m^2)
Kent Site Option A	16,353.1	7.6	16,360.7
Kent Site Option B	16,350	1.3	16,351.3
Kent Site Option C	16,978	76,803.3	93,781.3
Essex Site	-	5.1	5.1

Intertidal and Subtidal Habitats/Species (including saltmarsh)

13.73 The footprint for the ferry terminal structure together with the three options will result in a loss of intertidal mud habitat at the Kent Project Site of:

- Option A: 5,165 sq m (structures)
- Option B: 5,162 sq m (structures)
- Option C: 5,162 sq m (structures). For Option C there will also be a loss of 628 sq m of intertidal mud within the dredge pocket as this area will become subtidal. So total loss of 5,790 sq m.

13.74 Installing cofferdams for the outfalls will result in a temporary loss of approximately 4,186 sq m of intertidal mud habitat at the Kent Project Site. The cofferdam would be anticipated to be in place for a number of months so there may be opportunity for intertidal mud to become re-established once the cofferdam is removed.

13.75 For context, the loss of intertidal mud (including temporary loss due to the cofferdams) equates to 0.11-0.12% of intertidal mud in the Thames Middle WFD water body for all options (based on an extent in the Thames Middle WFD water body of 8,387,766 sq m (838.78 ha)).

13.76 At the Essex Project Site there will be no intertidal habitat loss.

13.77 In addition, 5,812 sq m of saltmarsh will also be lost within the footprint of the Swanscombe Ferry Terminal for all three options. Installing cofferdams for the outfalls is estimated to potentially result in a further temporary loss of approximately 1,190 sq m of saltmarsh. There is approximately 1,300,600 sq m (130.06 ha) of saltmarsh within the Thames Middle WFD water body. This is a loss of approximately 0.54% of saltmarsh that is currently present with the Thames Middle water body (this is also assessed in Appendix 13.7: *WFD Assessment*, document reference: 6.2.13.5).

13.78 However, as embedded mitigation for he Proposed Development an area of up to 3 ha (30,000 sq) of saltmarsh will be created with further areas of saltmarsh enhanced. See Appendix 12.3*: Ecological Mitigation and Management Framework* (document reference 6.2.12.3) for details.

13.79 With this embedded mitigation in place, the loss of saltmarsh is assessed to be of negligible magnitude on this high value receptor. Overall, it is considered that the loss of saltmarsh is of **minor adverse significance**.

13.80 In the subtidal zone at the Kent Project Site, the piles for the new passenger pier will result in the loss of approximately 1.3 sq m of subtidal habitat with a further 76,802 sq m lost as a result of the dredge pocket if Option C is chosen. At the Essex Project Site, the loss of subtidal habitat will be approximately 5.1 sq m due to the footprint of the piles for the extension to the jetty.

13.81 The loss of intertidal/subtidal mud has the potential to affect *A. romijni* which is a protected feature of the Swanscombe MCZ and is protected by section 9 and Schedule 5 of the Wildlife and Countryside Act. Potential effects on *A. romijni* and intertidal mud as as supporting feature, in terms of management of the MCZ have been assessed within a separate MCZ Assessment (Appendix 13.8: document reference: 6.2.13.8). Although intertidal mud is protected in this location as a supporting habitat for *A. romijni*, the only individuals recorded during project-specific intertidal and subtidal surveys conducted at this site in 2015 and 2020 were in the subtidal zone with no tentacled lagoon worm individuals recorded in the intertidal zone. In addition, the MCZ assessment concluded that the area of intertidal mud habitat potentially permanently lost during construction is very small in relation to the availability of this habitat in the MCZ for Options A and B in particular. It was considered unlikely that the Proposed Development would hinder the achievement of the conservation objectives stated for the MCZ for the intertidal mud feature and it was considered that the public authority would be able to exercise its functions to further the conservation objectives stated for the MCZ for this feature.

13.82 Under Option C a total of 76,802 sq m of subtidal habitat would be dredged. Although sediment in dredge pockets can be recolonised over time, this area is considered to be lost for the purposes of assessment due to the removal of individuals within the extracted sediment. Based on the numbers of *A. romijni* individuals potentially present in subtidal sediments in this area and that this species was recorded within the proposed dredge pocket during the 2020 survey (Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions*, document reference: 6.2.13.2), the magnitude of this impact is assessed to be moderate on this high value species and the overall significance of this effect on *A. romijni* is assessed to be of **moderate adverse significance.** Therefore, if Option C is selected mitigation would be required with potential options to be discussed with statutory consultees/regulators. It is for this reason that Option C would only be pursued if Options A and B prove to be unfeasible. The outcome was similar for the MCZ assessment where it was considered for Option C (i.e. with dredging) there would be a significant risk that the conservation objectives for tentacled lagoon worm would be hindered in terms of habitat loss and disturbance and Options A and B would be preferred Options and if Option C was pursued a Stage 2 assessment would be required.

13.83 If Option A or B is chosen, due to the very small areas of subtidal habitat lost or disturbed due to the works, the effect on *A. romijni* is assessed to be of **minor adverse significance.**

13.84 Other intertidal habitats (other than saltmarsh) and subtidal species/habitats present within the construction area are relatively widespread within the tidal Thames (Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions*, document reference: 6.2.13.2) and the loss of other intertidal and subtidal species/habitats is assessed to be of **minor adverse significance**.

Fish

13.85 The main fish species that could be affected from habitat loss from the installation of piles and possible dredging are benthic fish species (e.g. flatfish and gobies) and other species which utilise the estuary margins (e.g. juvenile sea bass). Fish are highly mobile and could swim away from the area if disturbed by construction activities. Intertidal mud is widespread within the wider Thames Estuary and is available in the immediate vicinity of the Kent and Essex Project Sites so fish would not have to move far to find similar habitat.

13.86 The loss of benthic habitat is assessed to be of **minor adverse significance** for fish.

Designated Sites

13.87 The Kent Project Site directly interacts with the Swanscombe MCZ. Potential effects on the MCZ are indicated within the MCZ assessment (Appendix 13.8, document reference: 6.2.13.8). Potential effects are indicated above and overall it was concluded that for all options it was considered unlikely that the Proposed Development would hinder the achievement of the conservation objectives stated for the MCZ for the intertidal mud feature and it was considered that the public authority would be able to exercise its

functions to further the conservation objectives stated for the MCZ for this feature. Therefore effects on the intertidal mud MCZ feature are considered to be **negligible.** The areas of subtidal habitat lost with Options A and B is extremely small so effects on the MCZ feature tentacled lagoon worm would be expected to be of **minor adverse significance**, but with the dredging required for Option C it was considered that there would be a significant risk that the conservation objectives for tentacled lagoon worm would be hindered in terms of habitat loss and disturbance and a Stage 2 assessment would be required. For this reason, Options A and B are the preferred Options and Option C will only be pursued if Options A and B are not feasible.

13.88 There will not be any loss of habitat at the West Thurrock Lagoon & Marshes SSSI and there is therefore no significant effect on this site.

Physical Disturbance and Displacement

Construction Details

13.89 There could be physical disturbance and displacement of intertidal invertebrates, subtidal invertebrates or fish within areas immediately outside the piling, dredging and construction areas due to physical disturbance of sediment. For subtidal invertebrates and fish, this could include light smothering of some individuals by sediment settling out of solution.

13.90 Details on access to the foreshore for construction personnel, plant and equipment has not yet been determined. Taking a worst-case approach, there is potential for affects associated with access of personnel and plant to the foreshore.

Intertidal Habitat/Species (including saltmarsh)

13.91 Construction and dredging activities in the intertidal area are likely to disturb sediment in the areas immediately outside the construction footprints and a small number of intertidal species and small areas of habitats including saltmarsh may be disturbed or displaced. However, there is unlikely to be a detectable change in population levels and similar intertidal mud habitats are widespread in the tidal River Thames and the number of invertebrate individuals affected are considered to be negligible in relation to the wider population.

13.92 It is considered likely that any effect would be of **minor adverse significance** for intertidal species and habitats**.**

13.93 Saltmarsh require suspended sediment to develop and can survive smothering of up to 5 cm depth for a month or longer (Tyler-Walters 2001). The effect of sediment resuspension and deposition on saltmarsh during construction (if any) is assessed to be of **minor adverse significance.** If construction personnel, plant and equipment access the Swanscombe Ferry Terminal construction site through the saltmarsh areas, there is the potential for physical disturbance to the saltmarsh habitat. Saltmarsh is considered to

have a low sensitivity to trampling and vehicle use (Tyler-Walters 2001). The effect will be limited to the area traversed and the magnitude of the impact is assessed to be minor. Overall, the significance of trampling and vehicle use through the saltmarsh is assessed to be of **minor adverse significance** on this high value receptor.

Subtidal Habitat/Species

13.94 The area of subtidal sediment potentially affected by this disturbance during piling of the jetty and the dredge pocket would be larger than the area within the pile, White's Jetty footprints and dredge pocket, but would still be very small in relation to the availability of similar habitats within the Kent and Essex Project Sites and wider Estuary. In addition, any disturbed/displaced benthic invertebrates would only be displaced a short distance and in general individuals are likely to survive such a disturbance although some may be subject to injury/mortality. The disturbance would be small in relation to the availability of similar habitat within the Kent and Essex Project Sites and the number of individuals affected would be negligible in relation to wider populations within the tidal River Thames. However, as *A. romijni* is a high value species, the overall significance of the effect is assessed to be of **adverse minor significance**. Any effects of disturbance of organisms due to the works would be **negligible** for all other subtidal species and habitats.

Fish

13.95 Fish are highly mobile and any fish physically disturbed by piling and other works due to sediment movement/changes in habitat would be able to avoid the area during periods of disturbance and return to the area if required once disturbance has ceased. The subtidal habitat that may be disturbed during construction is widespread within the Kent and Essex Project Sites and wider Estuary, and fish would not have to move far to find similar habitat.

13.96 Any effects are considered likely to be of **minor adverse significance** for protected species and of **negligible** significance for other fish species**.**

Designated Sites

13.97 Construction activities in the intertidal area are likely to disturb sediment in the areas immediately outside the construction footprint (within a number of metres of a pile location, for example) and species such as *A. romijni* which is a feature of the MCZ may be disturbed or displaced. There could also be displacement due to use of positional thrusters by vessels and due to scour at outfall locations. The potential effects on the Swanscombe MCZ are presented within the MCZ Assessment (Appendix 13.8, document reference: 6.2.13.8). The areas subjected to these effects, however, are considered to be extremely small in relation to the availability of suitable habitats within the Proposed Development Site and the wider MCZ. If Option C is chosen, dredging will be required and the effects of disturbance and displacement will be far greater than if Option A or B are chosen. Under Options A and B, the conclusion of the MCZ assessment was that for the Swanscombe MCZ there is limited risk of the Proposed Development hindering the achievement of the conservation objectives stated for the MCZ and the MMO would be able to exercise its

functions to further the conservation objectives stated for the MCZ and for the purposes of assessment effects are considered to be of **minor adverse significance** with Options A and B. Under Option C, however, there is a significant risk that achievement of conservation objectives could potentially be hindered in terms of the loss/disturbance of intertidal and subtidal habitat for tentacled lagoon worm. For this reason, Options A and B are the preferred Options and Option C will only be pursued if Options A and B are not feasible.

13.98 No effects are considered likely for the supporting habitats of the West Thurrock Lagoon & Marshes SSSI given the distance from the Kent and Essex Project Sites. It is considered likely that any effect would be of **minor adverse significance** for West Thurrock Lagoon & Marshes SSSI**.**

Visual Disturbance

Construction Details

13.99 Visual disturbance could be associated with the presence of vessels during construction of the jetty. There is also potential for visual disturbance due to any artificial light used during the construction works, but this is considered as a separate impact pathway below.

Fish and Marine Mammals

13.100 Fish and marine mammals are highly mobile and are also well habituated to the presence of vessels in the tidal River Thames. Fish could avoid the area due to any visual disturbance if required. In addition, the numbers of marine mammals frequenting the tidal River Thames is very low. Effects are considered to be of **minor adverse significance** for protected species and of **negligible** significance for other non-protected fish species**.**

Increase in Underwater Noise and Vibration

Construction Details

13.101 The biggest potential source of noise and vibration is from the piling for the new passenger pier at the Kent Project Site, extension of the jetty at the Essex Project Site and mooring area at the Essex Project Site. In addition, if cofferdams are required for the installation of outfalls for the wastewater treatment facility and surface water runoff and for saltmarsh creation (with re-profiling of the shoreline in the 'dry'), the cofferdam walls are likely to be piled into place. Taking a precautionary approach it has been assumed that percussive piling could be used as a worst-case scenario. If piles were installed using vibropiling or drilled into place using a rotary auger drill, then potential noise and vibration levels would be much lower.

13.102 The peak sound levels generated by percussive piling are influenced by several factors including pile type and diameter, hammer size and substrate type (Popper *et al*. 2014). Percussive piling uses the downward impact of hammers to drive piles into the substrate.

Percussive piling can generate impulses with sound pressure levels of 180-235 dB re: 1 µPa (DPTI 2012). The noise and vibration generated by percussive piling is intermittent as opposed to continuous.

13.103 The largest pile that will be used for the project is a 2 m diameter pile. A worst-case scenario has been assumed which is a cast-in-stainless-steel (CISS) pile of 2.4 m diameter. A study of piling of this type of pile in approximately 10 m water depth indicated peak estimated noise levels at source were 220 dB re 1 μPa_{Peak}[1], 205 dB re 1 μPa_{RMS}[2] and 195 dB SEL_{cum}[3] (Caltrans 2015).

13.104 There will be two piles of this size for the Ro-Ro slipway for Option A. The other piles are all smaller: four 1 m diameter piles for the Ro-Ro gangway; two 0.9 m diameter piles for the passenger pier at the Kent Project Site; and eight 0.9 m diameter piles for the extension of the jetty at the Essex Project Site. Piles for the cofferdam would likely be AZ steel sheets which are generally smaller and generate less noise when installed than the 1-2 m diameter piles.

13.105 General construction hours will be 08.00 hours to 18.00 hours Monday to Friday and 08.00 hours to 13.00 hours on Saturdays, with no working on Sundays without prior agreement from the relevant local authority. At this stage of the Project it is not known when piling will take place and so a worst-case scenario has been assessed which is that piling may take place at any time of year.

13.106 Dredging activity also generates noise and the assessment has been conducted based on deployment of a backhoe dredger.

13.107 Noise and vibration would also be generated by the barges and other boats utilised to construct the new jetties and mooring structures. For the purposes of assessment, the upper limit for daily barge movements during construction is likely to be the capacity of the berths at the resort site, this has been assessed at 10 barge movements per day, (ES Appendix 10.1: *Preliminary Navigational Risk Assessment*, document reference: 6.2.10.1). It is likely that piles may be installed by a vessel such as a jack up barge, there may be floating cranes, safety boats or supply vessels. Some indicative underwater noise levels for the operation of similar vessels are provided in Table 13.15.

[1] The peak pressure is the range in pressure between zero and the greatest pressure of the signal.

[2] The root-mean-square (rms) pressure is the square root of the average of the square of the pressure of the sound signal over a given duration.

[3] Sound exposure level (SEL) is a measure of energy that takes into account both received level and duration of exposure. It can be computed for multiple pulses or signals to generate a value equivalent to a single exposure for the cumulative sound energy (SEL_{cum}).

Table 13.15. Typical Source Noise Levels for expected Construction Vessels.

Vessel	Vessel Details	Frequency Range (kHz)	Extrapolated Source Noise Level	Reference
Tug	Manoeuvring sealift barge in shallow water	0.01 to 20	170 dB re 1µ Pa, peak-peak (based on measurement of 144 dB rms re 1 µPa @ 60 m) Equivalent to 221 dB re 1 μPa^2s SEL	Richardson (2006); Patterson & Blackwell (2007); Xodus Group (2015)
Crew Boat	8.5 m long underway at 13 knots	0.01 to 20	175 dB re 1µ Pa, peak-peak (based on measurement of 166 dB rms re 1 µPa @ 1m)	Zykov & Hannay (2006)
Two stroke and four stroke vessels	Various vessel types	0.2 to 40	130 to 149 dB re 1 μPa^2s SEL	Jensen *et al*. (2009)
Backhoe Dredger	3,434-hp, 61 m long, can operate up to 25 m water depth	0.020 to 11	179 (max. measurement of engine/generator noise of 167 dB re 1 µPa @ 1m rms, and of the bottom scoop of 179.4 dB re 1 µPa @ 1m rms)	Reine *et al*. (2012)

Benthic Invertebrates

13.108 Anthropogenic sources of underwater noise and vibration have been shown to have potential effects on benthic invertebrates that do not rely on acoustics for communication. Studies of invertebrates have indicated that increased noise and vibration levels can result in increased mortality, injury to tissues, growth and reproductive rates, and food uptake in invertebrates (Popper & Hawkins 2018; Hawkins & Popper 2016; Solan *et al*. 2016; Aguilar de Soto *et al*. 2016; Spiga *et al*. 2012).

13.109 Invertebrate species are unable to detect sound pressure but are likely to be able to detect particle motion through a variety of organs such as hairs on the body that respond to mechanical stimulation, chordotonal organs associated with joints, or vibrations transmitted through the exoskeleton from the substrate (Popper & Hawkins 2018).

13.110 The effects of pile driving on a bivalve mollusc has been studied by Spiga *et al*. (2016) with individuals subjected to pile driving exhibiting increased feeding (filtering) rate than those in ambient conditions. This is a developing area of research, however, and currently there are insufficient data on the effects of underwater noise and vibration on invertebrates to establish noise criteria (Popper *et al*. 2014).

13.111 There is potential for underwater noise and vibration from the piling works to have an effect on individuals of some of the invertebrate species present and taking a precautionary approach it is assumed some individuals could suffer injury or mortality (with lesser effects expected to be potentially associated with noise and vibration generated by vessels). However, noise and vibration from vessels and piling activity will rapidly attenuate with increased distance from the source and these effects are not expected to be detectable at a population level. The effects of noise and vibration from dredging will be less than for piling. The effect is assessed to be **negligible.**

Fish

13.112 Underwater noise and vibration may cause the following effects on fish:

- Behavioural effects (e.g. reduced detection of predators/prey, inhibited communication between conspecifics, alteration in swimming behaviour);
- Masking effects (i.e. the reduced detectability of a given sound owing to the simultaneous occurrence of another sound);
- Temporary threshold shift (TTS) in hearing (short or long-term changes in hearing sensitivity that may or may not reduce fitness);
- Recoverable tissue injury (not resulting in mortality e.g. hair cell damage, minor internal or external hematoma etc.); and
- Mortality or potential mortal injury (immediate or delayed death).

13.113 There can also be vibration effects within the immediate vicinity of piling or other sources of noise that can cause slight movement of sediment that in turn may have an effect on the behaviour of benthic fish species, or could potentially affect the viability of fish eggs near the source (Popper & Hawkins 2018). Vibration can also refer to the effects of particle motion (separate from sound pressure) in the water column. However, very little research has been conducted on the effects of vibration on fish. Noise and vibration are produced at the same time and so for the purposes of this assessment we have referred to them together as appropriate. However, this is a complex field of research requiring further academic investigation, beyond the scope of this project.

13.114 Hearing abilities of fish are related to the morphological adaptations of the acoustico-lateralis apparatus, in particular the distance of the swim bladder to the inner ear (Hastings & Popper 2005; Mason 2013). Species with no swim bladder (e.g. flatfish) have a lower hearing ability than many other fish species and rely on the detection of particle motion (the oscillatory displacement of fluid particles in a sound field) (Popper *et al*. 2014). Fish species with a swim bladder but with no connection to the inner ear (e.g. salmon) have better hearing but can also only detect particle motion. Species that have an extension of the swim bladder that terminates in the inner ear (e.g. herring) can hear sounds over a far

greater range than other species (Popper *et al*. 2014; Gill *et al*. 2012) and can detect both particle motion and sound pressure (a form of stress measured in terms of force/unit area).

13.115 Popper *et al*. (2014) provides criteria that can be applied to assess the potential effects of noise and vibration on fish from different marine activities such as piling, dredging and vessel movements. The approach assesses the potential effects of underwater noise and vibration on fish based on grouping species according to their hearing apparatus, specifically whether they have no swim bladder, they have a swim bladder but it is not involved in hearing, or they have a swim bladder which is involved in hearing (Popper *et al*. 2014).

13.116 The noise levels are based on consideration of peak noise (the maximum absolute value of the instantaneous sound pressure (or motion) during a specified time interval), and cumulative Sound Exposure Level (SEL_{cum}) which is the linear summation of the individual sound events over the time period of interest and can be calculated as:

SELss +10log 10 (N)*

*where SELss is the Sound Exposure Level for a single strike and N is the number of impulsive events (Popper *et al*. 2014).

13.117 Insufficient data exists to make a recommendation for guidelines in relation to masking effects or behavioural effects and therefore a subjective approach has been adopted in which relative risk of an effect is placed in order of rank at three distances from the source – near (tens of metres from the source), intermediate (hundreds of metres from the source) and far (thousands of metres from the source) (refer to Table 13.16). If very large piles are used as described above, the Peak noise levels at source and Cumulative Sound Exposure are likely to exceed the values indicated in Table 13.13. However, as specific underwater noise data for the proposed piling approach are not available, this cannot be confirmed at this stage. Sound levels would attenuate rapidly throughout the water column with increased distance from the source.

Table 13.16. Proposed mortality, potential injury, temporary threshold shift, masking and behaviour criteria for fish (Popper et al. 2014).

Fish Grouping	Mortality and potential mortal injury	Impairment			
		Recoverable injury	Temporary Threshold Shift	Masking	Behaviour
Pile Driving					
No swim bladder (particle motion detection)	>219 dB SEL_{cum} or >213 dB peak	>216 dB SEL_{cum} or >213 dB peak	>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Swim bladder is not involved in hearing (particle motion detection)	210 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Swim bladder is involved in hearing (primarily pressure detection)	207 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	186 dB SEL_{cum}	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Shipping and Continuous Sounds					
No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Swim bladder is not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Swim bladder is involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB rms for 48 hrs	158 dB rms for 12 hrs	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low

Notes: peak and rms sound pressure levels dB re 1 µPa; SEL dB re 1 $\mu Pa^2 \cdot s$. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N; tens of metres from source), intermediate (I; hundreds of metres from source), and far (F; thousands of metres from source).

13.118 For continuous noise sources such as vibropiling, dredging and vessel noise, quantitative criteria for assessment are only available for recoverable injury and TTS. For other potential effects (i.e. masking and behaviour changes) the subjective approach indicated above is applicable (see Table 13.6).

13.119 This assessment focuses on key fish species of conservation importance indicated in Appendix 13.2: *Marine Biology and Biodiversity Baseline Conditions*, document reference: 6.2.13.2.

European Plaice, Dover Sole, Sand Goby, Common Goby, Angler Fish, Bullhead, Raitt's Sand Eel, Lamprey (River and Sea)

13.120 These are examples of species in the category 'No swim bladder (particle motion detection)'. These species do not detect sound pressure and primarily detect particle motion.

13.121 For vessel noise, using the criteria set out by Popper *et al*. (2014) there is a high risk of masking effects for individuals within hundreds of metres with a moderate risk beyond this distance. Behavioural effects may be evident at distances of hundreds of metres from the source. However, these effects are unlikely to cause mortality or mortal injury. If vessels were continually generating noise throughout the construction period there would be a moderate risk of TTS within tens of metres of the activity; however, vessel activity at the Kent and Essex sites would be expected to be intermittent.

13.122 The peak noise levels generated by percussive pile driving could result in mortality or potentially mortal injury, although it would be expected that such noise levels would only be encountered in the immediate vicinity of the piling.

13.123 Piling activities will be restricted to standard working hours and therefore there would be extensive windows of no piling activity when fish could move past the area and fish could swim away from the area if required.

13.124 Effects are considered likely to be of **minor adverse significance.**

Atlantic Salmon, Sea Trout, European Smelt, Short-Snouted Seahorse

13.125 These are examples of species in the category of 'Swim bladder is not involved in hearing (particle motion detector)'. It has been found that Atlantic salmon only respond to low frequency tones (below 380 Hz) with particle motion as the stimulus (Hawkins & Johnstone 1978). This species, therefore, is primarily a kinetic detector with poor hearing compared to species that hear sound pressure. Similarly, sea trout have a swim bladder but do not possess specialised hearing structures and do not have a wide hearing bandwidth or sensitivity to sound pressure levels. It is considered that they rely on particle motion for hearing. European smelt has similar peak hearing thresholds to these species.

13.126 When considering pile driving there could be mortality or potential mortal injury close to

the noise source as the source noise levels (220 dB peak) exceed the criteria for these types of effects (>207 dB peak), although such noise levels are only expected to be encountered very close to the piling source and noise attenuates rapidly away from the noise source. There is also potential for recoverable injuries, TTS, behavioural effects and masking effects to occur.

13.127 For vessel noise, using the criteria set out by Popper *et al*. (2014) there is a high risk of masking effects for individuals within hundreds of metres with a moderate risk beyond this distance. Behavioural effects may be evident at distances of hundreds of metres from the source. However, these effects are unlikely to cause mortality or mortal injury. If vessels were continually generating noise throughout the construction period, there would be a moderate risk of temporary threshold shift within tens of metres of the activity; however, vessel activity at the Kent and Essex Project Sites would be expected to be intermittent.

13.128 As set out above, a worst-case scenario has been assumed which is that noisy activities such as piling may be conducted during fish migratory periods. However, piling activities will be restricted to standard working hours and therefore there would be extensive windows of no piling activity when fish could move past the area and fish could swim away from the area if required. Any effects are considered likely to be of **moderate adverse significance**. Consequently, mitigation measures have been proposed to reduce the significance of this effect (see the *Proposed Mitigation* section).

European Eel, Herring, Shad, Atlantic Cod, Whiting

13.129 These are examples of species in the category 'Swim bladder is involved in hearing (primarily pressure detection)', although hearing capability does vary significantly between species. Clupeid fishes (herrings and shads) possess a swim bladder with special anatomical adaptations which increases the species sensitivity to underwater noise and enables them to detect noise pressure (Popper *et al*. 2014). In gadoid fish, such as Atlantic cod and whiting, the swim bladder has an accessory role in hearing and the species is pressure sensitive to high frequencies (Popper *et al*. 2014). European eels detect both sound pressure and particle motion which increases the species hearing sensitivity and bandwidth (Popper *et al*. 2014). At low frequencies, the eel's relevant stimulus parameter is particle motion and there is no involvement of the swim bladder. At higher frequencies the swim bladder enables the detection of pressure, but there are no specialised anatomical adaptions (Jerkø *et al*. 1989).

13.130 When considering pile driving there could be mortality or potential mortal injury, or a recoverable injury close to the noise source as the source noise levels (220 dB peak) exceed the criteria (>207 dB peak) for these types of effects, although such noise levels are only expected to be encountered very close to the piling source and noise attenuates rapidly away from the noise source. TTS may occur in individuals further away from the noise source as the criteria is 186 dB SEL_{cum} and piling may generate levels of 195 dB SEL_{cum}. There is also potential for behavioural effects and masking effects to occur.

13.131 Using the criteria set out by Popper *et al*. (2014), and in the context of vessel noise, individuals could experience masking effects up to thousands of metres from the source. The criteria suggest there is a high risk of behavioural effects tens of metres from the source which decreases to moderate risk hundreds of metres from the source. These behavioural and masking effects are unlikely to impact the survival of individuals. The noise levels at which there are risks of TTS or recoverable injury (refer to Table 13.17) could potentially be generated by vessels. However, these effects are associated with continuous exposure for 12 to 48 hours and any vessel noise associated with construction works would be expected to be far more intermittent. Up to 10 barge movements a day are likely to be required for construction of the passenger pier at the Kent Project Site and extension to Tilbury jetty (Essex Project Site), (Appendix 10.1: *Preliminary Navigational Risk Assessment*, document reference: 6.2.10.1).

13.132 Migratory periods are sensitive periods when considering the effects of underwater noise and vibration on diadromous fish species. As the detailed timings of the work are not yet known, a worst-case scenario has been assumed which is that noisy activities such as piling may be conducted at any time of year, including during fish migration periods. However, piling activities will be restricted to standard working hours and therefore there would be extensive windows of no piling activity when fish could move past the area. Any effects are considered likely to be of **moderate adverse significance.** Consequently mitigation measures have been proposed to reduce the significance of this effect (see the *Proposed Mitigation* section).

Marine Mammals

13.133 Underwater noise and vibration can cause physical injury to marine mammals in the form of Permanent Threshold Shift (PTS) (i.e. permanent hearing damage caused by very intensive noise or by prolonged exposure to noise) or TTS. It can also cause behavioural effects such as avoidance of an area subject to noise disturbance.

13.134 Southall *et al*. (2019) provides criteria for assessing the effects of noise and vibration on marine mammals. Southall *et al*. (2019) presents estimated audiograms, weighting functions and underwater noise exposure criteria for six species groupings which include all marine mammals:

- Low-frequency cetaceans (LF);
- High-frequency cetaceans (HF);
- Very high-frequency cetaceans (VHF);
- Sirenians (SI);
- Phocid carnivores in water (PCW) & Phocid carnivores in air (PCA); and
- Other marine carnivores in water (OCW) & Other marine carnivores in air (OCA).

13.135 Noise sources are categorised as either non-impulsive (continuous) or impulsive sources. Exposure criteria are given in frequency-weighted sound exposure level; whilst dual exposure metrics are provided for impulsive noise criteria which include, frequency-weighted SEL and unweighted peak sound pressure level. Exposures that exceed specified respective criteria for exposure metrics are interpreted as resulting in TTS or PTS onset.

13.136 The main marine mammals that could potentially be present in the vicinity of the Kent and Essex Project Sites have been allocated to these hearing groups and the assessment has focussed on these species:

- Grey seal (*Halichoerus grypus*) – PCW;
- Harbour seal (*Phoca vitulina*) – PCW;
- Harbour porpoise (*Phocoena phocoena*) – VHF; and
- Bottlenose dolphin (*Tursiops truncatus*) – HF.

13.137 Marine mammals that could possibly be present in the area could potentially be affected if non-impulsive noise levels indicated in Table 13.17 are reached during the proposed construction works. Non-impulsive noise sources include vessel noise. Similarly, marine mammals in the vicinity of the construction works could also be affected if impulsive noise levels from activities such as piling reach the values indicated in Table 13.18**.**

Table 13.17. Non-impulsive noise: TTS and PTS onset thresholds for Very High Frequency cetaceans (VHF), High Frequency cetaceans (HF) and Phocid Carnivores in Water (PCW): SEL thresholds in dB re 1 µPa2s under water.

Hearing Group	Permanent Threshold Shift: SEL weighted	Temporary Threshold Shift: SEL weighted
Very High Frequency cetaceans (VHF)	173	153
High Frequency cetaceans (HF)	198	178
Phocid carnivores in water (PCW)	201	181

Table 13.18. Impulsive noise: TTS and PTS onset thresholds for Very High Frequency cetaceans (VHF), High Frequency cetaceans (HF) and Phocid Carnivores in Water (PCW): SEL thresholds in in dB re 1 µPa2s under water and peak SPL thresholds in dB re 1 µPa under water.

Hearing Group	Permanent Threshold Shift: SEL weighted	Temporary Threshold Shift: SEL weighted	Permanent Threshold Shift: Peak SPL (unweighted)	Temporary Threshold Shift: Peak SPL (unweighted)
Very High Frequency cetaceans (VHF)	155	140	202	196
High Frequency cetaceans (HF)	185	170	230	224
Phocid carnivores in water (PCW)	185	170	218	212

13.138 Data on the cumulative SEL of vessels suggest that PTS and TTS effects could occur in all four species of marine mammals within close proximity to construction vessels. However, it is not expected that marine mammals would stay close to construction vessels for any length of time but are more likely to transition through the area. In addition, many construction vessels will use anchors to remain in position whilst working on site and so will have engines switched off thereby generating less noise. Up to 10 construction barges may travel to the Kent and Essex Project Sites a day during the construction period, (ES Appendix 10.1: *Preliminary Navigational Risk Assessment*, document reference: 6.2.10.1). The potential impact of noise and vibration on marine mammals from vessels is assessed to be of negligible magnitude and the overall effect is assessed to be of **minor adverse significance.**

13.139 Based on the source levels produced by percussive piling and the criteria provided in Table 13.18 above, peak noise levels from piling for the passenger pier at the Kent Project Site, the extension of Tilbury jetty and the moorings (Essex Project Site) have the potential to cause PTS in harbour porpoise and harbour and grey seals. Repeated exposure to these noise levels (SEL_{cum}) may also cause PTS in bottlenose dolphin in addition to the three aforementioned species. Noise from piling will attenuate rapidly away from the noise source and so this affect will be localised to a small area near the piling activity. Further away from the piling there is potential for TTS and behavioural effects to occur.

13.140 The number of marine mammals in the area at any one time is expected to be low (see Baseline Conditions) and so the potential for marine mammals to be close enough to piling to cause injury is expected to be low. However, it is possible that noise from piling could deter the movement of individuals upstream or downstream along the tidal Thames. The potential significance of this effect is assessed to be of **moderate adverse significance.**

Consequently, mitigation measures have been proposed to reduce the significance of this effect (see the *Proposed Mitigation* section).

Use of Artificial Lighting

Construction Details

13.141 The construction sites will be lit overnight for health and safety purposes.

13.142 Navigation lighting will be in accordance with PLA and International Maritime Organization (IMO) International Regulations for Preventing Collisions at Sea 1972 (COLREG) requirements.

13.143 Light levels for each aspect of construction and navigational lighting are anticipated to be similar to current lighting levels routinely experienced along the Thames Estuary.

Intertidal Habitats/Species

13.144 The majority of the intertidal mudflats at the Kent Project Site are classified as *Hediste diversicolor* and *Streblospio shrubsolii* in littoral sandy mud (EUNIS: A2.3221; JNCC: LS.LMu.UEst.Hed.Str); but the area in front of Bell Wharf is classified as the broader classification Polychaete / oligochaete dominated upper estuarine mud shores (EUNIS: A2.32; JNCC: LS.LMu.UEst). The characterising species of these biotopes are not considered to be sensitive to the effects of changes in incident light (Ashley & Budd 2020).

13.145 The effect would be very localised in relation to the distribution of intertidal species in the area and due to the natural turbidity of the Thames Estuary the depth of light penetration into the water column is expected to be limited reducing the potential magnitude of impact on intertidal species as they become inundated on the flood tide. The effect of artificial light is assessed to be of **minor significance.**

Fish

13.146 Fish can be attracted to light sources or can actively avoid artificial light (ZSL 2016). Both behavioural changes have the potential to alter fish movement including migration through an area. Many predatory fish rely on visual cues to locate and capture prey as indicated by variations in feeding efficiency with changes in turbidity and light availability (Becker *et al*. 2013; Thompson 2013). Consequently, in areas which are naturally dark there is potential for increased light levels to influence the behaviour and feeding of fish (Becker *et al*. 2013).

13.147 Laboratory experiments have indicated that with an increase in prey density the feeding intensity of Atlantic herring *C. harengus* increased at higher light intensities but not in dark conditions (Batty *et al*. 1990). Behavioural responses to artificial light have also been demonstrated in various fish species for example, common grey mullet *Mugil cephalus* and gilthead seabream *Sparus auratus* were found to aggregate more with an increase in

light intensity and were clearly attracted to the light source (Marchesan *et al*. 2005). In contrast, European sea bass *Dicentrarchus labrax* was neither particularly attracted nor inhibited by the presence of light (Marchesan *et al*. 2005).

13.148 There have been few assessments of the effects of anthropogenic light on fish in the field. An assessment of the effects of an artificially lit structure on estuarine fish, however, examined differences in fish behaviour during lit and unlit conditions using DIDSON multi-beam sonar. It was found that small fish were more likely to aggregate together when lights were on (Becker *et al*. 2013). In addition, there was a clear and consistent increase in the abundance of large predatory fish (>500 mm TL) around the pontoon structure on nights when the floodlight was turned on and the larger fish tended to hold their place more in the water column to remain within lit areas, suggesting increased light optimised feeding conditions for larger individuals (Becker *et al*. 2013). Artificial lighting has the potential to increase schooling of smaller fish species and in turn aggregations of smaller fish can attract larger predators to the area with the light also enhancing foraging conditions (Thompson 2013).

13.149 For migrating species there is evidence that artificial light can result in temporary/localised delays to migration for example, when fish are attracted to a light source, such as dock lighting, at night (Weitkamp 1982; Simenstad *et al*. 1999). It is known, however, that nocturnal movement of salmonids takes place through harbours under conditions of strong dockside and ship-borne illumination. Similarly, both ammocoete larvae and adult lamprey have been shown to exhibit a clear preference for less illuminated areas (Ullén *et al*. 1993), although there is also some evidence of lamprey being attracted to light (Frederiks *et al*. 1996). Consequently, exposure of migratory fish to anthropogenic light, especially in a heavily lit environment such as the Thames Estuary, may not influence behaviour or individuals could potentially demonstrate attraction or avoidance behaviour depending on circumstances.

13.150 A key consideration for assessment is that due to the high turbidity of the Thames Estuary, the area of the water column potentially exposed to increased light levels will be restricted to surface layers and the zone of influence of the lighting will be restricted to a short distance from the light source. In addition, fish migrating through and utilising the Thames Estuary would be expected to be habituated to anthropogenic lighting which is present throughout the Estuary. Overall, in relation to the numbers of fish foraging, residing in or migrating through the Thames Estuary, any effects would be associated with a restricted number of individuals encountering the light source and there would be no effects at the population level. For the very high and high value fish receptors the significance of effect is assessed as **minor (potentially adverse or beneficial)**. For the medium value fish receptors the significance of effect is assessed as **negligible.**

Marine Mammals

13.151 There is limited evidence to suggest that there are any adverse effects on marine mammals from artificial lighting (Orr *et al*. 2013). However, it is possible that the addition of artificial lighting in the marine environment may attract inquisitive species such as seals

and dolphins, could interfere with navigation or may alter feeding patterns in species that are primarily visual predators e.g. could result in an increase in night predation on fish, especially if fish are congregating in lit areas (Yurk & Trites 2000). In particular, seals would be able to detect sources of light during construction if works were conducted at night.

13.152 The Thames Estuary is an active waterway with heavy boat traffic. Marine mammals in the area would be expected to be well habituated to the presence of vessels and light from other anthropogenic sources. Overall, additional light from construction equipment and vessels from the Project is assessed to be **negligible** for all species.

Collision Risk with Vessels

Construction Details

13.153 During the construction of the passenger pier, possible refurbishment of White's Jetty, extension of the Tilbury jetty and mooring it is likely that a range of construction vessels will be required. For the purposes of assessment it is estimated that up to 10 construction barges may travel to the Kent and Essex Project Sites a day during the construction period (Appendix 10.1: *Preliminary Navigational Risk Assessment*, document reference: 6.2.10.1).

Marine Mammals

13.154 The marine mammal species potentially present in the vicinity of the Site are harbour porpoise, bottlenose dolphin, harbour seal and grey seal. These species are agile and have fast swimming speeds which could help them evade collisions with vessels and vessel propellers. However, when collisions do happen this can lead to physical injury and in some cases fatalities.

13.155 Incidents of mortality and injury of harbour porpoise caused by vessels are uncommon in UK waters. Out of 439 post mortem examinations on stranded harbour porpoise between 2010 and 2015, 13 deaths (2.9%) were attributed to probable effect of a boat collision (CSIP 2015). A further 25 harbour porpoises died of acute physical trauma of unknown origin which maybe the result of vessel strike but could also be undiagnosed bycatch or caused by bottlenose dolphin attacks (CSIP 2015). A total of 21 post mortem examinations were carried out on stranded bottlenose dolphins between 2010 and 2015. Of these, none were considered to be a result of vessel strike and one was the result of physical trauma of an unknown origin.

13.156 Despite being fast and agile, grey seals can collide with anthropogenic structures such as fishing gear and vessels (Scottish Government 2013). Reduced perception levels of a collision threat through distraction, whilst undertaking other activities such as foraging and social interactions, are possible reasons for collisions (Wilson *et al*. 2007) and seals can also be very curious of new foreign objects placed in their environment which could also increase the risk of collision. Seals are relatively robust to potential strikes, however, as they have a thick sub-dermal layer of blubber which can defend their vital organs from the worst of any blows (Wilson *et al*. 2007). In general, incidents of mortality or injury of

grey seals caused by vessels remain a very rare occurrence in UK waters, although numerous instances are expected to remain unreported (Thompson *et al*. 2013; CSIP 2015).

13.157 To evade a strike, marine mammals tend to require acoustic information to be able to determine in which direction and at what speed a vessel is moving. Where there is erratic movement of watercraft (e.g. private personal watercraft) the risk of collision is considerably greater than that associated with other watercraft (e.g. a barge or ferry) travelling on a direct course. The vessels involved in the works for the Project would be anticipated to transit relatively slowly and would travel in a direct course as far as possible.

13.158 Once on site, the vessels involved in the construction of the Proposed Development are anticipated to remain relatively stationary just moving short distances as required. Consequently, the risk of a collision with marine mammals is considered to be extremely small. The potential significance of collision risks is assessed to be **negligible**.

Presence of Structures in Estuary Margins

Construction Details

13.159 During construction there will be construction equipment and infrastructure built in the water column for the Ro-Ro facility and new jetties. During installation of the outfalls for the wastewater treatment facility and surface water runoff there is potential that temporary cofferdams will be required. If required, there would be one cofferdam for the wastewater outfall and up to five for the surface water runoff outfalls. These cofferdams may be 30-50 m long with a width of 7 m and would be placed in both saltmarsh and intertidal mud habitats. They would be temporary structures and at this stage it is anticipated they would not be in place for more than a few months.

Fish

13.160 The introduction of these structures could present a physical barrier to movement of fish in the Estuary margins.

13.161 Individuals which are migrating upstream or downstream through the estuary but favour the main channel for their upstream or downstream movements are not anticipated to be affected by the physical presence of the proposed structures as there will not be any blockage in the central channel. This includes species such as European silver eels (Jansen *et al*. 2007), juvenile and adult Atlantic salmon and sea trout (Moore *et al*. 1995, Lacroix *et al*. 2004, Aarestrup *et al*. 2000) and adult European smelt (BEEMS 2011). This is also considered to relate to European glass eels which utilise selective tidal stream transport during estuarine movement and move to marginal areas of the estuary to seek refuge at the end of the flood tidal phase before moving back towards the central channel on the following flood tide (Harrison *et al*. 2014).

13.162 The physical presence of structures is only expected to potentially affect the movements

of some species that are actively moving or migrating in the channel margins or using the margins as a refuge during certain tidal states (including the saltmarsh habitat). Species which are considered to be potentially affected due to their migration upstream or downstream in the intertidal zone are:

- European plaice: larvae utilise selective tidal stream transport whilst migrating upstream into nursery grounds. They migrate to midwater during the flood tide and settle on the bottom during the ebb tide (Rijnsdorp *et al*. 1985, Creutzberg *et al*. 1977). Spawning occurs in late winter from January to March in the North Sea (Ellis *et al*. 2012) therefore larval individuals will be migrating into the estuaries from February through to April, before using the Thames Estuary as a nursery ground from April to September;

- European flounder: larvae and juveniles utilise selective tidal stream transport whilst migrating upstream into nursery grounds. They migrate to midwater during the flood tide and settle on the bottom during the ebb tide (Bos 1999, Jager 1999). Spawning occurs in spring from February to June (Ellis *et al*. 2012) in the North Sea, therefore larval individuals will be migrating through the estuary from March to July, before using the Thames Estuary as a nursery ground from April to September;

- Dover sole: larvae and juveniles utilise selective tidal stream transport whilst migrating upstream into nursery grounds on entry to estuaries (Grati *et al*. 2013). Spawning occurs in spring from March to May (Ellis *et al*. 2012) in the Thames Estuary, therefore larval individuals will be migrating through the estuary from March to June, before using the Thames Estuary as a nursery ground from April to September; and

- River lamprey and sea lamprey: juveniles use local lower velocity areas, like wall edges or the channel bed, to pass obstacles whilst migrating downstream to the sea (Keefer et *al*. 2011, Kemp *et al*. 2011, Tummers *et al*. 2016). Downstream migration of juvenile sea and river lamprey (known as 'transformers') is thought to peak between October and December for sea lamprey (Potter *et al*. 1978) and between January and March for river lamprey (Potter & Huggins 1973).

13.163 A key consideration, however, is that the permanent structures to be constructed in the water column are anticipated to have an open design so would not result in complete blockage of a section of the water column. Individuals would be able to navigate around, and in many cases, through the structures and there are not anticipated to be any delays to migration due to the presence of the structures. Temporary cofferdams will not have an open structure and so may cause a temporary physical barrier to movement for fish species in these areas.

13.164 The species listed above, and other juvenile migrating species such as elvers, when migrating upstream or downstream in the flow in the channel margins are likely to encounter the cofferdam and an area of slack water upstream or downstream of the cofferdam. This would require individuals to navigate around the cofferdam into deeper water to continue their upstream or downstream migration which could potentially cause

a temporary delay to their migration. This effect will occur over a very limited spatial extent of the tidal River Thames. Effects will therefore be local, temporary and short-term and are unlikely to compromise the spawning or survival success of any of these species.

13.165 Overall, the potential significance of the presence of structures on fish migration/movement is assessed to be of minor significance**.**

Marine Mammals

13.166 Marine mammals in the area would be expected to be well habituated to the presence of structures in the marine environment. Marine mammals would easily navigate around the structures if encountered and are highly mobile so will be able to avoid areas of visual disturbance if required due to presence of construction plant.

13.167 The potential significance of the presence of structures on marine mammal movements is assessed to be of **negligible** significance**.**

Spread of Invasive Non-native Species

Construction Details

13.168 Within the UK, pathways of introduction involving vessel movements (fouling of hulls and ballast water) have been identified as the highest potential risk routes for the introduction of non-native species (Carlton 1992; Pearce *et al*. 2012). This could either be from discharge of ballast water at the Kent and Essex Project Sites or via transportation on vessel hulls. Construction of the passenger pier jetty and potential construction of the Ro-Ro slipway (Option A) or the rebuilding of White's Jetty (Option B) at the Kent Project Site and extension to the Tilbury Terminal jetty at the Essex Project Site would be conducted by a small number of construction vessels. These vessels are expected to remain within the tidal River Thames for the entire construction phase. The main vessels in operation during construction have not yet been confirmed but would likely be barges, tugs and pilot vessels.

13.169 Once non-native species become established and disperse within a new habitat they can out-compete local species for space and resources, prey directly on local species, or introduce pathogens (Roy *et al*. 2012). Consequently, the introduction of non-native species could potentially affect the ecological functioning of communities in the intertidal and subtidal zones.

Plankton

13.170 Non-native species of plankton can be transported from one area to another in the ballast water of vessels. As the Ballast Water Management Convention has been ratified and all vessels will be fully compliant with International Maritime Organisation (IMO) guidelines, and due to the rapid dispersal of plankton with tidal currents, the likelihood of the effect occurring at the proposed Development site is unlikely. As the Proposed Development

will adhere to this legislation, the significance of the effect is assessed to be **negligible.**

Intertidal and Subtidal Habitats/Species

13.171 A number of non-native species are known to be present in the intertidal zone at the Kent and Essex Project Sites (see *Baseline conditions: Non-Native Species* section above). For example, the Chinese mitten crab *E. sinensis* is known to be present in the area and the wider Thames Estuary, as well as a number of other non-native intertidal species such as Asian clam *Corbicula fluminea* and zebra mussel *Dreissena polymorpha*. Species such as the carpet sea squirt *Didemnum vexillum* and the quagga mussel *Dreissena rostiformis bugensis* are known to be present within the tidal River Thames, along with a range of other subtidal species (see *Baseline conditions: Non-Native Species* section above). It is possible that non-native species could spread to the intertidal and subtidal habitat as a result of the works for the Proposed Development, or species from the intertidal habitat could be spread elsewhere thereby affecting local populations. Without further mitigation the magnitude of the impact is assessed to be moderate.

13.172 The effects are considered likely to be of **moderate adverse significance.**

Indirect Effects via the Food Chain

Construction Details

13.173 The main indirect effects for consideration are the numerous potential food chain interactions. For example, any changes in phytoplankton abundance could then influence zooplankton feeding on them with subsequent effects on organisms higher up the food chain.

Plankton and Intertidal and Subtidal Species/Habitats

13.174 Effects identified for plankton and intertidal and subtidal species/habitats have all been assessed to be of negligible or minor significance following embedded mitigation. Consequently, any indirect effects on benthic invertebrates or other species associated with changes in plankton would be local and temporary, and the magnitude of the impact is considered to be negligible. The potential significance of indirect effects via the food chain are assessed to be **negligible.**

Fish

13.175 Fish are mobile and individuals would be able to move to different areas to forage as required and will naturally do so to maximise their survival and foraging success. Due to the availability of food resources within the Estuary this effect is assessed to be of **negligible** significance for all fish species.

Marine Mammals

13.176 Any indirect effects would be local and temporary. Taking into account the assessment

above for fish, the significance of the effect is assessed to be **negligible** for marine mammals.

Accidental Pollution Events (e.g. oil spill)

Construction Details

13.177 During construction, it is possible that some small accidental pollution events may occur. This can occur on land and drain into the tidal River Thames, or small accidental spills may occur from vessels.

Plankton

13.178 The introduction of pollutants to the water column from the works such as oils could cause toxic effects on plankton. The size of these accidental spills is likely to be small. The effect, however, would be reversible on the plankton population as the community in the vicinity of the Proposed Development would be replenished on each tide. The magnitude of the impact is therefore considered to be moderate. Any effects would be of **minor adverse significance**.

Intertidal and Subtidal Habitats/Species (including saltmarsh)

13.179 The introduction of pollutants to the water column from the works such as oils could cause toxic effects on the intertidal and subtidal habitats and species. Whilst the size of these accidental spills is likely to be small, the sensitivity of some species to the toxic effects of oil is assessed to be high. The magnitude is assessed to be moderate. The overall significance of the effect on intertidal and subtidal habitats and species is assessed to be of **moderate adverse significance**. Mitigation is therefore proposed.

Fish and Marine Mammals

13.180 The introduction of pollutants to the water column from the works such as oils could cause toxic effects on fish and marine mammals. The size of accidental species is likely to be small and fish and marine mammals are mobile and individuals would be expected to be able to move away from any areas of pollution they are able to detect. The magnitude of the impact is assessed to be moderate. Overall the effects on fish and marine mammals would be of **moderate adverse significance**. Mitigation is therefore proposed.

Operation

Change in Hydrodynamics and Sediment Accretion/Erosion

Operational Details

13.181 The physical presence of new structures within the tidal River Thames will affect current movements and tidal velocity in the vicinity of structures and has the potential to cause localised increases and decreases in current speeds.

13.182 Modelling results indicate that due to the presence of structures installed for the Proposed Development for Option A on a peak ebb and peak flood tide there could be a localised reduction in current speed of 0.05 to 0.1 m/s over a distance of 400 m (peak ebb tide) to 600 m (peak flood tide) with speed reductions of 0.1 to 0.2 m/s over a distance of 300 m (peak flood tide) to 400 m (peak ebb tide), (ES Appendix 17.4, document reference: 6.2.17.4).

13.183 For Option B (without the Ro-Ro pontoon) reductions in current speed were modelled to have a smaller footprint over a distance of 400 m on the peak ebb and flood tides and remained within the range 0.05 to 0.1 m/s with only small spots of speed reduction greater than 0.1 m/s seen close to White's Jetty (ES Appendix 17.4, document reference: 6.2.17.4).

13.184 Dredging under Option C would change the natural tidal range on small sections of the intertidal zone and potentially affect water flow. The hydrodynamic assessment has indicated potential reductions in current speed of 0.05 to 0.1 m/s over a distance of 700 m on a peak ebb tide and 600 m on a peak flood tide. At the time of peak ebb tide the area of larger changes in currents which might have an effect on other estuary processes is restricted to the immediate are of the dredging, extending from the new passenger pontoon to White's Jetty. Within this area the modelling indicates some areas of speed reduction greater than 0.2 m/s. On a peak flood tide, speed reductions greater than 0.1 m/s are modelled over a distance of 500 m, extending from the dredged area towards the north west of White's Jetty.

13.185 Considering the considerable variation in current speed in the tidal Thames during the tidal cycle the changes indicated by the hydrodynamic modelling are extremely small.

13.186 Hydrodynamic and sediment modelling indicates that there will not be a discernible effect on suspended sediment concentrations for any of the options (ES Appendix 17.4, document reference: 6.2.17.4). For all options, the structures at the Kent Project Site is modelled to cause a localised change in the distribution of sediments increasing the proportion of the 5 mm size sediment in a small area northeast of White's Jetty and a coarsening of the sediment directly under the floating pontoon of the passenger pier. No effects on the erosion or deposition patterns are seen on the intertidal areas at the Kent Project Site.

13.187 At the Essex Project Site only limited effects on erosion and deposition and bed substrate

are predicted and these are in the immediate area of the proposed extension of the existing jetty. No changes to the pattern of erosion and deposition are predicted on the intertidal areas to the north of the jetty.

13.188 Vessel docking procedures (for the Clipper ferries, shuttle ferries operated by Clipper and supply vessels) may use manoeuvring thrusters (e.g. bow thrusters, stern thrusters or azimuth thrusters) which are likely to generate sufficiently powerful localised flows during docking operations to re-suspend sediment and lead to scouring of the Estuary bed and potentially result in the movement of sediment within the Kent and Essex Project Sites. The loaded draught of Thames Clippers is approximately 1.5 m. The effects on sediments could potentially be evident within a localised area while the system reaches an equilibrium. Following this period, the levels of accretion and scouring are expected to stabilise. Sediment suspended by vessel manoeuvring is likely to be deposited locally to the Kent or Essex Project Sites.

13.189 Saltmarsh habitat would be created as part of project and it is anticipated that approximately 3 ha of saltmarsh habitat could be created (see Embedded Mitigation Measures section and Appendix 12.3: *Ecological Mitigation and Management Framework,* document reference: 6.2.12.3). Hydrodynamic and sediment modelling indicates that habitat creation areas on the east of the peninsula are anticipated to receive more fine sediment than those on the west (ES Appendix 17.4, document reference: 6.2.17.4). For all options, on the ebb tide, small spots of speed increase (0.05 to 0.2 m/s) are shown by the new breaches out of the habitat creation areas. This is likely due to the water flowing out of the habitat creation areas as they dry out (ES Appendix 17.4, document reference: 6.2.17.4). Small spots of speed increase are also evident at the time of peak flood. However, as the time of peak flood is closer to high water when the habitat areas are flooded, these small areas of increase are surrounded by areas of speed decrease (0.05 to 0.2 m/s). This is due to the interaction of the passing flow with that entering the habitat areas and the increased flow cross section area present when the habitat areas are inundated (ES Appendix 17.4, document reference: 6.2.17.4) and these effects are limited to the immediate area of the habitat areas.

Intertidal Habitats/Species

13.190 The majority of the intertidal mudflats at the Kent Project Site are classified as *Hediste diversicolor* and *Streblospio shrubsolii* in littoral sandy mud (EUNIS: A2.3221; JNCC: LS.LMu.UEst.Hed.Str); but the area in front of Bell Wharf is classified as the broader classification Polychaete / oligochaete dominated upper estuarine mud shores (EUNIS: A2.32; JNCC: LS.LMu.UEst). A2.3221 has a medium sensitivity to changes in water flow (Ashley & Budd 2020).

13.191 Although it was not found during the Project-specific intertidal surveys (see Appendix 13.2: *Marine Biology and Biodiversity Baseline Conditions*, document reference: 6.2.13.2 and Appendix 13.4: *Intertidal Benthic Ecology Survey*, document reference: 6.2.13.4), the tentacled lagoon worm *A. romijni* may be present within the intertidal habitat. This species has a low sensitivity to changes in water flow (Tyler-Walters & White 2017).

13.192 Areas of new intertidal habitat in saltmarsh creation areas will be subject to sedimentation allowing saltmarsh habitat to form. A change in flow at the entrance to these areas is modelled to be very small with small area of increased water flow adjacent to small areas of decreased water flow. This may cause some very small erosion effects on intertidal mud habitat which are not anticipated to be detectable. As such the effect of hydrodynamic changes caused by saltmarsh creation on intertidal mud is assessed to be **negligible**.

13.193 Any erosion of intertidal mud sediment as a result of hydrodynamic changes from boat wash from ferries and other vessels using the jetties is expected to be very localised. It could be temporary in some areas, however, such effects could also be permanent and alter the habitat type present.

13.194 Whilst saltmarsh does naturally accrete sediments it is sensitive to the effects of erosion caused by changes in current movements and tidal velocity due to boat wash. Sediment within the saltmarsh that is eroded can result in a loss of saltmarsh habitat. The saltmarsh that is adjacent to the proposed new passenger jetty and alterations to Bell Wharf could potentially be affected by changes in current movements and tidal velocity as a result of increased levels of boat wash.

13.195 As embedded mitigation and as best practice, booms or other infrastructure will be included within the designs for the ferry terminal and jetty to minimise potential for erosion caused by boatwash.

13.196 The magnitude of the impact of boatwash on intertidal habitats and species is minor on these high value receptors. Overall the significance of the effect is assessed to be of **minor adverse significance.**

Subtidal Habitats/Species

13.197 The subtidal habitat in the vicinity of the proposed passenger pier location at the Kent Project Site was assigned to the habitat '*Polydora ciliata* and *Corophium volutator* in variable salinity infralittoral firm mud or clay' (EUNIS: A5.321; JNCC: SS.SMu.SMuVS.PolCvol) during the subtidal survey (Appendix 13.5: *Subtidal Benthic Ecology Survey Report,* document reference: 6.2.13.5*)*. This habitat is assessed to have a low sensitivity to changes in water flow (De-Bastos & Hill 2016). Two other habitats were also recorded within the Kent Project Site subtidal survey area: 'Sublittoral mixed sediment in variable salinity (estuaries)' (EUNIS: A5.42; SS.SMx.SMxVS) and '*Aphelochaeta* spp. and *Polydora* spp. in variable salinity infralittoral mixed sediment' (EUNIS: A5.421; JNCC: SS.SMx.SMxVS.AphPol) which is assessed to be 'not sensitive' to changes in water flow (De-Bastos & Tyler-Walters 2016). *A. romijni* was recorded within the subtidal habitat at the Kent Project Site. It has not previously been recorded at the Essex Project Site or east of the Swanscombe MCZ which is likely due to a combination of salinity and habitat conditions.

13.198 The subtidal habitat at the Essex Project Site was primarily assigned to the habitat

'*Aphelochaeta marioni* and *Tubificoides* spp. in variable salinity infralittoral mud' (EUNIS: A5.322; JNCC: SS.SMu.SMuVS.AphTubi) with one station assigned to the biotope EUNIS: A5.321 and the station further west into the main channel as EUNIS: A5.421 (Appendix 13.5: *Subtidal Benthic Ecology Survey Report,* document reference: 6.2.13.5). EUNIS: A5.322 is assessed to be 'not sensitive' to changes in water flow (De-Bastos & Hiscock 2016).

13.199 The area of subtidal sediment potentially affected by the change in tidal flows is very small in relation to the availability of similar habitats within the tidal River Thames and the effect is localised. Changes would be gradual and any disturbed/displaced benthic invertebrates would be expected to survive such changes.

13.200 The magnitude of the impact is negligible. In general, the subtidal habitats and species in this area are of medium value however there is potential for *A. romijni* to be present in the affected area which are a high value receptor. The significance of the effect is assessed to be **minor adverse significance**.

Fish

13.201 Increased turbidity caused by the resuspension of bottom sediments may reduce the visual range of fish, potentially impacting their feeding ability. Physiological effects may also occur such as reduced gill function. Fish are highly mobile and any fish physically disturbed due to sediment movement would be able to avoid the area and return if required once any disturbance has ceased. In addition, the tidal River Thames is naturally turbid and therefore the fish are expected to be adapted to high levels of suspended solids. The significance of the effect is assessed to be **negligible.**

Changes in Water Quality (suspended solids and release of sediment chemicals)

Operation Details

13.202 Operation activities that are planned in the intertidal and subtidal estuarine environment have the potential to generate water quality changes. The mechanisms through which water quality change may be generated are primarily:

- Increase in suspended sediment concentration via direct disturbance of estuary bed sediment from maintenance dredging for Option C.
- Indirect increase in chemical concentrations within the water column via disturbance and mobilisation of chemicals associated with contaminated sediments during dredging for Option C.
- Discharge from the waste water treatment outfall at the Kent Project Site.
- Surface water run off at both the Kent and Essex Project Sites.

13.203 If Option C is chosen, it is the intention that Bell Wharf will only be used during high tide during the operational phase and therefore maintenance dredging will not be conducted. If it was decided that Bell Wharf is to be used at all tides during operation of the proposed development, however, maintenance dredging may be required periodically which would cause disturbance and re-suspension of sediments. Consequently, consideration of maintenance dredging has been included in the assessment. This could lead to the release of any contaminants that may be present within them, which may in turn affect compliance with water quality standards. The main objective of the maintenance dredge would be to remove any recently deposited sediment. Consequently, the sediment type would likely be similar to that currently present, and the chemical concentrations may be lower than those potentially reached by the deeper dredging during construction. In addition, the area and volume of sediment that could potentially require maintenance dredging is anticipated to be a lot smaller than for the capital dredge. For these reasons any effects of maintenance dredging are anticipated to be no greater than the effects assessed for the construction phase capital dredge.

13.204 A full characterisation and assessment of sediment contamination is presented in Appendix 13.7: *WFD assessment* (document reference: 6.2.13.7). As set out in the Changes in Water Quality in the Construction assessment, changes in water quality as a result of the proposed development are assessed to be negligible.

13.205 A wastewater treatment facility will be constructed for the Kent Project Site that will require an outfall to be installed. Water released from this facility will be treated prior to discharge to ensure it complies with the relevant legislation. The location of this outfall will be the north east coast of the Peninsula (see chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17).

13.206 Surface water runoff outfalls will be installed at up to five locations along the Kent Project Site coastline (see chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17). A single outfall is anticipated to be installed at the Essex Project Site and will be sited to pass between existing infrastructure. The volume of runoff in a 1 in 2 year event is estimated to be 26,961 m^3 from the Kent Project Site and 127,235 m^3 during a 1 in 100 year event. As set out in chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17, there is potential for on-site activities to influence the water quality of the tidal River Thames. However, pollutant interceptors and siltation controls will be employed and the water will be treated prior to discharge. For full details of proposed mitigation to prevent pollution from surface water runoff entering the tidal River Thames see chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17. The residual environmental effects following implementation of these mitigation measures have been assessed to be not significant in chapter 17: *Water Resources and Flood Risk*, document reference: 6.1.17.

Plankton

13.207 As set out for Construction Effects, in terms of water quality, the main potential effect is likely to be associated with changes in suspended sediment levels that can result in

inhibition of photosynthesis and potentially limit the productivity of phytoplankton. In turn, reduced primary productivity or changes in the phytoplankton assemblage could have an influence on zooplankton assemblages feeding on the phytoplankton, and ichthyoplankton feeding on other plankton groups. Elevated suspended sediment levels can also clog the feeding apparatus of zooplankton and ichthyoplankton.

13.208 Within the Thames Estuary, however, suspended sediment concentrations are naturally very high and planktonic organisms present in the Estuary would be expected to be well adapted to survival in a turbid environment and would be dispersed on each flood and ebb tide.

13.209 Overall, any effects on plankton are assessed to be of **minor adverse significance**.

Intertidal and Subtidal Habitat/Species

13.210 Changes in water quality could potentially impact intertidal species and habitats when submerged and subtidal species and habitats. Resettlement of suspended solids could potentially inhibit breathing and feeding apparatus of some benthic species located on the surface of the sediment, however, organisms present in the intertidal area are expected to be well adapted to naturally high levels of suspended solids.

13.211 Chemicals released through mobilisation of contaminated sediment have the potential to cause toxic effects on intertidal and subtidal species. However, as set out in the Changes in Water Quality in the Construction assessment, changes in water quality as a result of the proposed development are assessed to be negligible.

13.212 Tidal movements would rapidly disperse any chemicals within the water column.

13.213 The significance of effect is assessed to potentially be **minor adverse.**

Fish

13.214 Increased turbidity caused by the resuspension of bottom sediments may reduce the visual range of fish, potentially impacting their feeding ability. Physiological effects may also occur such as reduced gill function. Fish are highly mobile species and expected to move away from unfavourable conditions where possible. In addition, the tidal River Thames is naturally turbid and therefore the fish are expected to be adapted to high levels of suspended solids. Potential increased chemical concentrations would likely be short-term and tidal movements would rapidly disperse chemicals in the water column. The effect is assessed to be of **minor adverse significance** for protected species and of **negligible** significance for other fish species.

Designated Sites

13.215 The Kent Project Site directly interacts with the Swanscombe MCZ, potential effects on the MCZ are indicated within the MCZ assessment (Appendix 13.8, document reference:

6.2.13.7). Water Quality was only taken through to MCZ assessment in terms of changes in suspended solid levels. Based on the outputs of hydrodynamic modelling (The London Resort: Hydrodynamic and sedimentation assessment - ES Appendix 17.4, document reference: 6.2.17.4) and the naturally high and variable turbidity in the Thames Estuary it was concluded that changes in suspended sediment levels would not have a significant effect on the MCZ features (intertidal mud; tentacled lagoon worm *A. romijni*).

13.216 West Thurrock Lagoon & Marshes SSSI is approximately 1 km from the Kent Project Site and is designated to protect wintering waders and wildfowl that use the intertidal mudflats. As the effects on water quality are assessed to be negligible, the magnitude of impact is assessed to be **no change** and significance of effect is assessed to be **no effect**.

Habitat Loss

Operational Details

13.217 If Options A or B are chosen there will not be a loss of habitat during operation of the Proposed Development. If these options are not feasible and Option C is chosen, maintenance dredging may be required periodically which would cause disturbance and re-suspension of sediments. It is unclear what extent of sediment would need to be dredged and how frequently it would be required. Any effects, however, are anticipated to be smaller in scale than for the capital dredge. Although sediment in dredge pockets can be recolonised over time, this area is considered to be lost for the purposes of assessment due to the removal of individuals within the extracted sediment.

Subtidal Habitats/Species

13.218 The significance of effect of the maintenance dredging would be **minor** for all subtidal habitat/species, with the potential exception of *A. romijni*. Potential effects on *A. romijni* would need to be considered when the extent of the maintenance dredge pocket is known and could be of **moderate** significance. Consultation will be held with statutory authorities and their advisors to determine any mitigation measures that may need to be applied.

Visual Disturbance

Operational Details

13.219 Visual disturbance could be associated with the presence of vessels during operation. The London Clipper currently only services as far east as Woolwich (Royal Arsenal). A new passenger pier at the Proposed Development will extend the ferry service further east. As set out in chapter 10*: River Transport* (document reference: 6.1.10), a new passenger ferry between the Essex Project Site and the Kent Project Site is expected to operate with 84 movements per day and a new passenger service between central London and the Proposed Development will comprise 54 movements per day (ES Chapter 13.10: *River Transport,* document reference: 6.1.10).

Marine Mammals

13.220 As indicated for the construction phase there are low numbers of marine mammals frequenting the tidal River Thames and marine mammals in the area would be expected to be well habituated to the presence of vessels and the presence of artificial light during operation. Any effects are considered likely to be localised and of **minor adverse significance**.

Increase in Underwater Noise and Vibration

Operational Details

13.221 Noise and vibration would be generated by the vessels and Clipper ferries utilising the new jetties and mooring structures. As described above for *Visual disturbance*, the new passenger ferry between the Essex Project Site and the Kent Project Site is expected to operate with 84 movements per day and a new passenger services between central London and the Proposed Development will comprise 54 movements per day (ES Chapter 10: *River Transport*, document reference: 6.1.10).

Intertidal and Subtidal Habitats/Species

13.222 As indicated in the construction phase assessment for this impact, anthropogenic sources of underwater noise and vibration have been shown to have potential effects on benthic invertebrates that do not rely on acoustics for communication. However, noise and vibration from vessels will rapidly attenuate with increased distance from the source. The effect is assessed to be **negligible.**

Fish

13.223 As indicated in the construction phase assessment for this impact, when considering vessel noise, there is a high risk of masking effects for individuals within hundreds of metres with a moderate risk beyond this distance. Behavioural effects may be evident at distances of hundreds of metres from the source. If vessels were continually generating noise throughout the construction period, there is a moderate risk of temporary threshold shift within tens of metres of the activity; however, vessel activity at the Kent and Essex sites would be expected to be intermittent and will not significantly increase in relation to the wider Thames estuary.

13.224 The effects of noise and vibration from vessels on fish with no swim bladder (such as European plaice, Dover sole, sand goby, common goby, angler fish, bullhead, Raitt's sandeel, river lamprey), is assessed to be of **negligible significance** at both the Kent and Essex sites.

13.225 The effects of noise and vibration is assessed to be of **minor adverse significance** for medium and high sensitivity hearing fish.

Marine Mammals

13.226 As indicated for the construction phase assessment for this impact, when considering vessel noise, data on the cumulative SEL of vessels suggests that PTS and TTS effects could occur in all four species of marine mammals within close proximity to vessels. However, it is not expected that marine mammals would stay close to operational vessels for an extended period of time but are more likely to transition through the area. The number of vessels that will be used for operational activities for the Proposed Development is not currently known and so the duration and frequency of vessel noise cannot be determined. Taking account of the points indicated above, however, the potential effects of noise and vibration on marine mammals from vessels is assessed to be of **minor adverse significance**. This will be confirmed through further assessment at the ES stage.

Introduction of New Artificial Habitat

Operational Details

13.227 The introduction of new structures into the intertidal and subtidal environment in the form of the new passenger jetty, ferry terminal and potentially the Ro-Ro ramp (Option A) at the Kent Project Site, and the extension of the jetty at Tilbury Terminal at the Essex Project Site will act as new hard substrate habitats. This will provide additional surface area for colonisation by organisms, mainly encrusting and colonial species and algae.

Intertidal and Subtidal Habitats/Species

13.228 The hard substrates could provide suitable habitat for colonisation of encrusting and colonising species (e.g. barnacles, encrusting sponges, sea squirts) and seaweed which would usually be restricted to rock and boulder habitats. The jetty legs would provide intertidal and subtidal habitat.

13.229 Any species colonising such habitats are expected to be consistent with species in the area that utilise hard substrate such as the existing Tilbury Terminal jetty infrastructure. The addition of hard substrate habitat can be viewed as beneficial and would promote local biodiversity, although it is appreciated that non-native species could be among those colonising these habitats. The effect is considered to be of **minor beneficial significance.**

Fish

13.230 Fish may utilise structures to provide shelter from tidal currents, and they may forage around hard structures which could support some prey items for fish. The effect is considered to be of **minor beneficial significance.**

Shading

Operational Details

13.231 The passenger pier and potential Ro-Ro slipway (Option A) at the Kent Project Site and extension to the jetty at the Essex Project Site will cause some shading of the habitat beneath these structures. The footprint of the passenger pier is 4,625 sq m. However, the floating pontoon of the passenger pier will move up and down with the tide and will therefore reduce the area permanently shaded by the structure. The surface of the pier also is anticipated to have mesh panels on the walkway to allow light to pass through the structure and minimise shading effects. For Option A, the Ro-Ro slipway, linkspan and gangway will have a footprint of 13,698 sq m.

Intertidal and Subtidal Habitats/Species

13.232 The majority of the intertidal mudflats at the Kent Project Site are classified as *Hediste diversicolor* and *Streblospio shrubsolii* in littoral sandy mud (EUNIS: A2.3221; JNCC: LS.LMu.UEst.Hed.Str); but the area in front of Bell Wharf is classified as the broader classification Polychaete / oligochaete dominated upper estuarine mud shores (EUNIS: A2.32; JNCC: LS.LMu.UEst). The characterising species of these biotopes are not considered to be sensitive to the effects of changes in incident light (Ashley & Budd 2020).

13.233 In the tidal River Thames, turbidity is high and light levels are generally low and so subtidal communities are adapted to low light conditions. The significance of the effect is assessed to be **negligible** for intertidal and subtidal habitats and species.

Fish

13.234 Fish may avoid areas of shading caused by the passenger pier and extension to Tilbury Terminal jetty. Small fish in particular are less likely to use habitat under piers and also less likely to use piling habitat than adjacent open water during the day (there are no significant differences at night) (Grothues *et al*. 2016).

13.235 Fish have a low sensitivity to shading and may even derive some positive benefits in terms of shelter, and the significance of the effect is assessed to be **negligible** for fish.

Use of Artificial Lighting

Operational Details

13.236 The Proposed Development will have buildings, walkways and the passenger pier lit overnight for health and safety purposes.

Intertidal Habitats/Species

13.237 The majority of the intertidal mudflats at the Kent Project Site are classified as *Hediste diversicolor* and *Streblospio shrubsolii* in littoral sandy mud (EUNIS: A2.3221; JNCC:

LS.LMu.UEst.Hed.Str); but the area in front of Bell Wharf is classified as the broader classification Polychaete / oligochaete dominated upper estuarine mud shores (EUNIS: A2.32; JNCC: LS.LMu.UEst) As described above for the use of artificial lighting during construction, none of the characterising species of these biotopes are considered to be sensitive to the effects of changes in incident light (Ashley & Budd 2020).

13.238 The effect would be very localised in relation to the distribution of intertidal species in the area and due to the natural turbidity of the Thames Estuary the depth of light penetration into the water column is expected to be limited reducing the potential magnitude of impact on intertidal species as they become inundated on the flood tide. The effect of artificial light is assessed to be of **minor significance.**

Fish

13.239 As described for the use of artificial lighting during construction, fish can be attracted to light sources or can actively avoid them (ZSL 2016). Further details on the potential effects are provided within the section assessing construction phase effects for this impact.

13.240 As there is high turbidity within the Thames Estuary the area of the water column potentially exposed to increased light levels will be restricted to surface layers and the zone of influence of the lighting will be restricted to a short distance from the light source. In addition, fish migrating through and utilising the Thames Estuary would be expected to be habituated to anthropogenic lighting which is present throughout the Estuary. Overall, in relation to the numbers of fish foraging, residing in or migrating through the Thames Estuary any effects would be associated with a restricted number of individuals encountering the light source and there would be no effects at the population level. For the very high and high value fish receptors the significance of effect is assessed as **minor (potentially adverse or beneficial)**. For the medium and low value fish receptors the significance of effect is assessed as **negligible.**

Marine Mammals

13.241 As described for the use of artificial lighting during construction, some marine mammals can be attracted to light sources.

13.242 The Thames Estuary is an active waterway with heavy boat traffic. Marine mammals in the area would be expected to be well habituated to the presence of vessels and light from other anthropogenic sources. The significance of the effect is assessed to be **negligible** for all species.

Collision Risk with Vessels

Operation Details

13.243 During the operation of the Proposed Development there would be a number of vessels visiting both the Kent and Essex Project Sites, and the London Clipper ferries calling at the

passenger pier. As described above for *Visual disturbance*, the new passenger ferry between the Essex Project Site and the Kent Project Site is expected to operate with 84 movements per day and a new passenger services between central London and the Proposed Development will comprise 54 movements per day (ES Chapter 10: *River Transport,* document reference: 6.1.10).

Marine Mammals

13.244 Information relating to the potential for collisions to occur between vessels and marine mammals is provided in the 'Collision risk due to vessel movements' in the Construction section of this assessment.

13.245 The operation of the Proposed Development is expected to increase the number of vessels in the tidal River Thames, however, the Clipper ferries will follow a clearly defined route that will not alter between transits, and this is also expected to be the situation for the ferry between the Kent and Essex Project Sites. Consequently, the chance of a collision between marine mammals in the tidal River Thames and the ferries operation for the Proposed Development is reduced as they follow a predefined route. Vessels travelling to Bell Wharf or to use the Ro-Ro facility would follow a direct course as far as possible. Consequently, the risk of a collision with marine mammals is considered to be extremely small and the significance of the effect is assessed to be **negligible** for all species.

Presence of Structures in Estuary Margins

Operation Details

13.246 During operation there will be new infrastructure in the water column for the Ro-Ro facility and new jetties.

Fish

13.247 The presence of these structures could present a physical barrier to movement of fish in the Estuary margins for species which are considered to utilise the estuary margins for migration (European plaice, European flounder, Dover sole, River and sea lamprey) (see equivalent section in Construction Phase impacts for further details).

13.248 A key consideration, however, is that the structures in the water column are anticipated to have an open design so would not result in complete blockage of a section of the water column. Individuals would be able to navigate around and in many cases through the structures and there are not anticipated to be any delays to migration due to the presence of the structures.

13.249 Overall the potential significance of the presence of structures on fish migration/movement is assessed to be of minor significance.

Marine Mammals

13.250 Marine mammals in the area would be expected to be well habituated to the presence of structures in the marine environment. Marine mammals would easily navigate around the structures if encountered and are highly mobile so will be able to avoid areas of visual disturbance if required.

13.251 The potential significance of the presence of structures on marine mammal movements is assessed to be of negligible significance**.**

Introduction and/or Spread of Invasive Non-Native Species

Operation Details

13.252 Pathways involving vessel movements (fouling of hulls and ballast water) present the highest potential risk routes for the introduction of non-native species for many projects (Carlton 1992; Pearce *et al*. 2012). This could either be from discharge of ballast water at site or via transportation on vessel hulls. During the operation of the Proposed Development there would be a number of vessels visiting both the Kent and Essex Project Sites, and the London Clipper ferries calling at the passenger pier. As described above for *Visual disturbance*, the new passenger ferry between the Essex Project Site and the Kent Project Site is expected to operate with 84 movements per day and a new passenger services between central London and the Proposed Development will comprise 54 movements per day (ES Chapter 10: *River Transport,* document reference: 6.1.10).

Plankton

13.253 Non-native species of plankton can be transported from one area to another in the ballast water of vessels. As the Ballast Water Management Convention has been ratified and all vessels will be fully compliant with IMO guidelines, and due to the rapid dispersal of plankton with tidal currents, the likelihood of the effect occurring at the Kent and Essex Project Sites is unlikely. With the proposed measures in place the significance of the effect is assessed to be **negligible.**

Intertidal Species and Habitats

13.254 As indicated for the construction phase assessment of this impact, there are a number of non-native intertidal species established within the Kent and Essex Project Sites. It is possible that non-native species could spread to the intertidal habitat during operational activities and thereby affect local populations. Without mitigation, the potential magnitude of this impact is assessed to be moderate as the effects have the potential to cause a substantial change in the abundance of native species over a prolonged period of time.

13.255 These effects are assessed to be of **moderate adverse significance.**

Subtidal Habitats and Species

13.256 As discussed above for intertidal habitats and species, without mitigation there is a risk of introduction and spread of non-native species. Without mitigation, the potential magnitude of this impact is assessed to be moderate as the effects have the potential to cause a substantial change in the abundance of native species over a prolonged period of time. These effects could be local or national and have a prolonged effect.

13.257 Overall, these effects are assessed to be of **moderate adverse significance**.

Indirect Effects via Food Chain

Operational Details

13.258 The main indirect effects for consideration are the numerous potential food chain interactions. For example, any changes in phytoplankton abundance could then influence zooplankton feeding on them with subsequent effects on organisms higher up the food chain.

Plankton, Intertidal and Subtidal Habitats/Species, Fish and Marine Mammals

13.259 The assessment text indicated for this impact for the Construction Phase is relevant here. Significance of effect is assessed to be **negligible** for all receptors.

Vessel Pollution (e.g. fumes, anti-fouling paint)

Operational Details

13.260 All vessels are prone to fouling by epiphytic organisms such as barnacles, algae and limpets. Fouling reduces vessel speed and increases fuel consumption. Hull fouling is managed by periodically (usually annually) dry docking the vessel to scrape epiphytes off the hull and by painting the hull with anti-fouling paint. This paint can contain elements that can leach into the aquatic environment and are harmful to aquatic organisms. Historically, anti-fouling paints contained tributyl tin (TBT) which is an effective biocide for vessel hulls but has a detrimental effect on the health of other aquatic organisms. The International Convention on the Control of Harmful Antifouling Systems for Ships 2008 prohibits the use of harmful organotins (including TBT) in anti-fouling paints used on ships and establishes a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems. Currently paints that contain copper are often used. Paints with copper are also harmful to aquatic organisms but to a lesser degree than TBT. Other alternatives are paints that use compounds that rapidly biodegrade in marine environments and natural products that use secondary metabolites produced by microorganisms as a defence mechanism in response to stress and have antimicrobial properties.

13.261 The Thames Clipper ferries and ferries operated by London Resort Holding Company will

operate to industry standards including measures such as dry docking vessels annually to ensure they are adequately maintained.

13.262 The Thames Clipper ferries are gradually being replaced by more and more efficient vessels which will decrease the amount of fuel used. Ferries use diesel fuel that generate fumes that are released to the atmosphere. However, these fumes are expected to be an insignificant addition to fumes released by other vessels operating on the Thames and so the potential effects of vessel fumes are not considered further.

Intertidal Species/Habitats and Subtidal Species/Habitats

13.263 Traditional anti-fouling paints contain substances that are harmful to intertidal and subtidal benthic species and cause effects such as endocrine disruption that results in imposex and intersex in gastropods. Newer anti-fouling paints may also cause similar effects, but to a lesser degree.

13.264 From an EIA perspective the increase in the number of vessels operating as a result of the Project will not significantly increase the number of vessels operating within the Thames. Consequently, the increased exposure of vessel fumes and antifouling paint in the context of the Thames Estuary is negligible and the potential for increases in these effects on intertidal and subtidal benthic species is assessed to be **negligible**.

Accidental Pollution Events (e.g. oil spill)

Operational Details

13.265 During operation, it is possible that some small accidental pollution events may occur. These could be associated with oil spillages from the ferries and other vessels utilising Tilbury Terminal jetty, the new passenger pier, White's Jetty or the new Ro-Ro facilities.

Plankton, Intertidal Species/Habitats, Subtidal Species/Habitats, Fish and Marine Mammals

13.266 The assessment text indicated for this impact for the Construction Phase is relevant here. Significance of effect is assessed to of **moderate adverse significance** for plankton, intertidal species/habitats, subtidal species/habitats, fish and marine mammals.

PROPOSED MITIGATION

Embedded Mitigation Measures

13.267 Mitigation measures that are embedded within the project design are described in Paragraph 13.37 and are as follows:

- An area of managed alteration to the flood defences and riverbank profile along sections of the Kent Project Site will be created to provide additional saltmarsh habitat to mitigate the loss of habitat at the Ferry Terminal. This will increase areas of mud flat, salt marsh, small pools, rocks and shingle areas, with reeds, sedges and grasses transitioning into scrub vegetation. This will be undertaken using two different methods: managed retreat of the flood defences in the area south of Bell Wharf and interventions at the shoreline to create an enhanced intertidal zone and encourage saltmarsh habitat to form along the north and northwest coast of the Peninsula. In total it is estimated that approximately 3ha of saltmarsh habitat will be created. Further details on both methods are provided in Appendix 12.3*: Ecological Mitigation and Management Framework* (document reference 6.2.12.3).

- Booms or other infrastructure within the designs for the ferry terminal and jetty to prevent erosion caused by boatwash.

13.268 This mitigation will be secured by a requirement in the DCO.

Mitigation to Reduce the Effects of Underwater Noise and Vibration

13.269 Effects of underwater noise on fish and marine mammals were assessed to be of moderate significance prior to mitigation. The underwater noise and vibration assessment has assumed a worst-case scenario of percussive (or hammer impact) piling to install large piles into the sediment for the new passenger jetty, possible building of the Ro-Ro slipway (Option A) or re-building of White's Jetty (Option B) at the Kent Project Site, and extension of the jetty at the Tilbury Ferry Terminal at the Essex Project Site. In relation to the construction programme the dates for these works have not yet been finalised, consequently for the purposes of assessment it was assumed that piling could be conducted at any time of year. To mitigate these potential effects the following measures will be considered:

- Planning pile driving works so they are not conducted at the same time at the Kent and Essex Project Sites;

- Using a quieter installation method e.g. vibropiling or rotary auger drilling, where possible depending on ground investigations;

- Using smaller piles which will require less force to install and reducing noise and vibration levels generated;

- Piling at low tide when intertidal areas will be exposed to the air and noise will not propagate as far through the water column;

- Employ 'soft start' procedures to piling to provide mobile receptors an opportunity to move away from the sound source.

13.270 This mitigation will be secured by a requirement in the DCO.

13.271 In addition, the following measure will be applied, where possible, if it is required with the above measures in place.

- Develop construction programme that avoids piling at sensitive times of the year including fish migration and spawning periods in the tidal River Thames.

Mitigation to Reduce the Effects of Non-Native Species

13.272 Effects on intertidal and subtidal habitats/species were assessed to be of moderate significance prior to mitigation. A project-specific Biosecurity Plan which will incorporate a Biosecurity Risk Assessment has been developed and will be a requirement of the DCO (see Biosecurity Plan ES Appendix 13.9, document reference 6.2.13.9). The Plan outlines numerous embedded mitigation design measures which would be incorporated into construction methods to limit the risk of introduction of invasive non-native species (INNS). Best practice guidelines will be followed and a biosecurity protocol will be implemented by the contractor. Biosecurity assessments will be undertaken for all vessels and further measures taken will include consideration of the following:

- Management of vehicles and vessels during construction including:
    - Biofouling;
    - Ballast water;
    - Movement of slow or stationary vehicles; and
    - Use of small vessels.
- Ports and harbour protocol:
    - Adherence to legislative guidance for specific port and harbour authorities.
- Conforming to industry guidelines:
    - Follow best practice guidance, apply Best Available Technology (BAT).
- Conforming to guidelines on marine biosecurity planning as advised by NE:
    - Follow best practice guidance as set out in the Natural England and Natural Resources Wales Biosecurity Planning guidance (Cook *et al*. 2015).

Mitigation to Reduce Construction and Operational Effects

13.273 As part of the works, a Construction Environmental Management Plan (CEMP) (ES

Appendix 3.2 Outline Construction and Environmental Management Plan (CEMP), document reference 6.2.3.2) and a handover Environmental Management Plan (EMP) will be implemented and will provide embedded mitigation against potential pollution from activities at the Site. The CEMP and handover EMP will be secured by a requirement in the DCO. The CEMP will include the following mitigation measures:

- Surface drainage will pass via settlement and oil interception facilities, where required, and discharge arrangements will be agreed with the utility provider;
    - Stockpiling of contaminated materials will be avoided, wherever possible. Stockpiles will be located on areas of hard standing or on plastic sheeting to prevent mobile contaminants infiltrating into the underlying ground; and
    - Potentially hazardous liquids on the Site such as fuels and chemicals will be managed and stored in accordance with best practice guidance, such as that published by the Environment Agency. Storage tank and container facilities will be appropriately bunded within designated areas and located away from surface water drains, docks and the tidal River Thames.
- Strict protocols will be put in place to minimise risks associated with oil spillages from the ferries and other vessels utilising Tilbury Ferry Terminal, the new passenger pier and the new Ro-Ro facilities. These will be included within the handover EMP for the Proposed Development which will also set out management procedures for transporting and storing of any potential hazardous materials.
- Both the CEMP and handover EMP will include measures to deal with any spillages and/or pollution incidents within a Pollution Incident Control Plan. This will include the provision of on-Site equipment for containing spillages, such as emergency booms and chemicals to soak up spillages. Any pollution incidents will be reported immediately to the Applicant and regulatory bodies such as the Environment Agency.

Best Practice Mitigation

13.274 The following mitigation is not required to reduce the significance of effects identified in this chapter but will be included as best practice:

- If Option C remains an option, phasing of dredging works to avoid sensitive seasons for marine species e.g. fish spawning or migration periods. This will be secured by a requirement in the DCO.
- The effects of trampling on sensitive habitats such as saltmarsh to be limited by restricting access by personnel and construction plant to clearly delineated routes. This will be secured by a requirement in the DCO.
- An outline lighting strategy (sets out measures to reduce effects on ecology including the use of dark buffer zones along the tidal River Thames to reduce the effects of

artificial lighting on fish and marine mammals). The lighting strategy will include measures such as that task and area lighting will be hooded or otherwise shielded to reduce light 'spill' into the surrounding area and will be positioned to avoid light spill into the tidal Thames Estuary (see Lighting Statement, document reference 7.9). This will be secured by a requirement in the DCO.

RESIDUAL ENVIRONMENTAL EFFECTS

13.275 The mitigation proposed above will reduce the magnitude of the impact for underwater noise and vibration effects to minor adverse significance for fish and marine mammals (see Table 13.19).

13.276 With the proposed saltmarsh habitat creation the residual significance of loss of intertidal mud habitat/saltmarsh is assessed to be of minor significance for intertidal habitats/species.

13.277 Implementation of the measures set out in the Biosecurity Plan will reduce the risk of introducing or spreading non-native species. This will reduce the overall significance of the effect to minor adverse significance for intertidal and subtidal habitats and species.

13.278 By employing management measures as set out in the CEMP, the risk of accidental pollution events will be greatly reduced. This will reduce the overall significance of the effect to minor adverse significance for plankton, intertidal and subtidal habitats and species, fish and marine mammals.

CUMULATIVE AND IN-COMBINATION EFFECTS

13.279 The main effects that could result in cumulative effects due to construction/operation phases of other plans/projects in the vicinity of the Proposed Development works are anticipated to be those that have a relatively large zone of influence.

13.280 For example, any nearby projects on the tidal River Thames that propose to increase vessel traffic could have cumulative effects in terms of collision risk for marine mammals, visual disturbance, underwater noise and potentially increased erosion to riverbanks from boat wash.

13.281 Underwater noise and vibration effects can extend for several kilometres upstream and downstream of the noise source. Consequently, plans/projects which involve piling activity could have cumulative effects on fish and marine mammals with considerations including the amount of piling involved for a project/plan, the duration of piling and the time of year of piling.

13.282 If dredging is conducted for other plans/projects in the vicinity of the Proposed Development and the sediment plume or underwater noise/vibration effects extend to the Kent and Essex Project Sites this could result in cumulative effects in relation to changes in water quality, increases in turbidity, smothering of habitats and underwater

noise and vibration.

13.283 This cumulative effects section assesses effects of the Proposed Development on marine ecology receptors when combined with the effects of other plans and projects in the area, including:

- Tilbury2 port development (NSIP ref: TR030003)
- Thurrock Flexible Generation Plant (NSIP ref: EN010092)
- The Pier, by Crest Nicholson (Dartford Borough Council, 17/01814/FUL)
- Purfleet Centre Regeneration (Thurrock Council, 17/01668/OUT)
- Tilbury Energy Centre

13.284 Information for the NSIP projects was obtained from the Planning Inspectorate (PINS) website and information for the other projects were obtained from the Dartford Borough Council, Thurrock Council and Gravesham Borough Council websites. These projects are either within the Zone of Influence of effects from the Proposed Development or have effects with a large Zone of Influence that could overlap with the Zone of Influence from the Proposed Development.

13.285 An assessment of cumulative effects of the Proposed Development with each of these projects has been provided for the construction and operation phase of the Proposed Development and taken into account the timings of the works where required and the nature of the works for each of the individual projects. Each project is briefly described below followed by the assessment.

13.286 Construction of the Proposed Development is anticipated to commence in 2023. Operation of the Proposed Development will be phased with Gate One opening in 2024 and Gate Two opening in 2029. Construction of the Proposed Development is anticipated to cease in 2029.

Tilbury2 Port Development (NSIP ref: TR030003)

13.287 Tilbury2 is a proposed new port terminal to be located on land that formed the western part of the previous Tilbury Power Station site. It will be 820 m east of the Essex Project Site, and will have associated facilities for importing, exporting and processing a variety of goods. The main components of Tilbury2 will be:

- A Roll-On / Roll-Off (RoRo) terminal for importing and exporting containers and trailers which has now been constructed.
- A ‘Construction Materials and Aggregates Terminal’ (CMAT) for handling and

processing bulk construction materials. This will be located at the northern part of the site.

13.288 Other parts of the site will be used for storage of bulk goods or vehicles (onshore).

13.289 A Development Consent Order (DCO) application for Tilbury2 was submitted to the Planning Inspectorate (PINS) (on behalf of the Secretary of State for Communities and Local Government) and all associated supporting environmental reports published on the PINS website.

13.290 The Tilbury2 scheme is now operational. It has been included within the Cumulative Assessment as the Ro-Ro facility only became operational in July 2020 and so the effects of this development as not considered to be included within the baseline.

Cumulative Effects Between the Proposed Development Construction and Tilbury2 Operation

13.291 The Tilbury2 project will require regular maintenance dredging to allow access to the Ro-Ro facility. Given normal licensing practice that staggers dredging operations within the same portion of the river it is expected that the construction phase dredge (only under Option C) for the Proposed Development will not be undertaken at the same time as any Tilbury2 maintenance dredging although this has not been assumed. Should these activities occur at the same time, this is not anticipated to result in a greater scale of potential water quality change, compared to either in isolation. Consequently, any cumulative effects associated with the capital dredging for the Proposed Development (only conducted under Option C) and Tilbury2 maintenance dredging are assessed to be of **minor significance**.

13.292 Other potential interactions between the construction phase of the Proposed Development and operational impacts of Tilbury2 could include disturbance to fish and marine mammals from artificial lighting of the Tilbury2 jetty and the construction works of the Proposed Development and an increased risk of collision with vessels for fish and marine mammals and underwater noise due to increased vessel traffic from Tilbury2 operations and construction activities for the Proposed Development. However, the magnitude of these impacts is assessed to be negligible and overall the cumulative effects of artificial lighting will be of negligible significance. The Tilbury2 ES indicated that during operation of Tilbury2, vessel traffic on the Thames will increase by approximately 10.5% (PoTLL 2017). The Tilbury2 ES stated vessels transiting to and from Tilbury2 will be relatively slow moving as they would be operating within a busy waterway and manoeuvring to enter or exit the port and so the risk of collision at these speeds would be low. Up to 10 construction barges may travel to the Kent and Essex Project Sites a day during the construction period and it is assessed that cumulative effects with Tilbury2 are negligible in terms of collision risk, increased levels of underwater noise and vibration for fish and marine mammals or increased risk of introduction or spread of INNS.

13.293 Overall cumulative effects are considered to be of **minor significance**.

Thurrock Flexible Generation Plant (NSIP ref: EN010092)

13.294 Thurrock Flexible Generation Plant is a flexible electricity generation plant on land next to Tilbury Substation in Thurrock. It will be 400 m east of the Essex Project Site. The main marine components of Thurrock Flexible Generation Plant will be the construction of a Ro-Ro causeway and capital dredging.

13.295 Construction is expected to start in 2021 for the majority of the Proposed Development including the marine components. Construction is expected to take either 1-2 years or 3-6 years depending on the options chosen for the construction programme. It is then expected to operate for up to 35 years.

Cumulative Effects Between the Proposed Development Construction and Thurrock Flexible Generation Plant Construction

13.296 Construction of the Ro-Ro causeway for the Thurrock Flexible Generation Plant has the potential to overlap with construction of the marine aspects of the Proposed Development. Both projects will require piling and so there is a potential for cumulative noise and vibration effects to occur on fish and marine mammals. These effects are not expected to be additive but may increase the duration of effects if piling activities take place consecutively between the two projects. If piling works are undertaken along this stretch of the tidal River Thames for a sustained period during sensitive ecological periods such as fish migration the cumulative effect has the potential to be of **minor significance** to migrating fish species (with appropriate mitigation measures for this potential impact applied for each project).

13.297 If piling for these two projects is to be conducted at the same time or consecutively, mitigation to reduce this cumulative effect should include timing of piling works to avoid a sustained period of piling works between the two projects as far as possible.

13.298 The dredging required under Option C, for the Proposed Development is at the Kent Project Site which is 4 km west of the Thurrock Flexible Generation Plan. This option would only be pursued, however, if Option A and B proved to be unfeasible. As stated above for the Tilbury 2 assessment, given normal licensing practice that staggers dredging operations within the same portion of the river it is expected that the construction phase dredge (Option C) for the Proposed Development will not be undertaken at the same time as any Thurrock Flexible Generation Plant capital dredging although this has not been assumed. Should these activities occur at the same time, this is not anticipated to result in a greater scale of potential water quality change, compared to either in isolation. Consequently, any cumulative effects associated with the Proposed Development capital dredging (only required under Option C) and Thurrock Flexible Generation Plant capital dredging are assessed to be of **minor significance**.

Cumulative Effects Between the Proposed Development Construction and Thurrock Flexible Generation Plant Operation

13.299 During operation, the main effect of the Thurrock Flexible Generation Plant will occur from maintenance dredging. If Option C is chosen, it is possible that capital dredging for the Proposed Development may take place at the same time as maintenance dredging for Thurrock Flexible Generation Plant. However, this is not anticipated to result in a greater scale of potential water quality change, compared to either in isolation. Consequently, any cumulative effects associated with capital dredging for the Proposed Development (only under Option C) and Thurrock Flexible Generation Plant maintenance dredging are assessed to be of **minor significance**.

Cumulative effects between the Proposed Development operation and Thurrock Flexible Generation Plant operation

13.300 During operation, the main effect of Thurrock Flexible Generation Plant will occur from maintenance dredging. If Option C is chosen, it is possible that maintenance dredging for the Proposed Development may take place at the same time as maintenance dredging for Thurrock Flexible Generation Plant. However, this is not anticipated to result in a greater scale of potential water quality change, compared to either in isolation. Consequently, any cumulative effects associated with maintenance dredging for the Proposed Development (would only be required for Option C, and maintenance dredging may not be required) and Thurrock Flexible Generation Plant maintenance dredging are assessed to be of **minor significance**.

The Pier, by Crest Nicholson (Dartford Borough Council, 17/01814/FUL)

13.301 The Pier Project is for the construction of a high-rise tower for mixed residential development together with adjacent launching jetty for small boats. It will be directly adjacent to the western boundary of the Kent Project Site. The boat jetty will require piling from a jack- up barge and so there is potential for cumulative underwater noise and vibration effects on fish and marine mammals to occur. The construction for this site has not yet started so there is the potential for an overlap in construction with the Proposed Development. These effects are not expected to be additive but may increase the duration of effects if piling activities take place consecutively between the two projects. If piling works are undertaken along this stretch of the tidal River Thames for a sustained period during sensitive ecological periods such as fish migration the cumulative effect has the potential to be of **minor significance** to migrating fish species (with appropriate mitigation measures for this potential impact applied for each project).

13.302 During operation, the main effect will be the movement of small boats to and from the jetty. This is not expected to have a significant cumulative effect with the Proposed Development due to the small number of movement of small boats anticipated for The Pier in relation to the vessel activity associated with the Proposed Development.

Purfleet Centre Regeneration (Thurrock Council, 17/01668/OUT)

13.303 Purfleet Centre Regeneration will redevelop land on the north bank of the tidal River Thames in Purfleet city centre. The marine elements of this project are limited to replacement of parts of the river wall and flood defences (including piling) and the provision of surface water runoff outfalls. It is not clear when the piling for the river wall will be conducted for the Purfleet Centre Regeneration. The overall construction programme is from 2019 until 2034.

Cumulative Effects Between the Proposed Development Construction and Purfleet Centre Regeneration Construction

13.304 Both projects will require piling and so there is a potential for cumulative noise and vibration effects to occur on fish and marine mammals. These effects are not expected to be additive but may increase the duration of effects if piling activities take place consecutively between the two projects. If piling works are undertaken along this stretch of the tidal River Thames for a sustained period during sensitive ecological periods such as during migration of sensitive species the cumulative effect has the potential to be of **minor significance** to migrating fish species (assuming appropriate mitigation measures for this potential impact are applied for each project).

13.305 If piling for these two projects is to be conducted at the same time or consecutively, further mitigation to reduce this cumulative effect could include timing of piling works to avoid a sustained period of piling works between the two projects.

Cumulative Effects Between the Proposed Development Operation and Purfleet Centre Regeneration Operation

13.306 Effects from the discharge of surface water runoff from the Purfleet Centre Regeneration project were assessed to have insignificant effects on marine receptors. Consequently, cumulatively the operation of discharges from outfalls from the Proposed Development and the Purfleet Centre Regeneration project are not anticipated to have a significant effect on marine receptors as the discharge volumes would be very small in comparison to the volume of the tidal River Thames and runoff will dissipate quickly within the water column.

Tilbury Energy Centre

13.307 The Tilbury Energy Centre is a proposed power station development project that would consist of a Combined Cycle Gas Power Station with a generating capacity up to 2500 megawatts (MW), Open Cycle Gas Turbines with a generating capacity up to 300MW and an energy storage facility. Works would include construction and operation of intakes and outfalls, piling for a jetty and dredging.

13.308 This proposal is currently on a Project Freeze with no proposed resumption date for the application.

13.309 If the Project Freeze was removed and works were conducted it is anticipated that any cumulative effects could be reduced via careful timing of piling works to avoid piling at ecologically sensitive times of year and to avoid a sustained period of piling works between the two projects. In terms of dredging effects, due to the distance from the Kent Project Site any cumulative effects are anticipated to be negligible.

13.310 Overall, any potential cumulative effects are considered to be of **minor significance**.

CLIMATE CHANGE

13.311 Given the anticipated lifetime of the project (e.g. upwards of 50 years) there is potential for some effects of climate change during the period of operation of the Proposed Development. Additionally, there is the potential for measures, as yet unknown, to be undertaken in line with adaptation and resilient infrastructure planning which could modify those effects. There are numerous models covering the UK which simulate the possible change in climate and the UK Climate Projections (UKCP18) indicate there could be increases in mean summer temperatures in the longer term and milder winters (influencing sea water temperature), changes in rainfall distribution and seasonality, more extremes of weather and sea level rise (Defra 2011).

13.312 Potential effects of climate change on species/habitats include, but are not restricted to the following:

- Warming of the water column can have an effect on water chemistry such as associated decreases in dissolved oxygen levels.

- Due to warming sea temperatures there could be changes in species distribution as Lusitanian species (warm temperate species that originate south of the UK such as from the Iberian peninsula) move further north around the coast into the Thames Estuary.

- Changes in species distribution as boreal species (subarctic species with an affinity for cold water) move out of the Thames Estuary as their optimal habitat range is pushed northwards or into deeper waters;

- There could be increased opportunity for thermophilic non-native species to colonise the Thames Estuary.

- Increases in sea temperature may cause changes in growth rates of organisms and reproductive rates and affect the timing of spawning and other lifecycle characteristics.

- Increased water temperatures could promote primary productivity and potentially increase the frequency of phytoplankton blooms.

- Increases in sea level rise could result in 'coastal squeeze' causing a decrease in intertidal habitat such as saltmarshes.

- An increase in the frequency of high intensity storms could have effects of sediment transport and erosion / accretion of subtidal and intertidal habitats.

- A change in the frequency or severity of droughts causing a reduction in water levels or drying-out of watercourses used by migratory fish.

Effects of the Proposed Development with Climate Change

13.313 Organisms present within the Thames Estuary, and estuarine environments in general, are eurythermal (able to tolerate wide range of temperatures). Climate-related water temperature increases in the UK over the last three decades have been ~0.07-0.2°C per decade depending on location and it is predicted this could rise to a worst-case of ~0.3°C per decade in the southern North Sea by the end of the 21st century (Lowe *et al*. 2009 – UKCP09 Marine and coastal projections).

13.314 Overall, taking into account the outcomes of the assessments undertaken in this ES it is considered that the Proposed Development will not hinder Defra's efforts to improve biodiversity as set out in the Defra biodiversity strategy in relation to climate change effects (Defra 2011).

SUMMARY AND CONCLUSIONS

13.315 This chapter provides an assessment of the significance and consequences of likely ecological impacts upon identified receptors arising from the Proposed Development.

13.316 Further baseline information in support of this chapter is included within Appendix 13.2: *Marine Ecology and Biodiversity Baseline Conditions* (document reference: 6.2.13.2) and is referred to throughout the assessment. The approach taken in this assessment is made with reference to the guidelines published in 2018 by the Chartered Institute of Ecology and Environmental Management (CIEEM).

13.317 The following receptors were considered within the assessment for the Proposed Development:

- Plankton

- Intertidal Habitats and Species (including saltmarsh)

- Subtidal Habitats and Species
- Fish

- Marine mammals
- Designated sites

13.318 An embedded mitigation measure is the creation of areas of saltmarsh. This will be undertaken using two different methods: managed retreat of the flood defences in the area south of Bell Wharf; and interventions at the shoreline to create an enhanced intertidal zone and encourage saltmarsh habitat to form along the north and northwest coast of the Peninsula. In addition, booms will be employed at the passenger jetty at the Kent Project Site to reduce the effects of boatwash on the intertidal habitat. With these embedded mitigation measures in place the majority of effects were assessed to be of minor significance or lower for all receptors.

13.319 The assessment determined that the effects of underwater noise and vibration from piling could be of moderate significance for fish and marine mammals. A range of appropriate measures have been indicated to reduce the significance of effect to minor which will be secured under the DCO.

13.320 The risk of accidental pollution events was assessed to be of moderate adverse significance. By implementing the management measures set out within the Construction Environmental Management Plan (CEMP) and the handover Environmental Management Plan EMP) the risk is assessed to be of minor adverse significance. These measures will be secured under the DCO.

13.321 The risk of the introduction or spread of non-native species was assessed to be of moderative adverse significance. Implementation of the measures set out in a Biosecurity Plan will reduce the risk of introducing or spreading non-native species to minor adverse significance for intertidal and subtidal habitats and species. The requirement for a Biosecurity Plan will be secured under the DCO.

13.322 Following mitigation, all effects are expected to be of minor adverse significance or less during the construction and operation phase of the Proposed Development, with further discussion required in relation to *A. romijni* for Option C.

13.323 A WFD assessment (Appendix 13.7, document reference: 6.2.13.7) and MCZ assessment (Appendix 13.8, document reference: 6.2.13.8) have been conducted to support the ES.

13.324 The conclusion of the WFD assessment is that with the proposed mitigation in place, there is not expected to be any non-temporary effects on the ecological potential or chemical status at water body level and that the works would not prevent the water body from meeting its WFD objectives (see Appendix 13.7, document reference: 6.2.13.7).

13.325 The conclusion of the MCZ assessment is that for the Swanscombe MCZ there would be no significant risk of the Proposed Development hindering the achievement of the conservation objectives stated for the MCZ for Options A and B. For Option C it is considered there could be a significant risk of hindering the achievement of the

conservation objectives due to the loss of *A. romijni* individuals potentially in the dredge pocket (see Appendix 13.8: *MCZ assessment*, document reference: 6.2.13.8, for further details and considerations). For this reason Option C would only be pursued of Options A and B proved to be unfeasible.

13.326 A summary of the activities taking place during the construction and operational phases of the Proposed Development that will potentially impact the identified receptors, along with the proposed mitigation and residual effects is provided within Table 13.19 and Table 13.20.

Table 13.19. Summary of potentially significant construction effects.

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Changes in Water Quality						
Plankton	Medium	Low	Minor	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Intertidal Habitat and Species	High	Medium	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Subtidal Habitat and Species	Medium	Medium	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Fish	Very high – Medium	Medium	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Designated Sites	High	Medium	No change	Local, temporary, no effect	No additional mitigation	No effect
Loss of Habitat						
Intertidal Habitat/ Species and Saltmarsh	High	High	Moderate (for *A. romijni* with Option C)	Local, permanent, moderate adverse	Preference for Options A or B. Option C, would only be undertaken if Options A and B were not feasible. If Option C is pursued further mitigation options will be discussed with Natural England.	Minor adverse

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Subtidal Habitat and Species	Medium	High	Minor	Local, temporary, minor adverse for Options A and B; Moderate adverse for Option C	No additional mitigation for Options A and B; Option C, would only be undertaken if Options A and B were not feasible. If Option C is pursued further mitigation options will be discussed with Natural England.	Minor adverse
Fish	Very high – Medium	Low	Negligible	Local, permanent, minor adverse	No additional mitigation	Minor adverse
Designated Sites	High	High	No change	No effect	No additional mitigation	No effect
Physical Disturbance and Displacement						
Intertidal Habitat and Species	High	Medium	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Subtidal Habitat and Species	Medium	Low	Negligible	Local, temporary, negligible	No additional mitigation	Negligible
Fish	Very high – Medium	Low	Negligible	Local, temporary, minor adverse for protected species, negligible for other species	No additional mitigation	Minor adverse - negligible
Designated Sites	High	Low	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Visual Disturbance						
Fish	Very high – Medium	Low	Negligible	Local, temporary, minor adverse for protected species, negligible for other fish species	No additional mitigation	Minor adverse - negligible
Marine Mammals	Very high	Low	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Increase in Underwater Noise and Vibration						
Benthic Invertebrates	Medium (invertebrates that can detect noise)	Low	Negligible	Local, temporary, negligible	No additional mitigation	Negligible
Fish	Very high – Medium	High – low	Minor	Local, temporary, moderate adverse	Use of small piles; quieter installation methods; pile at low tide; employ ‘soft start’ procedures; avoiding piling at sensitive times of year including fish migration and spawning periods	Minor adverse

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Marine Mammals	Very high	High	Minor	Local, temporary, minor adverse effect from vessels. Local, temporary, moderate adverse effect from piling	Use of small piles; quieter installation methods; pile at low tide; employ 'soft start' procedures	Minor adverse
Use of Artificial Lighting						
Intertidal Habitats and Species	High	Low	Negligible	Local, temporary, minor	No additional mitigation	Minor (potentially adverse or beneficial)
Fish	Very high – Medium	High	Negligible	Local, temporary, minor for protected species (potentially adverse or beneficial), negligible for other species	No additional mitigation	Minor (potentially adverse or beneficial) - negligible
Marine Mammals	Very high	Medium	Negligible	Local, temporary, minor	No additional mitigation	Negligible
Collision Risk with Vessels						
Marine Mammals	Very high	Low	Negligible	Negligible	No additional mitigation	Negligible
Presence of Structures in the Estuary Margins						
Fish	Very high	Low	Negligible	Local, permanent, minor	No additional mitigation	Minor
Marine Mammals	Very high	Low	Negligible	Local, permanent, negligible	No additional mitigation	Negligible
Spread of Invasive Non-native Species						
Plankton	Medium	Medium	Negligible	Local to national, permanent, negligible	No additional mitigation	Negligible
Intertidal Habitats and Species	High	Medium	Moderate	Local to national, permanent, moderate adverse	Biosecurity Plan with Biosecurity Risk Assessment	Minor adverse

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Subtidal Habitats and Species	Medium	Medium	Moderate	Local to national, permanent, moderate adverse	Biosecurity Plan with Biosecurity Risk Assessment	Minor adverse
Indirect Effects via the Food Chain						
Plankton	Medium	Low	Negligible	Negligible	No additional mitigation	Negligible
Intertidal Species/ Habitats	High	Low	Negligible	Negligible	No additional mitigation	Negligible
Subtidal Species/ Habitats	Medium	Low	Negligible	Negligible	No additional mitigation	Negligible
Fish	Very high – Medium	Low	Negligible	Local, temporary, negligible	No additional mitigation	Negligible
Marine Mammals	Very high	Low	Negligible	Negligible	No additional mitigation	Negligible
Accidental Pollution Events						
Plankton	Medium	Medium	Minor	Temporary, local, minor adverse	No additional mitigation	Minor
Intertidal Habitats/ Species (Including saltmarsh)	High	High	Moderate	Temporary, local, moderate adverse	Measures outlined in CEMP	Negligible
Subtidal Habitat and Species	Medium	High	Moderate	Temporary, local, moderate adverse	Measures outlined in CEMP	Negligible
Fish	Very high – Medium	High	Moderate	Temporary, local, moderate adverse	Measures outlined in CEMP	Minor adverse - negligible

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Marine Mammals	Very high	High	Moderate	Local, temporary, moderate adverse	Measures outlined in CEMP	Minor adverse

Table 13.20. Summary of potentially significant operational effects.

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Change in Hydrodynamics and Sediment Accretion/Erosion						
Intertidal Habitats and Species	High	Medium	Minor	Local, temporary and/or permanent, minor adverse	No additional mitigation	Minor adverse
Subtidal Habitat and Species	Medium	Medium	Minor	Temporary and/or permanent, minor adverse	No additional mitigation	Minor adverse
Fish	Very high – Medium	Negligible	Negligible	Local, temporary, negligible	No additional mitigation	Negligible
Changes in Water Quality						
Plankton	Medium	Low	Minor	Local temporary, minor adverse	No additional mitigation	Minor adverse
Intertidal Habitat and species	High	Medium	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Subtidal Habitat and species	Medium	Medium	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Fish	Very high - medium	Medium	Negligible	Local, temporary, minor adverse for protected species, negligible for other species	No additional mitigation	Minor adverse - Negligible

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Designated Sites	High	Medium	No change	Local, temporary, no effect	No additional mitigation	No effect
Loss of Habitat due to Maintenance Dredging						
Subtidal Habitat and Species	Medium	High	Moderate (only applicable to Option C)	Local, temporary, moderate	to be agreed with statutory consultees	Minor
Visual Disturbance						
Marine Mammals	Very high	Negligible	Negligible	Local, temporary, minor adverse	No additional mitigation	Minor adverse
Increase in Underwater Noise and Vibration						
Benthic invertebrates	Medium (invertebrates that can detect noise)	Low	Negligible	Negligible	No additional mitigation	Negligible
Fish	Very high – Medium	High – low	Minor - negligible	Local, long-term, negligible for low sensitivity species, minor adverse for medium and high sensitivity hearing species	No additional mitigation	Minor adverse - negligible
Marine Mammals	Very high	High	Negligible	Minor adverse	No additional mitigation	Minor adverse
Introduction of New Artificial Habitat						
Intertidal and Subtidal Habitats/ Species	High	Medium	Minor	Local, permanent, minor beneficial	No additional mitigation	Minor beneficial
Fish	Very high – Medium	Low	Minor	Local, permanent, minor beneficial	No additional mitigation	Minor beneficial
Shading						
Intertidal Habitats and Species	High	Negligible	Negligible	Local, permanent, negligible	No additional mitigation	Negligible

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Subtidal Habitats and Species	Medium	Negligible	Negligible	Local, temporary and permanent, negligible	No additional mitigation	Negligible
Fish	Very high – Medium	Low	Negligible	Local, temporary and permanent, negligible	No additional mitigation	Negligible
Use of Artificial Lighting						
Intertidal Species and Habitats	High	Low	Negligible	Local, permanent, minor	No additional mitigation	Minor (potentially adverse or beneficial)
Fish	Very high – Medium	High	Negligible	Local, permanent, minor (potentially adverse or beneficial) for protected fish, negligible for other fish	No additional mitigation	Minor (potentially adverse or beneficial) - negligible
Marine Mammals	Very high	Medium	Negligible	Local, temporary, negligible	No additional mitigation	Negligible
Collison Risk with Vessels						
Marine Mammals	Very high	Low	Negligible	Negligible	No additional mitigation	Negligible
Presence of Structures in the Estuary Margins						
Fish	Very high	Low	Negligible	Local, permanent, minor	No additional mitigation	Minor
Marine Mammals	Very high	Low	Negligible	Local, permanent, negligible	No additional mitigation	Negligible
Introduction and/or Spread of Invasive Non-native Species						
Plankton	Medium	Medium	Negligible	Local or national, permanent, negligible	No additional mitigation	Negligible
Intertidal Species and Habitats	High	Medium	Moderate	Local to national, permanent, moderate adverse	Biosecurity Plan with Biosecurity Risk Assessment	Minor adverse

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Subtidal Habitats and Species	Medium	Medium	Moderate	Local to national, permanent, moderate adverse	Biosecurity Plan with Biosecurity Risk Assessment	Negligible
Indirect Effects via Food Chain						
Plankton	Medium	Low	Negligible	Negligible	No additional mitigation	Negligible
Intertidal Habitats and Species	High	Low	Negligible	Negligible	No additional mitigation	Negligible
Subtidal Habitats and Species	Medium	Low	Negligible	Negligible	No additional mitigation	Negligible
Fish	Very high – Medium	Low	Negligible	Negligible	No additional mitigation	Negligible
Marine Mammals	Very high	Low	Negligible	Negligible	No additional mitigation	Negligible
Vessel Pollution (e.g. fumes, anti-fouling paint)						
Intertidal Habitat and Species	High	Medium	Negligible	Negligible	No additional mitigation	Negligible
Subtidal Habitat and Species	Medium	Medium	Negligible	Negligible	No additional mitigation	Negligible
Accidental Pollution Events (e.g. oil spills)						
Plankton	Medium	Medium	Negligible	Negligible	No additional mitigation	Negligible
Intertidal Habitats and Species	High	High	Negligible	Negligible	No additional mitigation	Negligible
Subtidal Habitats and Species	Medium	High	Negligible	Negligible	No additional mitigation	Negligible

Receptor	Value Of Receptor	Sensitivity Of Receptor	Magnitude Of Impact	Likely Significant Effect	Mitigation Measures	Likely Residual Effect
Fish	Very high – Medium	High	Negligible	Minor adverse for protected fish, negligible for fish that are not protected	No additional mitigation	Minor adverse - negligible
Marine Mammals	Very high	High	Negligible	Minor adverse	No additional mitigation	Minor adverse

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