

SILVERTOWN TUNNEL

6.1.10 Environmental Statement Chapter 10 – Marine Ecology

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APFP Regulation 5(2)(a)

Revision **10**

Planning Act 2008

Infrastructure Planning (Applications: Prescribed
Forms and Procedure) Regulations 2009

November~~April~~ 2016

Silvertown Tunnel Environmental Statement [v1.1](#)

Chapter 10 Marine Ecology

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Silvertown Tunnel

ES Chapter 10 – Marine Ecology

6.1.10

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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1.1	15/11/2016	David Rowe (TfL Lead Sponsor)		In response to MR3, Paragraph 10.3.8, 10.4.73,

				<p>10.4.78 and 10.4.82 have been updated to reflect the updated title of Drawing 10-1 – <i>Study area and Sightings Compiled as Part of the Thames Marine Mammal Sightings Survey (2004 to 2015)</i>. The title of Table 10-4 has been amended to reflect errata highlighted in ME4. In response to ME7 and ME8, Paragraph 10.5.1 has been amended to include additional commitments in the revised CoCP and dDCO to be submitted at Deadline 1; the further timing restrictions and protective provisions requested by the EA in their RR [RR-299] have been incorporated in the updated text. References to</p>
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				waste disposal strategy in Table 10-15 and 10.5.1, has been amended to SWMP (see FWQ MR11 (b)).
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List of Abbreviations

A	Anadromous
BAP	Biodiversity Action Plan
BOD	Biological Oxygen Demand
C	Catadromous
CAMS	Catchment Abstraction Management Strategy
CBD	Convention on Biological Diversity
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Construction Environmental Management Plan
CHaMP	Coastal Habitat Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CMS	Construction Method Statement
CoCP	Code of Construction Practice
COD	Chemical Oxygen Demand

CRoW	The Countryside and Rights of Way Act 2000
dB	Decibel
DCO	Development Consent Order
DECC	Department of Energy & Climate Change
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
EAL	Emirates Air Line
EC	European Commission
EIA	Environmental Impact Assessment
ER	Estuarine Residents
ES	Environmental Statement
EU	European Union
FS	Freshwater Stragglers
GES	Good Environmental Status
GES	Good Ecological Status

GIS	Geographic Information System
GLA	Greater London Authority
IUCN	International Union for Conservation of Nature
LBAP	Local Biodiversity Action Plan
LNR	Local Nature Reserve
MCZ	Marine Conservation Zone
MMD	Marine Migrant Dependant
MMO	Marine Management Organisation
MMOS	Marine Migrant Opportunistic Species
MPA	Marine Protected Area
MPS	Marine Policy Statement
MS	Marine Stragglers
MSFD	The Marine Strategic Framework Directive
NE	Natural England

NERC	Natural Environment and Rural Communities
NFFO	National Federation of Fisherman's Organisations
NM	Nautical Mile
NN NPS	National Networks National Policy Statement
NNR	Natural Nature Reserve
NPPG	National Planning Practice Guidance
NPS	National Policy Statement
OS	Ordnance Survey
OSPAR	The Convention for the Protection of the Marine Environment in the North-East Atlantic (1992)
PCBs	Polychlorinated Biphenyl
PLA	Port of London Authority
pMCZ	proposed Marine Conservation Zone
PSA	Particle Size Analysis
rMCZ	recommended Marine Conservation Zone

S&R	Sustainability and Renewal
SAC	Special Areas of Conservation
SCANS	Small Cetacean Abundance in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SFF	Scottish Fishermen's Association
SMRU	Sea Mammal Research Unit
SPA	Special Protection Areas
SSC	Suspended Sediment Concentrations
SSSI	Site of Special Scientific Interest
SWMP	Site Waste Management Plan
TEBP	Thames Estuary Benthic Programme
TraC	Transitional and Coastal Water Bodies
UKOOA	UK Offshore Operator's Association
WCA	Wildlife and Countryside Act
WFD	Water Framework Directive

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WID	Water Injection Dredging
ZSL	Zoological Society London

Glossary of Terms

Benthic	A description for animals, plants and habitats associated with the seabed.
Best Practice Measures	Professional procedures that are accepted or prescribed as being correct or most effective to maintain quality.
Biodiversity Action Plan Priority Habitat	UK BAP priority habitats cover a wide range of semi-natural habitat types, and were those that were identified as being the most threatened and requiring conservation action under the UK Biodiversity Action Plan (UK BAP).
Chemical Status	An expression of the pollutants within the water. Waters with good chemical status are those with concentrations of pollutants that do not exceed the environmental limit values specified in the Water Framework Directive.
Code of Construction Practice	The Code of Construction Practice contains a series of measures and standards of work to be applied to the construction of a project ensuring a consistent approach to the management of construction activities.
Cofferdam	A form of ground excavation support, usually temporary works, used during construction of underground or near-surface engineering works.
Construction Environmental Management Plan	A Construction Environmental Management Plan sets out the intended methods of the effective management of potential environmental impacts arising

	during the construction of a project.
Contractor	Anyone who directly employs or engages construction workers or manages construction work. Contractors include sub-contractors, any individual self-employed worker or business that carries out, manages or controls construction work.
Ecological Status	An expression of the structure and functioning of aquatic ecosystems associated with surface waters. Such waters are classified as being of good ecological status when they meet the requirements of the Water Framework Directive.
Excavated Material	Ground or other material removed during a construction process, usually by mechanical means.
Geographical Information Systems	A computer system for capturing, storing, checking and displaying data related to positions on Earth's surface. GIS is useful to show many different kinds of data on one map.
Good Ecological Status	The objective for a surface water body to have biological, structural and chemical characteristics similar to those expected under nearly undisturbed conditions
Good Status	A general term meaning the status achieved by a surface water body when both the ecological status and its chemical status are at least good or, for groundwater, and when both its

	quantitative status and chemical status are at least good.
Intertidal	The area of a shore which is covered at high tide and uncovered at low tide.
OSPAR	OSPAR is the mechanism by which 15 Governments & the EU cooperate to protect the marine environment of the North-East Atlantic. OSPAR started in 1972 with the Oslo Convention against dumping and was broadened to cover land-based sources and the offshore industry by the Paris Convention of 1974. These two conventions were unified, up-dated and extended by the 1992 OSPAR Convention. The new annex on biodiversity and ecosystems was adopted in 1998 to cover non-polluting human activities that can adversely affect the sea. The fifteen Governments are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom. OSPAR is so named because of the original Oslo and Paris Conventions ("OS" for Oslo and "PAR" for Paris).
Pathway	The route by which potential contaminants may reach receptors.
PCB	<p>A polychlorinated biphenyl is a synthetic organic chemical compound of chlorine attached to biphenyl, which is a molecule composed of two benzene rings.</p> <p>Polychlorinated biphenyls were widely used as dielectric and coolant fluids in</p>

	<p>electrical apparatus, cutting fluids for machining operations. Due to PCBs' environmental toxicity and classification as a persistent organic pollutant, PCB production was banned by the United States Congress in 1979.</p>
Polychlorinated Biphenyl (PCBs)	<p>A polychlorinated biphenyl is a synthetic organic chemical compound of chlorine attached to biphenyl, which is a molecule composed of two benzene rings.</p>
Probable effect levels (PELs)	<p>An indicator from the Canadian Sediment quality guidelines, that provide a basic indication on the degree of contamination and likely impact on ecology.</p> <p>The guidelines define three ranges of chemical concentrations with regard to biological effects, with concentrations above the PELs indicating the probable effect range within which adverse effects frequently occur.</p>
River Basin District	<p>A river basin or several river basins, together with associated coastal waters. A river basin district is the main unit for management of river basins under the WFD.</p>
Silt	<p>The generic term for particles with a grain size of 4-63mm, i.e. between clay and sand.</p>
Site Waste Management Plan (SWMP)	<p>A document that outlines how the Scheme will reduce, manage, and dispose of its solid waste.</p>
Subtidal	<p>The portion of the shore which lies below the level of mean low water for</p>

	spring tides. Normally it is covered by water at all states of the tide.
Surface Water	Water that appears on the land surface that has not seeped into the ground, i.e. lakes, rivers, streams, standing water, ponds, precipitation.
Waste	Waste is defined in Article 1(a) of the European Waste Framework Directive 2008/98/EC (Ref 13-3) as 'any substance or object in the categories set out in Annex I which the holder discards or intends to discard or is required to discard'. The term 'holder' is defined as the producer of the waste or the person who is in possession of it and 'producer' is defined as anyone whose activities produce waste. Waste can be further classified as hazardous, non-hazardous or inert.
Water Framework Directive	European Union legislation, Water Framework Directive (2000/60/EC) establishing a framework for European Community action in the field of water policy.

10. MARINE ECOLOGY

10.1 Introduction

- 10.1.1 This chapter identifies the potential marine ecological impacts of the Silvertown Tunnel Scheme. As described in Chapter 4, Scheme Description of the Environmental Statement (ES) (Document Reference 6.1.4) the elements of the Scheme that could impact on the marine environment are envisaged to include recommissioning of the existing NAABSA (Not Always Afloat but Safely Aground) berth facility at the Thames Wharf, the construction, operation, and decommissioning of a new temporary jetty within the River Thames, along with an associated dredge and the disposal of the dredge arisings. The methods for disposal of dredge arisings (should this be required) will be determined as part of a detailed Site Waste Management Plan (SWMP). A SWMP is included in Volume 6.10 of the ES (Document Reference 6.10), however options will not include disposal at sea. This chapter also addresses marine ecology impacts related to the moving of two existing moorings, increased vessel movements on the river during the construction of the tunnel and the possible vibration effects arising from the tunnel boring itself.
- 10.1.2 This chapter describes the existing baseline conditions relating to the marine ecology topic and addresses the likely significant effects of the Scheme on relevant marine ecology receptors.
- 10.1.3 The marine related works are temporary and limited to the construction of the Scheme; accordingly, there are no impacts on marine ecology caused by the Scheme in operation and as such none are considered in this chapter.
- 10.1.4 Relevant marine ecology receptors that have been identified in this chapter include:
- marine Nature Conservation Protected Areas and Species;
 - benthic marine habitats and species (including invasive non-native species);
 - marine fish and shellfish; and
 - marine mammals.

10.1.5 All drawings referenced within this chapter are presented in Volume 2 of the ES (Document Reference 6.2) and all appendices referenced in this Chapter are presented in Volume 3 (Document Reference 6.3).

10.2 Regulatory and policy framework

10.2.1 This marine ecology environmental assessment has been undertaken in accordance with current international and national legislation, and national, regional and local plans and policies relating to nature conservation in the context of the Scheme. A summary of the relevant legislation and policies and the requirements of these policies has been provided in Table 10-1 below. The detailed design of the Scheme and the overarching mitigation strategy will be undertaken to ensure compliance with all relevant policy and legislation relating to the protection of marine ecology.

Table 10-1 Policy and Legislation

Policy/Legislation	Summary of Requirements	Scheme Response
<p>National Policy Statement for National Networks (NN NPS)</p>	<p>In line with The Government’s biodiversity strategy as set out in <i>Biodiversity 2020: A Strategy for England’s wildlife and ecosystem services</i>, whereby the aim is to reduce overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, the NN NPS states that as a general principle ‘<i>development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives</i>’</p>	<p>The mitigation measures described in this chapter (see Section 10.5) will be implemented to ensure no Scheme related significant adverse effects arise in relation to relevant marine ecological interests.</p>
	<p>Paragraph 5.22 states: ‘<i>Where the project is subject to EIA the applicant should ensure that the environmental statement clearly sets out any likely significant effects on internationally, nationally and locally designated sites of ecological or geological conservation importance (including those outside England) on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity and that the statement considers the full range of potential impacts on ecosystems.</i>’</p> <p>Paragraph 5.25 states: ‘<i>As a general principle, and subject to the specific policies below, development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of</i></p>	<p>This chapter outlines the likely significant effects on internationally, nationally and locally designated sites of marine ecological conservation importance.</p> <p>The mitigation measures described in this chapter (see Section 10.5) will be implemented to ensure no Scheme related significant adverse effects arise in</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p><i>reasonable alternatives. The applicant may also wish to make use of biodiversity offsetting in devising compensation proposals to counteract any impacts on biodiversity which cannot be avoided or mitigated. Where significant harm cannot be avoided or mitigated, as a last resort, appropriate compensation measures should be sought.</i></p> <p>Paragraph 5.36 states: <i>Applicants should include appropriate mitigation measures as an integral part of their proposed development, including identifying where and how these will be secured. In particular, the applicant should demonstrate that:</i></p> <ul style="list-style-type: none"> • during construction, they will seek to ensure that activities will be confined to the minimum areas required for the works; • during construction and operation, best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised (including as a consequence of transport access arrangements); • habitats will, where practicable, be restored after construction works have finished; • developments will be designed and landscaped to 	<p>relation to relevant marine ecological interests.</p> <p>The mitigation measures described in this chapter (see Section 10.5) will be implemented to ensure no Scheme related significant adverse effects arise in relation to relevant marine ecological interests.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>provide green corridors and minimise habitat fragmentation where reasonable; and</p> <ul style="list-style-type: none"> opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals, for example through techniques such as the 'greening' of existing network crossing points, the use of green bridges and the habitat improvement of the network verge. 	
National Planning Policy Framework	The National Planning Policy Framework sets out the Government's planning policies for England and how these are expected to be applied. The framework acts as guidance for local planning authorities and decision-takers, both in drawing up plans and making decisions about planning applications. Section 11 of the framework 'Conserving and enhancing the natural environment' incorporates policies requiring that development impacts on biodiversity are minimised.	The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.
National Planning Practice Guidance (NPPG)	NPPG provides that the planning system should contribute to and enhance the natural and local environment, minimise pollution and other adverse effects on the local and natural environment and minimise impacts on biodiversity.	The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.
The Convention on the Conservation of	The principal aims of the Bern Convention are the conservation and protection of the wild plant and animal	The potential for the presence of protected habitats and species has been investigated as part of

Policy/Legislation	Summary of Requirements	Scheme Response
European Wildlife and Natural Habitats 1979 (the Bern Convention)	<p>species (and the natural habitats thereof) listed in Appendices I and II of the Convention. It also seeks to increase co-operation between governments and to regulate the exploitation of the species listed in Appendix III, which includes migratory fish species, cetaceans and grey seal.</p> <p>The Bern Convention was implemented in Europe via two directives: Council Directive 79/409/EEC on the Conservation of Wild Birds (the EC Birds Directive) in 1979 and Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the EC Habitats Directive) in 1992. The Convention is implemented in UK law by the Wildlife and Countryside Act (1981 and as amended).</p>	<p>determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>
The Convention on Biological Diversity 1992 (Biodiversity Convention or CBD)	<p>The CBD was the first treaty to provide a legal framework for biodiversity conservation. It focuses on the conservation of all species and ecosystems and, therefore, provides protection to all biodiversity. The Convention requires that national strategies, plans or programmes are developed for the conservation and sustainable use of biodiversity.</p> <p>In the UK, the CBD is implemented via the Post-2010 Biodiversity Framework, which in 2012 replaced the UK Biodiversity Action Plan.</p>	<p>The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>
The Convention on the	The Convention aims to conserve migratory species and	The potential for the Scheme to adversely affect

Policy/Legislation	Summary of Requirements	Scheme Response
<p>Conservation of European Wildlife and Natural Habitats 1979 (the Bern Convention)</p>	<p>their habitats by providing strict protection for endangered migratory species that are listed in Appendix I of the Convention. It involves multilateral agreements for conserving and managing those migratory species that would benefit from international co-operation (listed in Appendix II of the Convention) and the undertaking of co-operative research.</p> <p>Within the UK, protection of Appendix I species is carried out through the Wildlife & Countryside Act (1981 as amended). The Countryside and Rights of Way Act 2000 (CRoW) was also enacted in England and Wales to offer further support by increasing penalties and enforcement powers. It also strengthened the protection of sites from damage caused by third parties.</p>	<p>migratory marine species has been evaluated as part of this environmental impact assessment. Mitigation measures will be implemented to ensure the Scheme has no adverse effects on relevant marine ecological interests.</p>
<p>The Convention for the Protection of the Marine Environment of the North-East Atlantic 1992 (the OSPAR Convention)</p>	<p>The OSPAR Convention provides a comprehensive approach to addressing sources of maritime pollution and other matters affecting the marine environment. Annex V of the Convention provides a framework for governments to develop their own conservation measures. Article 2 requires parties to 'take necessary measures to protect and conserve the ecosystems and the biological diversity of the maritime area, and to restore, where practicable, marine areas which have already been adversely affected'.</p>	<p>The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>The Convention includes the establishment of a list of threatened and/or declining species and habitats. This list provides an overview of the biodiversity 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 on the OSPAR Convention and protection of marine biodiversity OSPAR Convention protected habitats and species.</p> <p>The most recent OSPAR List of Threatened and/or Declining Species and Habitats lists <i>inter alia</i> native oyster, Allis shad, European eel, cod, sea lamprey, thornback ray, Atlantic salmon and harbour porpoise as being under threat and/or in decline in Region II (the Greater North Sea, which includes the English Channel and Thames Estuary).</p>	
<p>The Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (the Ramsar Convention or Wetlands Convention)</p>	<p>The Ramsar Convention is an intergovernmental treaty that embodies the commitments of its member countries to maintain the ecological character of their wetlands of international importance and to plan for the 'wise use', or sustainable use, of all of the wetlands in their territories. Ramsar sites are wetlands of international importance designated under the Ramsar Convention.</p> <p>Policy statements relating to the status of Ramsar sites have been issued by Government, to extend their level of</p>	<p>The closest Ramsar site that supports marine features (the Thames Estuary and Marshes Ramsar site) is located approximately 30km from the proposed Order limits and as such is considered to fall well outside of the assessment study area appropriately adopted for the purposes of the marine ecology assessment set out in this chapter.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>protection to that of sites designated as part of the EU Natura 2000 network under the EC Birds and Habitats Directives.</p>	
<p>EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (EC Habitats Directive)</p>	<p>The Habitats Directive was adopted in 1992 and is the means by which the EU meets its obligations under the Bern Convention. The Directive promotes the maintenance of biodiversity by requiring Member States to maintain or restore natural habitats and wild species that are listed on the Directive’s annexes. Economic, social and cultural requirements must be considered, alongside regional and local characteristics.</p> <p>To maintain or restore habitats listed in Annex I and species listed in Annex II of the Directive to ‘Favourable Conservation Status’, a network of Special Areas of Conservation (SACs) have been created. Annex II species include Atlantic salmon, harbour porpoise and grey and common seals.</p> <p>Annex IV of the Habitats Directive lists European Protected Species which are species of plants and animals (other than birds) protected by law throughout the European Union. All species of cetacean are listed in Annex IV of the Habitats Directive.</p>	<p>The closest SAC that supports marine features (Essex Estuaries SAC) is located over 50km from the proposed Order limits and as such is considered to fall well outside of the assessment study area appropriately adopted for the purposes of the marine ecology assessment set out in this chapter.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>In England, the Directive is implemented under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), which apply to land and territorial waters to the 12 nautical mile (nm) limit. The amendments are consolidated by the Conservation of Habitats and Species Regulations 2010 out to 12nm from the coast and by the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended) between 12nm from the coast and 200nm or the limit of the UK Continental Designated Area.</p>	
<p>EC Directive on the Conservation of Wild Birds (2009/147/EC) (EC Birds Directive)</p>	<p>The Birds Directive was adopted by the Members States in 1979 as a response to increasing concern about the declines in Europe's wild bird populations resulting from pollution and loss of habitats as well as unsustainable use. It was also in recognition that wild birds, many of which are migratory, are a shared heritage of the Member States and that their effective conservation required international co-operation.</p> <p>The directive recognises that habitat loss and degradation are the most serious threats to the conservation of wild birds. It therefore places great emphasis on the protection of habitats for endangered as well as migratory species (listed in Annex I), especially through the establishment of a coherent network of Special Protection Areas (SPAs) comprising all the most suitable territories for these species.</p>	<p>The closest SPA that supports marine features (the Thames Estuary and Marshes SPA) is located approximately 30km from the proposed Order limits and as such is considered to fall well outside of the assessment study area appropriately adopted for the purposes of the marine ecology assessment set out in this chapter.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>Since 1994 all SPAs form an integral part of the NATURA 2000 ecological network.</p> <p>In England the provisions of the Birds Directive are implemented through the Wildlife & Countryside Act 1981 (as amended), the Conservation of Habitats and Species Regulations 2010 and the Offshore Marine Conservation Regulations 2007.</p>	
<p>The Water Framework Directive (2000/60EC)</p>	<p>The Water Framework Directive (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 2003 (the Water Framework Regulations). The aim of the WFD is to achieve 'good ecological and good chemical status' in all inland and coastal waters by 2015 unless alternative objectives are set or there are grounds for derogation. 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 hydro-morphological, chemical and biological indicators (including benthic invertebrates, macroalgae, fish, phytoplankton and angiosperms).</p> <p>The WFD Directive was transposed into UK law via the</p>	<p>A WFD Assessment has been undertaken (see Appendix 10-A (Document Reference 6.3.10.1)). The assessment has informed the mitigation measures described within this chapter.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>Water Environment (WFD) (England and Wales) Regulations 2003 SI 3242. The Regulations provide the mechanism to implement river basin districts within England and Wales in accordance with the Water Framework Directive. The proposed development is in the South East River Basin District.</p>	
<p>EU Marine Strategy Framework Directive (2008/56/EC)</p>	<p>The Marine Strategy Framework Directive (MSFD) provides a framework for managing human activities with an ecosystem-based approach to support the sustainable use of marine goods and services. The objective of the MSFD is for EU marine waters to achieve 'good environmental status' (GES) by 2020. GES involves protecting the marine environment, preventing its deterioration and restoring it where practical, while using marine resources sustainably. For the UK, the co-ordination of strategies for reaching GES is achieved through the OSPAR Convention.</p> <p>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, including the consideration of hydrographical conditions. 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</p>	<p>The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>came into force on 15 July 2008, and was transposed into UK law via the Marine Strategy Regulations 2010.</p>	
<p>The Conservation of Habitats and Species Regulations 2010 (Habitats Regulations)</p>	<p>The Conservation of Habitats and Species Regulations 2010 (referred to as the Habitats Regulations) consolidate all the various amendments made to the 1994 Regulations in respect of England and Wales. The Regulations transpose the EC Habitats Directive into national law. The Habitats Regulations provide for the designation of Special Areas of Conservation (SACs). They also require the compilation of a register of European sites in a network called Natura 2000. European sites include SACs and Special Protection Areas (SPAs), the latter of which is classified under the Birds Directive.</p> <p>Natural England has statutory responsibility to advise relevant authorities as to the conservation objectives for European Marine Sites and operations which may cause deterioration or disturbance of natural habitats and species. This advice is provided under Regulation 35 of the Habitats Regulations. The role of the conservation objectives for a European Marine Site is to define the nature conservation aspirations for the features of interest, thereby representing the aims and requirements of the Habitats and Birds Directives in relation to the site.</p>	<p>The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological features.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>The Habitats Regulations also protect animal species listed in Schedule 2 from deliberate capture, killing, disturbing or trading, and plant species in Schedule 4 from being picked, collected, cut, uprooted, destroyed or traded without a licence.</p>	
<p>Marine and Coastal Access Act 2009</p>	<p>The Marine and Coastal Access Act 2009 aims to enable better protection of marine ecosystems and prevent a decline in marine biodiversity. The Act sets out provisions for more coherent planning in the marine environment in terms of issuing consents and permits for activities in the marine and coastal environment and sets out how decision makers should take account of the appropriate marine policy documents.</p> <p>The Act also contains provisions to allow for the creation of a new type of Marine Protected Area (MPA), called a Marine Conservation Zone (MCZ). MCZs protect a range of nationally important marine wildlife, habitats, geology and geomorphology and can be designated anywhere in English inshore and UK offshore waters. Sites are selected to protect not just rare and threatened habitats and/or species, but the full range of marine wildlife. Within the south east region, the development of recommendations for MCZ has been coordinated by the Balanced Seas Regional MCZ Project (Balanced Seas, 2011).</p>	<p>The overlap of the Scheme with the Thames Estuary rMCZ site has been taken into account in the identification of potential marine ecological impact pathways.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>The UK Government consulted on the first round of recommended Marine Conservation Zones (rMCZs) in English Inshore and English and Welsh Offshore Waters between 13 December 2012 and 31 March 2013. On 21 November 2013, Defra announced the designation of 27 MCZs around England's coast, none of which fall within the vicinity of the proposed development. The whole Thames Estuary was, however, recognised as a recommended MCZ (rMCZ) for consideration in future designation rounds.</p> <p>In January 2015, Defra opened the consultation on a second tranche of MCZs. On the 17 January 2016, 23 sites were designated as part of the second phase. Despite being recognised as an rMCZ in 2013, the Thames Estuary was not designated in 2016. Designation of the site is currently on hold while an investigation into the implications of designation on potential developments within the estuary takes place.</p>	
<p>The Wildlife and Countryside Act 1981 (as amended)</p>	<p>The Wildlife and Countryside Act (WCA) consolidates and amends existing legislation to implement the Bern Convention and the Birds Directive. The act contains four parts and 17 schedules, covering inter alia: protection of wildlife (birds and some animals and plants); the countryside; national parks; and the designation of protected</p>	<p>The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>areas.</p> <p>The WCA 1981 provides for the designation and management of Sites of Special Scientific Interest (SSSI). These sites are designated to safeguard, for present and future generations, the diversity and geographic range of habitats, species, and geological and physiographical features, including the full range of natural and semi-natural ecosystems and of important geological and physiographical phenomena throughout England and Wales. Various species of marine animals are also protected from being killed, injured or disturbed under provisions in Schedule 5 of the WCA 1981.</p> <p>All cetaceans (whales and dolphins) are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to take, injure or kill these species. Disturbance in their place of rest, shelter or protection is also prohibited.</p>	<p>ecological interests.</p>
<p>Salmon and Freshwater Fisheries Act</p>	<p>The Salmon and Freshwater Fisheries Act 1975 applies to salmon, trout (including sea trout), eel and freshwater fish. Section 38 concerns the construction on, over or under tidal lands below high-water mark of ordinary spring tides. In this scenario, construction must be undertaken in accordance with plans and regulations approved in writing by the</p>	<p>The potential impact pathways by which fish could be affected by the construction of the Scheme have been identified. Mitigation measures will be implemented to ensure the Scheme no adverse effects on fish or other relevant marine ecological interests.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	Secretary of State.	
The Eels (England and Wales) Regulations 2009	The Eels Regulations came into force in 2010 and implement Council Regulation (EC) No. 1100/2007 of 18 September 2007, which established measures for the recovery of the stock of European eel. The UK submitted 15 Eel Management Plans for approval by the Commission in December 2008. These plans are set at the River Basin District level, as defined under the Water Framework Directive 2000/60/EC, covering England and Wales, Scotland and Northern Ireland. The proposed development falls into the South East River Basin District.	The potential impact pathways by which eels could be affected by the construction of the Scheme have been identified. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on eels or other relevant marine ecological interests.
Conservation of Seals Act 1970	Pinnipeds (seals) are protected under the Conservation of Seals Act 1970 (taking effect in England, Scotland, Wales). This Act does not prohibit the killing of seals but does regulate the way in which seals can be killed. For example, there is an annual close season for grey seals extending from 1 September to 31 December and an annual close season for common seals extending from 1 June to 31 August. It is a criminal offence to wilfully kill, injure or take a seal during the close season or to attempt to do so. The Act also gives the Secretary of State the power to make an order prohibiting the killing, injuring or taking of seals in an area where such an order is necessary for the proper conservation of seals.	The potential impact pathways by which marine mammals could be affected by the construction of the Scheme have been identified. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on eels or other relevant marine ecological interests.
UK Marine Policy	The UK Marine Policy Statement (MPS) is the framework for	The Scheme is consistent with, and will contribute to,

Policy/Legislation	Summary of Requirements	Scheme Response
Statement, 2011	<p>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 UK Marine Policy Statement's high level marine objectives which are:</p> <ul style="list-style-type: none"> • Achieving a sustainable marine economy; • Ensuring a strong, healthy and just society; • Living within environmental limits; • Promoting good governance; and • Using sound science responsibly. <p>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. The MPS recognises that the primary environmental considerations of marine dredging and disposal activities include morphological changes, hydrological effects, increase in turbidity and changes to natural sedimentary systems. The proposed development falls within the South East Inshore marine plan area. A marine plan has not yet</p>	the achievement of the UK Marine Policy Statement's high level marine objectives.

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>been produced for this area and the timescales for this have not been finalised. A consultation draft of the plan may be published in the examination period and this chapter will be re-considered if necessary in the light of its contents.</p>	
<p>UK Biodiversity Action Plan</p>	<p>The UK Biodiversity Action Plan (UK BAP) was published in 1994, and was the UK Government's response to the Convention on Biological Diversity (CBD), which the UK signed up to in 1992 in Rio de Janeiro. Action plans for the most threatened species and habitats were set out to aid recovery, and national reports, produced every three- to five-years, showed how the UK BAP was contributing to the UK's progress towards the significant reduction of biodiversity loss called for by the CBD. The UK BAP priority list contains 1150 species and 65 habitats requiring special protection.</p> <p>The 'UK Post-2010 Biodiversity Framework', published in July 2012, succeeds the UK BAP, and is the result of a change in strategic thinking following the publication of the CBD's 'Strategic Plan for Biodiversity 2011–2020' and its 20 'Aichi Biodiversity Targets', at Nagoya, Japan in October 2010, and the launch of the new EU Biodiversity Strategy in May 2011. The Framework demonstrates how the work of the UK contributes to achieving the Aichi Biodiversity Targets, and identifies the activities required to complement the country biodiversity strategies in achieving the targets.</p>	<p>The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>

Policy/Legislation	Summary of Requirements	Scheme Response
	<p>Many of the tools developed under UK BAP remain of use. The lists of priority species and habitats agreed under UK BAP still form the basis of much biodiversity work in each of the devolved administrations.</p>	
<p>The Natural Environment and Rural Communities Act (NERC Act) 2006</p>	<p>The NERC Act makes provision about bodies concerned with natural environment and rural communities, and it regulates inter alia nature conservation in the UK, wildlife and SSSIs. The UK BAP list has been used as a reference to draw up the species and habitats of principal importance in England under S41 of the NERC Act 2006 (NERC 2006). The S41 list contains 943 species and 56 habitats of principal importance which occur in England. These are the species and habitats which were identified as requiring action under the UK BAP and which continue to be regarded as conservation priorities under the UK Post-2010 Biodiversity Framework.</p>	<p>The potential for the presence of protected habitats and species has been investigated as part of determining the marine ecology baseline description. The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>
<p>Thames Catchment Abstraction Management Strategy (CAMS)</p>	<p>The Thames catchment abstraction licensing strategy sets out how the Environment Agency will manage water resources in the Thames catchment and how they will manage existing abstraction licences and water availability for further abstraction.</p>	<p>Existing activities on the areas of the Thames affected by the Scheme have been taken into account in determining the marine ecology baseline description.</p>
<p>Biodiversity 2020: A strategy for England's Wildlife and Ecosystem</p>	<p>The Strategy aims to halt the loss of biodiversity, support healthy ecosystems and establish coherent ecological networks.</p>	<p>The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine</p>

Policy/Legislation	Summary of Requirements	Scheme Response
Services		ecological interests.
The London Plan (2011)	Regional planning policy for London is presented in the London Plan: Spatial Development Strategy for Greater London. It contains various policies with regard to nature conservation in London.	The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.
The Mayor's Biodiversity Strategy (2002)	Connecting with London's Nature: The Mayor's Biodiversity Strategy provides a framework for the delivery of biodiversity policies in London.	The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.
London Biodiversity Action Plan	Managed by the London Biodiversity Partnership (2006) the London BAP sets out priority habitats and species for the city (Ref 10-1).	The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.
Newham's Biodiversity Resource: Evidence Base For The Local Development Framework (May 2010)	This is the Biodiversity Action Plan for the London Borough of Newham. The action plan lists a number of habitats (including rivers and wetlands) and species within Newham for which targets have been set to increase their range and distribution.	The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests or SINCs.
Greenwich Biodiversity Action Plan (March 2010)	The Greenwich BAP aims to achieve the targets relevant to the Royal Borough of Greenwich identified in both the UK and London BAP. The action plan lists a number of habitats and species within Greenwich for which targets have been set to increase their range and distribution. Waters' edge, rivers, ponds and wetland are listed as a priority habitat.	The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.

Policy/Legislation	Summary of Requirements	Scheme Response
<p>Newham Core Strategy (2013) London Borough of Newham Unitary Development Plan (2012)</p> <p>Policy EQ10</p>	<p>Core policy SC4 on Biodiversity states that: <i>'Biodiversity will be protected and enhanced and development will contribute to a net gain in the quantity and quality of Newham's natural environment by the following measures:</i></p> <ol style="list-style-type: none"> 1. <i>'Expecting that all major developments make a contribution to achieving the targets and actions for biodiversity, as set out in the Newham Biodiversity Action Plan, and in conjunction with provision of green infrastructure;</i> 2. <i>Permitting development only where it can be demonstrated that significant adverse impact on species and habitats is avoided;</i> 3. <i>Sites of Importance for Nature Conservation (SINCs) will be protected, and the designation of new SINCs will be supported. Development should contribute to their qualitative enhancement, including improvements to access'</i> 	<p>The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests including SINCs.</p>
<p>The Royal Greenwich Local Plan</p> <p>Policy OS(g) Green and River Corridors</p>	<p>The Policy states: <i>'The network of main green corridors and the ecological and wildlife value of the Borough's rivers, canals and lakes will be protected and enhanced. Development will not normally be permitted where it would damage the continuity of the wildlife habitat within the corridor.'</i></p>	<p>The mitigation measures described in this chapter will be implemented to ensure the Scheme has no significant adverse effects on relevant marine ecological interests.</p>
<p>London Invasive Species Initiative</p>	<p>The London Invasive Species Initiative objectives follow the principles of prevention, detection/surveillance and control/eradication of invasive species.</p>	<p>A review of the presence of non-native species within the vicinity of the Scheme has been undertaken to establish the ecology baseline</p>

Policy/Legislation	Summary of Requirements	Scheme Response
		<p>description. A risk assessment will be undertaken to identify measures to minimise the potential for the construction of the Scheme to import invasive species into the area, and to minimise the risk of spreading those which are already present. This will be documented in the Code of Construction Practice (CoCP) (Document Reference 6.10).</p>

10.3 Methodology

General approach

- 10.3.1 This assessment has been completed in accordance with the Chartered Institute of Ecology and Environmental Management's (CIEEM) Guidelines for Ecological Impact Assessment in the UK (Ref 10-2) and Guidance on Impact Assessment in Marine and Coastal Environments (Ref 10-3). These determine which ecological receptors are significant within a geographical context before the assessment of the impacts of the Scheme on significant receptors is undertaken.
- 10.3.2 A brief rationale for the scoping out of a number of potential impact pathways has been included to provide a full audit trail of the assessment.
- 10.3.3 Section 10.6 of the Chapter contains a summary of the potential impacts, including a determination of the 'significance of effects'.
- 10.3.4 This Chapter differs from the other assessment chapters within the ES in terms of the definitions that are applicable to each of the project stages. The marine related works are temporary during the construction period of up to 4 years and as such marine ecology is not considered further in relation to the Scheme in operation. The following construction work phases and related activities have been assessed with regard to the assessment of the likely significant effects of the Scheme on marine ecology:
- construction: Recommissioning of the NAABSA berth facility, and/or construction of the new temporary jetty and associated works (including a dredge of the river);
 - operation of the jetty and/or NAABSA berth facility during construction of the tunnel for up to 4 years; and
 - decommissioning of the new temporary jetty following construction of the tunnel.
- 10.3.5 The focus of the assessment has been on the temporary new jetty and associated works in the river, as these are considered to be the works that could give rise to significant effects in terms of marine impacts. The NAABSA berthing facility is already present and being used at Thames Wharf and would require minimal works to make it suitable for use in this Scheme.

Consultation

- 10.3.6 Consultation with regard to whether there were any likely marine ecology effects of the Scheme was undertaken with the Marine Management Organisation (MMO), Natural England (NE), Port of London Authority (PLA), Royal Borough of Greenwich and the Environment Agency (EA) in accordance with the S.42 of the Planning Act 2008 'duty to consult' with prescribed consultees.
- 10.3.7 A summary of the consultation that has been undertaken is provided in Table 10-2.

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Table 10-2 Summary of Consultation

Consultee	Date	Comments	Response
MMO (letter)	30/04/2015	Outlines marine licensable activities that form part of the proposed Scheme.	Considered as part of the assessments required for the proposed Scheme.
Port of London Authority (meeting)	07/09/2015	Meeting to discuss the outline of the proposed Scheme. Initial discussions on scope of potential survey, assessment and mitigation requirements.	Chapter drafted on the basis of discussions.
Environment Agency (meeting)	11/09/2015	Meeting to discuss the outline of the proposed Scheme. Initial discussions on scope of potential survey, assessment and mitigation requirements.	Chapter drafted on the basis of discussions.
MMO (letter)	13/10/2015	Need to provide details of the proposed dredge and the potential impacts on marine ecology receptors.	A detailed description of the construction works including those associated with the NAABSA and or the new temporary jetty is included in Appendix 4.A – Construction

Document Reference: 6.1.10

			Method Statement (CMS) (Document Reference 6.3.4.1). The impact assessment is provided in Section 10.6 of this chapter.
		Intertidal and subtidal benthic surveys are required. PSA data should also be collected.	Surveys have been carried out and the survey results are presented in Sections 10.4 and Appendix 10.B (Document Reference 6.3.10.2).
		Need to consider eels/ seahorses and update fish baseline with specific information.	The fish baseline has been updated to consider eels and seahorses (Section 10.4).
		Noise assessment needs to make use of latest references.	An underwater noise assessment has been undertaken in accordance with the latest references (see Section 10.6).

<p>Royal Borough of Greenwich (email)</p>	<p>20/10/2015</p>	<p>The Sustainability and Renewal (S&R) team are satisfied that the relevant issues have been considered, these being:</p> <ul style="list-style-type: none"> • dredging; • noise from piling for the new temporary jetty and its effect on invertebrates, fish and mammals; • removal of the temporary structure; • disruption/removal/alteration of habitat and introduction of habitat for non-native species; and • contamination of the waterway from sediment disruption and actions on the pier. 	<p>The chapter has fully considered these issues.</p>
<p>MMO (meeting)</p>	<p>12/11/2015</p>	<p>Discussed survey requirements.</p>	<p>Surveys have been carried out and the survey results are presented in Sections 10.4 and Appendix 10.B (Document Reference 6.3.10.2).</p>

<p>Environment Agency (letter)</p>	<p>23/11/2015</p>	<p>Need to provide details of the proposed dredge and the potential impacts on marine ecology receptors.</p> <p>It is assumed that the jetty will be a temporary structure.</p> <p>Must consider the effects associated with the removal of moorings.</p> <p>Need to consider features recognised within the rMCZ.</p>	<p>The envisaged Scheme description has been updated in Appendix 4.A – Construction Method Statement (CMS) (Document Reference 6.3.4.1). This confirms the new temporary jetty will be a temporary structure for up to 4 years during construction.</p> <p>The effects associated with the removal of moorings is assessed within Section 10.6.</p> <p>The effects of the construction of the Scheme on all protected habitats and species have been assessed within the assessment (see Section 10.6). This includes</p>
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		<p>Need to include a lighting plan for the new temporary jetty.</p> <p>Thames Tideway Tunnel needs to be taken into account within the cumulative/in-combination assessment.</p> <p>A WFD assessment will be required.</p>	<p>the rMCZ.</p> <p>A lighting plan for the new temporary jetty is provided in Appendix 4.A – CMS (Document Reference 6.3.4.1) and also described in Chapter 4 (Document Reference 6.1.4).</p> <p>Thames Tideway Tunnel considered within Section 10.7.</p> <p>A WFD assessment is provided as Appendix 10.A (Document Reference 6.3.10.1).</p> <p>Survey results are presented in Section 10.4 and Appendix</p>
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		Intertidal and subtidal benthic surveys are required. Contamination data should also be collected.	10.B.
PLA (letter)	23/11/2015	<p>Full details of the marine elements of the Scheme need to be included to ensure that the relevant impact pathways are identified and assessed.</p> <p>Restrictions are enforced with respect to the timing of piling within the estuary.</p>	<p>The envisaged Scheme description has been updated in Appendix 4.A – CMS (Document Reference 6.3.4.1). The marine ecology impact assessment of the Scheme is presented in Section 10.6.</p> <p>Piling restrictions have been included as mitigation measures within this chapter (see Section 10.5).</p>
MMO (letter)	21/12/2015	Contamination survey requirements provided.	Surveys for contamination were undertaken in December 2015 and January 2016.

MMO (email)	14/12/2015	MMO: sampling progress within intertidal/subtidal reaches of the river.	Survey results presented in Section 10.4 and Appendix 10.B (Document Reference 6.3.10.2).
Cefas (email)	15/12/2015	Confirmed revised approach to surface sample collection (invertebrates and contaminants).	Survey results presented in Section 10.4 and Appendix 10.B (Document Reference 6.3.10.2).
MMO (email)	04/01/2016	Confirmed that surface contamination samples could be collected as close as possible to the same locations as those at depth (i.e. not in exactly the same position). This was due to the difficulties associated with collecting the samples (as a result of the sediment types).	Survey results presented in Sections 10.4 and 10.6 and Appendix 10.B (Document Reference 6.3.10.2).
MMO (meeting)	12/04/2016	Meeting to provide an outline of the contents of the chapter, including the surveys and assessments that have been completed.	Verification that all comments raised by the MMO have been addressed.

The study area

- 10.3.8 The 'main study area' encompasses the full spatial and temporal extent of the likely significant effects on the environment that could arise from the Scheme. This area, which has been based on the outputs of the hydrodynamic and physical processes assessments (Chapter 16 – Surface Water Quality and Flood Risk of the ES (Document Reference 6.1.16) extends to Silvertown and the Greenwich Peninsula as shown on Drawing 10-1 – *Study area and Sightings Compiled as Part of the Thames Marine Mammal Sightings Survey (2004 to 2015)* (Document Reference 6.2). It extends approximately 300m beyond the boundary of the Order limits.

Methodology for establishing the baseline marine ecology environment

- 10.3.9 The description of the baseline marine ecology environment has been established through a desk study. A list of the data sources that have been interrogated for this purpose is provided at the start of the baseline description of each of the individual receptors (see Section 10.4 of this chapter).
- 10.3.10 A phase 1 intertidal habitat survey was undertaken in the vicinity of the proposed construction works on the 15 and 16 December 2015 (Drawing 10-2 - *Intertidal and subtidal ecology survey locations* (Document Reference 6.2)). The approach was based on the standardised Phase 1 mapping methodology detailed in the Marine Monitoring Handbook, procedural guidance No 3-1 (Ref 10-4) and CCW handbook for marine intertidal Phase 1 survey and mapping (Ref 10-5). Invertebrate samples were collected from nine intertidal and two subtidal locations to characterise the benthic assemblage in the river on and about the alignment traversed by the Scheme. Further detail is provided in, Appendix 10B – *Marine Ecology Survey Report* (Document Reference 6.3.10.2).

The description of the future marine ecology baseline ('without scheme' scenario)

- 10.3.11 The marine works involved in the construction of the Scheme are temporary (less than four years) and are of a nature such that there would not ordinarily be expected to be any perceptible change in the marine ecology baseline during this period. No further consideration has therefore been given to forecasting the future baseline of the marine ecology

receptors beyond the four years. The potential for any changes as a result of the implementation of others plans/ projects in that period, however, form part of the cumulative assessment.

Defining the importance/sensitivity of resource

10.3.12 The importance of a receptor, as classified in Table 10-3 is based on its value and rarity to either the ecosystem or socio-economy; and the level of protection it is afforded.

Table 10-3 Receptor importance

Receptor Importance	Definition
High	Receptor internationally designated and/or of international ecological importance. Likely to be rare with minimal potential for substitution or unable to tolerate change. May also be of high or very high socio-economic importance.
Moderate	Receptor nationally designated and/or of national ecological importance and with some ability to tolerate change and recover in the medium term. Likely to be relatively rare. May also be of high socio-economic importance.
Low	Receptor not designated but of local to regional importance and able to tolerate change effects to a large extent, with relatively rapid rate of recovery; or not designated/ of local importance but not tolerant to change.
Negligible	Receptor only of local importance with a high tolerance to change.

Methodology for assessing the significance of environmental effects of the Scheme on marine ecology

10.3.13 The four main steps that have been used to determine the significance of environmental effects of the Scheme on marine ecology are summarised below.

Step 1

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10.3.14 Identifying the potential environmental changes resulting from the Scheme and the features of interest/ receptors (including their respective value) that are likely to be affected (which are together referred to as the impact pathway).

Step 2

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10.3.15 Understanding the nature of the likely environmental changes in terms of: their exposure characteristics, the natural conditions of the marine ecology system and the sensitivity of the specific receptors, and the impact of the changes upon them.

Step 3

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10.3.16 An evaluation of the value and vulnerability of the ecological receptors has been undertaken as a basis for assessing the significance of an impact. The key significance levels for either beneficial or adverse impacts on relevant marine ecological receptors are summarised in Table 10-4.

Table 10-4 Receptor importanceSignificance levels

Significance Level	Definition
Negligible	Negligible change not having a discernible effect.
Minor	Effects tending to be discernible but tolerable by the receptor and unlikely to require any marine ecological mitigation
Moderate	Where these changes are adverse they may require mitigation which can include changes to the Scheme detailed design
Major	Effects are highest in magnitude and reflect the high vulnerability and importance of the marine ecological receptor to nature conservation. Where these changes are adverse they will require mitigation

10.3.17 Those impacts that are assessed as being moderate or above are considered to be significant for the purposes of this marine ecology assessment.

Step 4

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10.3.18 The final stage identified marine ecology impacts on receptors that were assessed as being of moderate and/or major adverse significance and that might therefore require mitigation measures to be applied to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure, the use of mitigation measures to alter the risk of exposure and hence the level of significance of the effect has been assessed and the ultimate residual effect identified.

10.4 Description of the baseline marine ecological environment

10.4.1 As part of describing the baseline marine ecological environment a list of available data sources has been identified for establishing the importance of each of the relevant marine ecological receptors in turn. This has been followed by a description of each receptor at two spatial scales, first, as a component part of an overview of the marine ecological environment of the Thames Estuary to provide wider context, and secondly, at the site specific scale.

Nature conservation protected habitats and species

Data sources

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10.4.2 The locations of environmental designations in the vicinity of the proposed Scheme were mapped using the Natural England GIS Boundary Database. The distance to these sites were calculated in a GIS framework. Where an overlap was identified the respective citations were consulted.

General overview

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10.4.3 The closest internationally designated sites that support marine features (the Thames Estuary and Marshes Special Protection Area (SPA) and Ramsar site) are located approximately 30km from the proposed Order limits and as such fall well outside of the assessment study area. In addition, there is possible SAC for harbour porpoise (the Southern North Sea possible SAC) located approximately 75km from the proposed development; similarly well beyond the study area.

10.4.4 The closest nationally designated ecological site that supports marine features (the Inner Thames Marshes Site of Special Scientific Interest (SSSI)) is located approximately 15km from the proposed Order limits and as such also falls well beyond the assessment study area.

- 10.4.5 The Scheme Order limits fall within the boundary of the Thames Estuary recommended Marine Conservation Zone (rMCZ) which stretches from Richmond to the wider mouth at Southend and Grain. Four subtidal and intertidal habitats and two species are under consideration for designation in this site. The habitat features are: intertidal mixed sediments (note: intertidal mud or saltmarshes are considered to be sufficiently protected by other designations), subtidal coarse sediment, subtidal sand and subtidal mud. The species are: tentacled lagoon worm (*Alkmaria romijni*) and European smelt (*Osmerus eperlanus*) (Ref 10-6).
- 10.4.6 This rMCZ was not among the first or second tranches of MCZs designated in 2013 and 2016 respectively. Designation of the recommended site is currently on hold as Defra has indicated a need to better understand the implications of the designation of the site for potential developments within the estuary. A formal MCZ assessment is consequently not required at this time (Ref 10-7).
- 10.4.7 The UK Biodiversity Action Plan (UK BAP) is the UK Government's response to the Convention on Biological Diversity signed in 1992. It describes the UK's biological resources and commits a detailed plan for the protection of these resources. Several priority habitats and species have been identified as part of the UK BAP at a nation-wide level.
- 10.4.8 UK BAP priority habitats identified within the vicinity of the Scheme include mudflats and coastal saltmarsh. Local Biodiversity Action Plans (LBAPs) aim to conserve biodiversity through local partnerships, taking into account both national and local priorities. The London LBAP identifies the whole of the Tidal Thames as a priority habitat. Similarly the Greenwich and the London Borough of Newham LBAPs include rivers and wetland as a priority habitat.
- 10.4.9 It should be noted that the majority of habitats and species contained within the BAP priority lists are now classified as habitats or species of principal importance for the conservation of biodiversity in England and Wales under the Natural Environment and Rural Communities (NERC) Act 2006.
- 10.4.10 The closest National Nature Reserve (NNR) and Local Nature Reserve (LNR) which support marine ecology are located over 44km and 10km from the application boundary respectively; well outside of the ecological assessment study area appropriately adopted for assessment of the Scheme's impacts on ecology.

- 10.4.11 Several Sites of Interest for Nature Conservation (SINCs) have been designated throughout London. Those with aquatic elements linked to or part of the Thames Estuary in the vicinity of the Scheme are the East India Dock Basin, Royal Docks and Thames and Tidal Tributaries SINCs.
- 10.4.12 The East India Dock Basin SINC is located approximately 0.5km from the proposed Scheme Order limits boundary; one of its qualifying ecological resources being the presence of saltmarsh. The Royal Docks SINC is an open body of water connected to the Thames and is located approximately 0.2km east of the Scheme boundary. The Thames and Tidal Tributaries is the only SINC that directly overlaps with the proposed Scheme. This SINC has been designated due to its importance to a number of ecological resources. Habitats that are described as important features of the site include saltmarsh, reedbeds, marsh-sow thistle and wetlands (Ref 10-8). These in turn constitute important ecological resources, for example, as nursery habitats for several species of fish.

Benthic habitats and species

Data sources

- 10.4.13 The benthic ecology of the Thames Estuary has been described based on a number of data sources. These data were used to inform the understanding of the relative ecological importance and functionality of the Thames Estuary. The principal data sources reviewed include:
- **Hub for London:** A desk based ecological study characterising the existing environment within the Thames. Produced for Transport for London as a result of investigations into expanding London's hub airport capacity (Ref 10-9).
 - **Environmental Baseline for TE2100:** A plan to set out the strategic direction for managing flood risk in the Thames Estuary to the end of the century and beyond. Provides information on the current environment and species present within the Thames (Ref 10-10).
 - **Greater Thames Coastal Habitat Management Plan (CHaMP) Scoping Document:** The (CHaMP) identifies and sets out plans to protect the important habitats within the Thames (Ref 10-11).
 - **Non-Native Species Secretariat (NNSS):** The NNSS coordinates the approach to invasive non-native species in Great Britain. The organisation provides information in the form of fact sheets on the most

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common/ most harmful invasive species currently present within the UK.

- **Environment Agency data (2012):** Environment Agency data taken from subtidal and intertidal sites at Woolwich and Greenwich.
- **Crossrail Instone Wharf Intertidal Studies:** An Environmental Statement carried out for the development at Instone Wharf which describes and evaluates the benthic habitat and species present at the site (Ref 10-12).
- **Emirates Air Line (EAL):** An Environmental Statement for the cable car development running between the Greenwich Peninsula and the Royal Victoria Dock. It contains a description of the benthic environment and community in the area of the cable car alignment. (Ref 10-13).
- **Enderby Wharf Benthic Biological Resource Assessment:** An Environmental Statement written to support the application of the development of Enderby Wharf. The existing benthic environment in the area is characterised (Ref 10-14).
- **Gallions Reach, Thames River Crossings Marine Benthic Survey:** A benthic survey to support an Environmental Statement characterising the sub-tidal and intertidal communities of the benthic environment at Gallions Reach.

10.4.14 In addition, a site specific Phase 1 intertidal habitat survey was undertaken in the vicinity of the proposed works on the 15 and 16 December 2015. Appendix 10B – *Marine Ecology Survey Report* (Document Reference 6.3.10.2). Invertebrate samples were collected from nine intertidal and two subtidal locations to establish the nature and character of the benthic assemblage in this area (Drawing 10-2 - *Intertidal and subtidal ecology survey locations* (Document Reference 6.2)). The survey results are described in Section 10.4 below.

Thames Estuary overview

10.4.15 The intertidal habitats in the Thames Estuary include areas of saltmarsh, eelgrass beds and shingle. Extensive intertidal sand and mudflats are present, with the mudflats up to 2km wide in places, however as the estuary narrows, mudflat fringes also become narrower. The intertidal flats of the estuary are mostly fine, silty sediment, with a few sandy areas. Salinity is generally considered the most significant factor influencing

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species distributions in estuaries (Ref 10-15). Changes in the invertebrate composition along the estuary reflect the tolerance that individual species have to variations in salinity (Ref 10-6).

- 10.4.16 The benthic assemblage of the Thames Estuary has been described previously in the Thames Estuary Benthic Programme (TEBP), wind farm environmental statements (Ref 10-16), the Greater Thames CHaMP (Ref 10-11) and Thames Estuary 2100 related studies (Ref 10-10, 10-17 and 10-18) as well as data held by the Port of London Authority.
- 10.4.17 Invertebrate species typically found within the intertidal zone in brackish sections of the Thames Estuary include polychaetes (or bristle worms) (such as *Nereis sp* and *Streblospio shrubsolii*) and tubificid oligochaetes such as *Limnodrilus hoffmeisteri*. Species found within the subtidal zone in brackish sections of the Thames Estuary include the estuarine amphipod *Gammarus zaddachi*, the oligochaete *Tubifex tubifex* and a non-native mollusc *Potamopyrgus antipodarum*. Freshwater invertebrate species that are tolerant of elevated salinity such as the gastropod *Lymnaea peregra*, leech *Helobdella stagnalis* and midges (*Chironomidae spp.*) are also recorded in the inner estuary.

Study Area

- 10.4.18 The proposed marine works associated with the Scheme are located in the inner estuary. The width of the estuary at this point is approximately 400m with a narrow strip of intertidal foreshore at low water. An intertidal Phase 1 habitat survey was undertaken in this area along with an intertidal and subtidal benthic invertebrate survey.
- 10.4.19 The western section of the intertidal area in the immediate vicinity of the Scheme is composed of coarse sand, while the eastern section contains a larger amount of silt and small areas of mudflat (see Appendix 10.B – *Marine Ecology Survey Report* (Document Reference 6.3.10.2)). Patches of debris and rubbish are present throughout the area but are particularly common along the eastern section. No visible fauna or signs of fauna (such as casts, trails or burrows) were recorded in the survey suggesting an improvised intertidal community (Drawing 10-3 - *Intertidal habitat map* (Document Reference 6.3.10.2)).
- 10.4.20 The coarse sand habitat is most appropriately described as a more sheltered and lower salinity version of LS.LSa.MoSa.BarSa (Barren littoral coarse sand). The mudflat habitat is considered to be representative of LS.LMu.UEst.Tben (*Tubificoides benedii* and other oligochaetes in littoral

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mud) but without presence of *T. benedii*. Intertidal mudflat habitat is a Biodiversity Action Plan (BAP) Priority Habitat (Ref 10 - 19) and listed as a Habitat of Principal Importance in England under the Natural Environment and Rural Communities (NERC) Act 2006 Section 41 (Ref 10-20). However, the extent of mudflat habitat in this area is small and is considered to be of limited ecological importance.

- 10.4.21 The infaunal community within the surveyed area was highly impoverished with very limited diversity. The oligochaete *Limnodrilus hoffmeisteri* dominated the community and contributed almost entirely to the low total abundances of organisms. This species commonly occurs in the upper Thames Estuary and is typically found in high densities at enriched locations such as those adjacent to sewage outfalls (Ref 10-21 and Ref 10-22). Other species of oligochaete, nematode and gastropod were also found but in very low numbers.
- 10.4.22 A similar community characterised by a low density of oligochaete annelids was recorded in the adjacent intertidal muds at the mouth of the River Lea in 2006 and near Woolwich between 2005 and 2006 (Ref 10-23). The overall intertidal assemblage recorded in the vicinity of the Scheme is therefore considered typical of the intertidal mud community in the wider area (Ref 10-24; Ref 10-25; Ref 10-26; Ref 10-27; Ref 10-12). No benthic species of conservation importance were found to be supported by the intertidal habitat within the vicinity of the Scheme.
- 10.4.23 The surface subtidal sediments within the vicinity of the Scheme consisted predominantly of cobbles and gravels. Due to the presence of cobbles and pebbles, the seabed is assumed to be highly scoured and frequently disturbed. This is reflected by the macrofaunal community found within the area which was impoverished and dominated by mobile opportunistic species such as the scavenging amphipod *Gammarus zaddachi* and brackish mud shrimp *Apocorophium lacustra*.
- 10.4.24 These results are consistent with previous research which indicated that *G. zaddachi* is the dominant species in terms of biomass and abundance in some sections of the inner Thames Estuary (Ref 10-25). Oligochaete, isopods, polychaete and molluscs were all recorded in this habitat but in low abundances. Similar communities have been found in other subtidal areas of the inner Thames and are mainly characterised by low species diversity and abundances (Ref 10-27, Ref 10-10).
- 10.4.25 *Cochliopidae* Type A, *Cochliopidae* Type B and *Tenellia adspersa* (protected under the Wildlife and Countryside Act (1981) and listed as a

UK BAP and UK Red Data Book Species) were recorded approximately 4.7 km upstream of the Scheme at Enderby Wharf in 2009 (Ref 10-14). Additionally, the nationally rare bryozoan *Victorella* sp. (protected under Schedule 5 of the Wildlife and Countryside Act 1981, classed as a UK BAP species and a Species of Principle Importance in the Natural Environment and Rural Communities Act, 2006), the sea mat *Electra crustulenta* (a species only recorded at a few locations around the UK) (Ref 10-28), and Chinese mitten crab (Ref 10-29) were recorded at Gallions Reach, approximately 3.2 km downstream of the proposed Scheme. However none of these species, nor any other of conservation status, were recorded in the vicinity of the Scheme.

Non-native species

10.4.26 In general non-native species find their way into UK coastal waters by a variety of means however, the most significant mode is via shipping by attachment to hulls or in ballast water, with the latter being identified as one of the four most common means of transfer (Ref 10-9). The high levels of commercial shipping, recreational boating and imports of animals for aquaculture or the seafood trade within the Thames Estuary has resulted in several non-native invasive species becoming established within the estuary. These include the following species that have been identified in the River Thames that could occur in the vicinity of the Scheme development (based on their environmental tolerances and a review of site specific data) (Ref 10-30; Ref 10-27):

- **Chinese mitten crab (*Eriocheir sinensis*):** The Chinese mitten crab originates from Asia, but over the past 20 years has become increasingly prevalent in British river systems. British wildlife is affected by the Chinese mitten crab because it is a voracious predator. It also poses a threat to habitats through the burrowing activity of adults, which leads to the erosion of river banks (Ref 10-31).
- **Zebra mussel (*Dreissena polymorpha*):** The Thames Estuary was invaded by the zebra mussel during the early 18th century and they are still commonly found in high abundances (Ref 10-30). The major threat to British wildlife is from their sheer abundance. These high abundances affect other wildlife by using up space for attachment needed by native species, and even colonizing the shells of other species (which affects their ability to feed and burrow. Each female can release up to one million eggs per season, giving a single mussel the ability to establish a whole population (Ref 10-32).

- **Asiatic clam (*Corbicula fluminea*):** This species was first discovered in Western Europe during the 1980's. They are capable of self-fertilisation and release 400 juveniles each per day (Ref 10-33). The Asiatic clam competes with native mussel species for food and space, but is also responsible for altering benthic substrates upon which other species rely. Furthermore, the Asiatic clam has a greater resilience against pollution, increasing its potential to outcompete the more sensitive species found in the UK. They can also occur in such densities that they ~~can foul~~ water intake pipes of power plants and other industrial water systems (Ref 10-34).
- **Slipper limpet (*Crepidula fornicata*):** Slipper limpet competes for food and space with other filter-feeding species, and has been known to displace mussel beds (Ref 10-35). The modern British population is known to have been introduced to Essex between 1887 and 1890 in association with the oyster, *Crassostrea virginica*, which was imported from North America (Ref 10-36).
- **Carpet sea squirt (*Didemnum vexillum*):** This invasive sea squirt grows in colonies, often in a carpet-like form on the seabed and other substrates. The sea squirt is able to spread rapidly, and become dominant in new environments, thus excluding other benthic organisms and creating a homogenous habitat (Ref 10-37). Fragments from a colony are able to break off and establish in a new location. The colonies may overgrow fish spawning grounds and hinder the ability of fish to feed on benthic species (Ref 10-38). Commercially, the carpet sea squirt poses a risk to aquaculture, for example through the colonisation of substrates preventing scallop recruitment (Ref 10-39).
- **Pacific oyster (*Crassostrea gigas*):** The Pacific oyster was first introduced from Portugal into the River Blackwater, Essex, in 1926 as a commercial crop and has since established itself in the wild. Pacific oysters themselves attach to almost any hard surface in sheltered waters. Whilst they usually attach to rocks in their native range, the oysters can also be found in muddy or sandy areas and will also settle on adult specimens of the same or other mollusc species. Impacts on native populations include displacement through competition for food and space; habitat change and hybridization with local oyster species (Ref 10-36).
- **Polychaete (*Boccardiella ligERICA*):** This brackish water species tolerant of a wide range of salinities that originates from Europe. Its

native range extends between Germany and Portugal where it can be found on a variety of substrate types including soft mud, sand, hard clay, shell debris, wood and fouled ships. No impacts have been reported for this species, but introduced populations can reach high densities in some areas, outcompeting local species and becoming the dominant member of the benthos (Ref 10-40). The Environment Agency benthic sampling in the Thames Estuary (Ref 10-27) has recorded this species in close proximity to the proposed Scheme.

- **Jenkin's spire shell (*Potamopyrgus. antipodarum*):** Originally native to the freshwater streams and lakes of New Zealand this species was first introduced in the Thames Estuary in 1852 and has since become widespread in freshwater and brackish habitats in the UK. The species may establish very dense populations (several 100,000 snails/m²), and can dominate communities. Consequently, it can consume large amounts of primary production, alter ecosystem dynamics, compete with and displace native invertebrates, and negatively influence higher trophic levels (Ref 10-41).

10.4.27 Many of these species are widespread throughout the Thames Estuary with records of Chinese mitten crab, Zebra mussel, the polychaete *B. ligerica* and Jenkin's spire shell both upstream and downstream of the proposed Scheme (Ref 10-27; Ref 10-42). Only two invasive species, *P. antipodarum* and *B. ligerica*, were recorded within the site specific surveys carried out in December 2015 (see Appendix 10.B – *Marine Ecology Survey Report* (Document Reference 6.3.10.2)).

Fish and shellfish

Data sources

10.4.28 The fish and shellfish ecology of the Thames Estuary has been described based on a number of data sources. These data were used to inform the understanding of the relative importance and functionality of the Thames Estuary. The key data sources reviewed include:

- fishBase (www.fishbase.org) (Ref 10-43): An online database containing data on fish ecology, distribution and biological information;
- marine Aggregate Regional Environmental Assessment of the Outer Thames Estuary: Summary of the distribution and ecology of fish and shellfish in the southern North Sea and Thames Estuary (Ref 10-44);

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- spawning and nursery grounds of selected fish species in UK waters: During the late 1990s, a collaborative project between the Centre for Environment, Fisheries and Aquaculture Science (Cefas), the Fisheries Research Service, the UK Offshore Operator's Association (UKOOA), the Scottish Fishermen's Association (SFF) and the National Federation of Fishermen's Organisations (NFFO) produced the Fisheries Sensitivity Maps in British Waters. This report (Ref 10-45) included maps of the main spawning and nursery grounds for 14 commercially important species (cod, haddock, whiting, saithe, Norway pout, blue whiting, mackerel, herring, sprat, sandeels, plaice, lemon sole, sole and Norway lobster). This data has since been updated by Cefas based on more recent survey data and additional analyses to complement the original maps (Ref 10-42);
- benthic Ecology of the Thames Estuary: Trawl data held by the Port of London Authority (PLA) from between February 2002 and November 2005 from a large number of surveys undertaken in the Thames Estuary (Ref 10-46); and
- Kentish Flats Beam, Otter and Bass Trawl Surveys: Trawl surveys undertaken during pre-construction and post-construction of the Kentish Flats offshore wind farm between 2002 and 2007 (Ref 10-47).

10.4.29 Of particular relevance are a number of recent monitoring projects which have been undertaken specifically in the vicinity of the proposed Scheme. These data sources include the following:

- Environment Agency Transitional and Coastal Water Bodies (TraC) Fish Monitoring: The results of ongoing annual Water Framework Directive (WFD) fish monitoring at Woolwich and Greenwich using trawls, seine netting and kick sampling techniques. These surveys were either undertaken in the spring (May to June) or autumn (September to November). Data for the most recent five years (2011 to 2015) has been analysed (Ref 10-48); and
- Limmo Peninsula Fish Surveys. The fish populations within Limmo Peninsula and Bow Creek region of the River Lea (a tributary to the Thames with its mouth nearby to the proposed Scheme) were sampled on three occasions in 2005 and 2006. The surveys which were undertaken as part of the baseline data for a proposed development used a combination of seine and fyke nets (Ref 10-49).

10.4.30 A number of other surveys and scientific studies on fish and shellfish have informed the description of this marine ecological resource where appropriate.

General overview

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10.4.31 The Thames Estuary supports a diverse fish fauna with over 100 fish species having been recorded in the estuary over the past 30 years (Ref 10-50; 10-1). Fish species with known spawning and nursery locations within the Thames Estuary include herring, lemon sole, and Dover sole. Other commercially important fish species which also utilise the Thames Estuary for nursery areas include plaice, sprat and bass. Diadromous fish which migrate through the estuary include the European eel, sea lamprey, river lamprey and the twaite shad. The Thames Estuary is also an important area for many shellfish species, with large beds of common cockle, native oyster and blue mussel being present throughout the outer Estuary (Ref 10-42; 10-44).

10.4.32 The distribution and ecology of demersal fish (bottom dwelling), pelagic fish (free swimming), elasmobranchs (sharks and rays), diadromous fish (migratory) and shellfish within the Thames Estuary are each described in detail below. The assessment has primarily focused on key species which are of either commercial and / or conservation importance. Each section initially provides a Thames Estuary wide overview before focusing specifically on the Silvertown and the Greenwich Peninsula study area. The functional guilds for estuarine fish defined by Ref 10-51 have been used in the assessment tables in order to provide a summary on the life history and ecology of each fish species. The function guilds of estuarine fish are described below:

- **Freshwater stragglers (FS):** Freshwater species found in low numbers in estuaries and whose distribution is usually limited to the upper reaches of estuaries with low salinity.
- **Marine stragglers (MS):** Species that spawn at sea and typically enter estuaries only in low numbers and occur most frequently in the lower reaches. This category contains fish that are generally intolerant of reduced salinity.
- **Marine migrant opportunistic species (MMOS):** Species that spawn at sea and often enter estuaries in large numbers; particularly as juveniles. Some of these species are highly euryhaline and move throughout the full length of the estuary. Species in this category can

use, to varying degrees, near-shore marine waters as an alternative habitat.

- **Marine migrant dependent (MMD):** Species that spawn at sea but often enter estuaries in large numbers, particularly as juveniles that seek the shelter of estuarine habitats. Some of these species are highly euryhaline and move throughout the full length of the estuary.
- **Estuarine residents (ER):** Estuarine species capable of completing their entire life cycle within the estuarine environment;
- **Anadromous (A):** Species that migrate from the sea into fresh water to breed.
- **Catadromous (C):** Species that migrate from fresh water into the sea to breed.

10.4.33 Certain fish species are protected under a range of legislation including the EU Habitats Directive, the Wildlife and Countryside Act 1981 (and amendments) and the Bern Convention, as well as being on OSPAR threatened species list, International Union for Conservation of Nature (IUCN) red list and Biodiversity Action Plan (BAP) priority species/grouped plan list. European smelt is an ecological resource identified in the Thames Estuary rMCZ.

10.4.34 A summary of legislation protecting species relevant to the inner Thames Estuary is provided in Table 10-5. Further consideration of the potential impacts on each of the protected species has been included in the assessment (by factoring in their level of importance).

Table 10-5 Summary of UK protection legislation for fish and shellfish species within the inner Thames Estuary

Group	Fish Species Category	Species	Conservation Status and Importance
Diadromous fish species	C	European eel <i>Anguilla anguilla</i>	UK BAP, OSPAR listed and on the global red list; Thames Eel Management Plan (EMP) (High)
	A	Salmon <i>Salmo salar</i>	UK BAP, Appendix III of Bern Convention; Annexes II, V of the EC Habitats Directive, OSPAR (High)
	A	Sea lamprey <i>Petromyzon</i>	Annexes II, V of the EC Habitats Directive, UK BAP,

Group	Fish Species Category	Species	Conservation Status and Importance
		<i>marinus</i> and River lamprey <i>Lampetra fluviatilis</i>	Appendix III of Bern Convention (river lamprey), OSPAR (sea lamprey) (High)
	A	Shads <i>Alosa alosa</i> and <i>A. fallax</i>	UK BAP, Appendix III Bern Convention, Annexes II and V EC Habitats Directive, Wildlife and Countryside Act (High)
	A	Brown/Sea Trout <i>Salmo trutta</i>	UK BAP (Moderate)
	A	European Smelt <i>Osmerus eperlanus</i>	UK BAP; Thames Estuary rMCZ feature (Moderate)
Pelagic bony fish species	MMOS	Atlantic herring <i>Clupea harengus</i>	UK BAP (grouped plan) of commercial importance (Moderate)
	MMD	Bass <i>Dicentrarchus labrax</i>	Of commercial importance (Moderate)
	MMOS	Sprat <i>Sprattus sprattus</i>	Of commercial importance (Low)
	MMD	Dover Sole <i>Solea solea</i>	UK BAP (grouped plan); of commercial importance (Moderate)
	MMOS	European Plaice <i>Pleuronectes platessa</i>	UK BAP (grouped plan); of commercial importance (Moderate)
	MMOS	Whiting <i>Merlangius merlangus</i>	UK BAP (grouped plan); of commercial importance (Moderate)
	MS	Short-snouted seahorse <i>Hippocampus hippocampus</i>	UK BAP, Wildlife and Countryside Act (Moderate)

Source: (Ref 10-52 and Ref 10-51)

Demersal bony fish species

Thames Estuary overview

10.4.35 Demersal species are bottom-dwelling or mid-water fish that have a close association with the seabed.

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- 10.4.36 The Thames Estuary is considered to be a low intensity nursery ground for several commercially important gadoids including cod and whiting. The outer Thames Estuary is also a low intensity spawning ground for cod and sandeel (Ref 10-42). Other demersal roundfish species regularly recorded in the estuary include included gobies, pogue and dragonet (Ref 10-44; 10-46).
- 10.4.37 A range of flatfish species are commonly recorded in the Thames Estuary including the commercially important sole. This species has high intensity spawning and nursery grounds in the outer estuary. The Thames Estuary is also a low intensity nursery ground for plaice. Flounder and dab are also regularly recorded (Ref 10-42).

Study Area

- 10.4.38 The most abundant demersal roundfish species recorded in Environment Agency TraC fish monitoring data for the period 2011 to 2015 at Woolwich and Greenwich was the sand goby (total of 1097 fish recorded) (Table 10-6). This species is commonly recorded in estuarine waters. Other estuarine fish species which were relatively abundant in the surveys included the sand smelt and common goby. Both adult and juvenile estuarine fish species were recorded within the surveys.
- 10.4.39 Juvenile demersal marine species including whiting and red mullet were also recorded in the surveys. These species occur seasonally in the inner Thames Estuary. Of particular interest was the occurrence of a single short-snouted seahorse in the Greenwich seine net sampling in 2011 (Ref 10-48).
- 10.4.40 Flounder and the commercially important Dover sole were the most numerous flatfish species recorded during the surveys. Both juvenile and adult flounder were recorded with juvenile Dover sole mainly being recorded.
- 10.4.41 Small numbers of freshwater species tolerant of low salinity conditions such as common bream, zander and roach were also recorded (Ref 10-48).
- 10.4.42 Fish monitoring at the nearby River Lea in the Limmo Peninsula and Bow Creek area also found the demersal fish assemblage to comprise predominantly brackish species including common goby and flounder (Ref 10-49).

Table 10-6 The abundance of demersal fish recorded in Environment Agency TraC fish monitoring at Woolwich and Greenwich (2011 to 2015)

Species	Category	Greenwich 1.5 m Beam Trawl	Greenwich Seine Net	Woolwich Otter Trawl	Total	Average length (mm)
Three-spined stickleback	ER and FS		6	1	7	29
Chub	FS		2		2	36
Common bream	FS	2	134		136	74
Common goby	ER	2	7	36	45	38
Dab	MMOS			1	1	76
Dace	FS		5		5	84
Dover sole	MMD	1		923	924	96
Flounder	MMD	27	78	840	945	149
Pogge	MMOS			2	2	87
Painted goby	MMD			9	9	32
Perch	FS		2	2	4	73
Pike	FS		1		1	70
Pouting / Bib	MMOS			3	3	188
Red mullet	MS			6	6	138
Roach	FS		3		3	90
Roach/comm on bream hybrid	FS		1		1	58
Sand goby	ER	6	2	1089	1097	57
Sand smelt	ER and MMD		23		23	60
Short-snouted seahorse	MS		1		1	52
Tub gurnard	MS			2	2	199
Whiting	MMOS			42	42	194
Zander	FS		1		1	168

Source: Ref 10-48

Pelagic bony fish (osteichthyes) species

Thames Estuary overview

10.4.43 Pelagic species are free-swimming fish that inhabit the mid-water column. They tend to have little association with the seabed and as a result are

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often distributed over widespread and indistinct grounds, often forming large shoals. Pelagic fish, such as clupeids (herring and sprats) and mackerel are important prey resources for seabirds and marine mammals (Ref 10-53).

- 10.4.44 The outer Thames Estuary is considered to be a high intensity spawning ground for herring (Ref 10-54). There are two known herring stocks present in this area; an inshore stock that spawns in spring in the northern part of the Thames Estuary, and the North Sea herring stock which enters the southern half of the Thames Estuary seasonally. Herring have been found to be most commonly recorded during the spring and summer in the Thames Estuary, with only very small catches inshore in winter (Ref 10-34). The Thames Estuary is also a low intensity nursery ground for mackerel. Other commonly recorded pelagic species in the estuary include sea bass and sprat (Ref 10-44, and Ref 10-54) (Table 10-7).

Study Area

- 10.4.45 Marine pelagic species such as sprat and sea bass (predominantly juveniles), which occur seasonally in the inner River Thames, were also recorded in the Environment Agency TraC fish monitoring at Woolwich and Greenwich. Fish surveys at the nearby River Lea in the Limmo Peninsula and Bow Creek area, also found the pelagic fish assemblage to comprise predominantly of sea bass (Ref 10-48).
- 10.4.46 Herring spawn on gravel and similar habitats in shallow water between 15-40 m depth (Ref 10-54). Gravel material recorded on the seabed in the study area (Appendix 10B – *Marine Ecology Survey Report* (Document Reference 6.10.3.2)) could be potentially suitable for herring spawning. However, no known spawning grounds are recorded in this part of the estuary. In addition, only low numbers of herring have been recorded in Environment Agency TraC fish monitoring at Woolwich and Greenwich in recent years. Furthermore, the salinity levels recorded in the study area are at the lower limit considered suitable for herring spawning (Ref 10-55). Based on these factors, herring spawning ground is considered unlikely to occur in the study area.

Table 10-7 The abundance of pelagic fish recorded in Environment Agency TraC fish monitoring at Woolwich and Greenwich (2011 to 2015)

Species	Category	Greenwich Seine Net	Woolwich Otter Trawl	Total	Average Length
Herring	MMOS	8	2	10	74
Sea bass	MMD	76	4	80	66
Sprat	MMOS	54	40	94	48

Source: Ref 10-48

Elasmobranchs

Thames Estuary overview

10.4.47 Elasmobranchs are fish which possess a cartilaginous skeleton and include sharks and rays. The Thames Estuary is a low intensity spawning ground for Thornback ray with the estuary considered to be of regional importance to the species (Ref 10-54). Studies of ray movements in the Thames Estuary showed that 96% of rays tagged were recaptured there, suggesting that these rays form distinct sub-populations and exhibit small scale movements (Ref 10-44). Other commonly recorded elasmobranchs include the small-spotted catshark and starry smoothhound.

Study Area

10.4.48 No elasmobranchs have been recorded in recent fish monitoring data in the area (Ref 10-48). This is expected because commonly occurring elasmobranch species in the outer Thames Estuary such as thornback rays and small-spotted catshark, are unlikely to be able to tolerate the low salinity conditions found in the study area.

Diadromous fish species

Thames Estuary overview

10.4.49 Diadromous fish migrate between salt and freshwater and in the Thames Estuary include European smelt, river lamprey, sea lamprey, twaite shad, Atlantic salmon, sea trout and European eel.

10.4.50 The European smelt is a shoaling pelagic fish which is a primarily anadromous species around the UK. Spawning takes place in the early spring with the eggs hatching about a month later. The Thames supports nationally important populations of this species (Ref 10-1).

- 10.4.51 The river lamprey and the sea lamprey are both anadromous species, spawning in freshwater but completing part of their lifecycle in estuaries or at sea (Ref 10-56). The sea lamprey adult growth phase is short and lasts around two years. In this time the species is parasitic, feeding on a variety of marine and anadromous fishes, including shad, herring, salmon, cod, haddock and basking sharks. Unlike sea lamprey, the growth phase of river lamprey is primarily restricted to estuaries. The spawning migration of sea lamprey usually takes place in April and May when the adults start to migrate back into fresh water. River lamprey usually migrate into fresh water from October to December. These species have begun to re-colonise the catchment areas of the Thames Estuary with sightings increasing in recent years.
- 10.4.52 The twaite shad is an anadromous species which migrates from marine waters into the lower reaches of estuaries between April and June to spawn in freshwater near the tidal limit (Ref 10-57). Occasional seasonal presence is suspected but has yet to be proven for the Thames (Ref 10-1).
- 10.4.53 Atlantic salmon are an anadromous species which migrates to freshwater to spawn, whilst spending most of its life in the marine environment. They spawn in upper reaches of rivers, where they live for one to three years before migrating to sea as smolts. At sea, salmon grow rapidly and after one to three years return to their natal river to spawn. Atlantic salmon smolts move out of the rivers and migrate downstream to the sea in spring, with the main movements occurring between April and end of May. The majority of adult salmon return to their natal rivers between June and September. The UK and Irish Atlantic salmon population comprises a significant proportion of the total European stock (Ref 10-58). The species has been reintroduced into the Thames in recent years but the population is only maintained by periodic stocking.
- 10.4.54 European eel is catadromous species which migrates to the marine environment (Sargasso Sea) to spawn. The Thames Estuary is considered to be particularly important for the European eel which is recorded in the estuary year round. In their multi-method sampling surveys for estuaries, the Environment Agency have collected numerous records for the species throughout the Thames Estuary, and the estuary has the second highest density of eels in all surveyed estuaries in the UK (Ref 10-44). Elvers migrate up river in the spring between April and October with adult silver eels migrating downstream during the autumn (Ref 10-59).

Study Area

- 10.4.55 The European smelt was the most abundant migratory species recorded in Environment Agency TraC fish monitoring data at Woolwich and Greenwich for the period 2011 to 2015 (Table 10-8).
- 10.4.56 The only other migratory species recorded in Environment Agency TraC fish monitoring data at Woolwich and Greenwich for the period 2011 to 2015 was the European eel (Table 10-5). The monitoring has recorded a range of life stages for this species including elvers and glass eels. This species was also one of the most numerous species recorded in fish monitoring in the nearby River Lea in the Limmo Peninsula and Bow Creek area (Ref 10-49). Other species such as river and sea lamprey will pass through the area on migration.

Table 10-8 The abundance of migratory fish recorded in Environment Agency TraC fish monitoring at Woolwich and Greenwich (2011 to 2015)

Species	Category	Greenwich 1.5 m Beam Trawl	Greenwich Kick sample	Greenwich Seine Net	Woolwich Otter Trawl	Total	Average Length of Fish Recorded in the Samples (mm)
European eel*	C	2	23	12	4	41	111
European smelt	ER and MMD			14	262	276	152
*(including elvers and glass eel development stages)							

Source: Ref 10-48

Shellfish species

- 10.4.57 This section focuses on shellfish species (i.e. molluscs or crustaceans) which are consumed by humans. Information on other macrofauna is found within the Benthic Habitat and Species section (see Paragraph 10.4.13 of this chapter).

Thames Estuary overview

- 10.4.58 The Thames Estuary is an important area for many shellfish species, with large beds of common cockle and native oyster. The most important

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cockle-harvesting area in the Thames Estuary is the Maplin Sands (off the Essex coast) and surrounding area. Oysters are widely distributed through the outer Thames Estuary with major oyster fishing grounds located at Whitstable (Ref 10-44). The Estuary also provides important habitat for other shellfish species including blue mussel, whelk, pink shrimp and brown shrimp, lobster, and crabs (Ref 10-44). Within the Thames Estuary there are currently 12 designated shellfish waters:

- Dengie;
- Upper Roach;
- Roach and Lower Crouch;
- Upper Roach;
- Foulness;
- Outer Thames;
- Southend;
- Sheppey;
- Swalecliffe;
- Margate;
- Swale Central; and
- Swale East.

Study Area

- 10.4.59 Recent benthic surveys in the vicinity of the Scheme have recorded few shellfish species although low numbers of brown shrimp have been recorded (Appendix 10B – *Marine Ecology Survey Report*, Ref 10-23; 10-14; 10-12 (Document Reference 6.3.10.2)).

Marine mammals

Data sources

- 10.4.60 Numerous sources of information have been reviewed to inform the marine mammal baseline description. These include a number of national and regional studies to provide information on marine mammal distribution and ecology. The data was used to inform the understanding of the

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relative importance and functionality of the Thames Estuary in the context of the wider southern North Sea and eastern English Channel area. The main data sources include:

- Small Cetacean Abundance in the European Atlantic and North Sea programmes (SCANS and SCANS-II): The surveys undertook widespread ship based and aerial surveys of cetaceans in UK and adjacent waters in the summers of 1994 and 2005 (Ref 10-60). The programme provides detailed wide-scale survey data on cetacean abundance, distribution and density in North West European waters.
- atlas of Cetacean Distribution in North West European Waters: Comprehensive information on cetacean distribution in North West European waters is presented in Ref 10-61. This report provides a compilation of cetacean sighting records from a variety of systematic surveys and opportunistic sightings amounting to over 2,500 days of observation carried out since 1973.
- offshore energy Strategic Environmental Assessment (SEA): Detailed reviews of marine mammal distribution and ecology in UK waters have been carried out by the Sea Mammal Research Unit (SMRU), University of St. Andrews, as a contribution to the UK Department of Energy and Climate Change (DECC) Offshore Energy Strategic Environmental Assessment (SEA) (Ref 10-53).
- special Committee on Seals Annual Report: Information on the status of seals around the UK coast is reported annually by the SMRU-advised Special Committee on Seals (SCOS) (Ref 10-62).

10.4.61 Of particular relevance are a number of recent monitoring and survey projects which have been undertaken specifically in the Thames Estuary area. These data sources include the following:

- Thames Marine Mammal Sightings Survey (2004-2015): Shore based opportunistic sightings of marine mammals in the Thames compiled by the Zoological Society London (ZSL) (Ref 10-63; 10-60).
- Greater Thames Estuary Seal Surveys Report: Aerial transects and boat based surveys undertaken in August and December 2014 to better understand seal populations in the Thames Estuary (Ref 10-64).
- Common Seal Satellite Telemetry Surveys in the Thames Estuary: Satellite tagging surveys undertaken by ZSL and SMRU in January

2012. In total ten seals were tagged from seal colonies near Southgate and Margate Sands Ref 10-65).

- Common Seal Satellite Telemetry Surveys in the Thames Estuary: Satellite tagging surveys undertaken by SMRU in February 2006. Nine common seals were tagged from Margate and Long Sands Site of Community Importance (SCI) (Ref 10-63).
- Thames Strategic Environmental Assessment (SEA) Area aerial surveys (2002-2006): A series of larger scale aerial surveys were undertaken by Wildfowl and Wetlands Trust to cover the Thames Strategic Environmental Assessment (SEA) Area, as part of the Round 2 programme, supported and funded by both the Department of Trade and Industry (DTI, now DECC) and the offshore wind farm developers. These surveys were primarily undertaken to survey marine waterbirds although observations of marine mammals were also recorded (Ref 10-44; Ref 10-66).

10.4.62 A number of other surveys and scientific studies on marine mammals have also been taken account of in the assessment where appropriate.

General overview

10.4.63 The cetacean fauna (whales and dolphins) of the southern North Sea including the Thames Estuary is relatively poor, both in terms of the number of animals and diversity of species (Ref 10-58; 10-61; 10-53). While over ten species of cetaceans have been recorded in the southern North Sea, only harbour porpoise occurs relatively frequently in the Thames Estuary (Ref 10-67; 10-68). The bottlenose dolphin is occasionally observed in the eastern part of the English Channel and very rarely in the Thames Estuary (Ref 10-69; 10-63).

10.4.64 With regard to pinnipeds (seals), both grey and common seals breed at haul out sites along the Norfolk coast, Kent coast and Thames Estuary and are regularly recorded foraging in the Thames Estuary (Ref 10-62; 10-63).

10.4.65 All cetaceans (including harbour porpoise) are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to take, injure or kill these species. Disturbance to their place of rest, shelter or protection is also prohibited. All species of cetacean are also protected under the EU Habitats Directive, in Annex II and IV and the Bern Convention. In addition, harbour porpoise are listed

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as an OSPAR threatened species and in Appendix II of the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals).

- 10.4.66 Pinnipeds (grey and common seals) are protected under the Conservation of Seals Act 1970 (England, Scotland, Wales). Grey and common seals are also listed in Annex II of the EU Habitats Directive and protected from disturbance both inside and outside the designated sites. The grey seal is also listed as an Appendix III species under the Bern Convention (1979), which prohibits their deliberate disturbance, capture or killing and the disturbance of their breeding grounds.
- 10.4.67 The baseline assessment has focused on the three most commonly occurring marine mammal species in the Thames Estuary (common seal, grey seal and harbour porpoise). The distribution, abundance and ecology of each of these species are discussed further in the sections below. Each section initially provides a Thames Estuary wide overview of the presence of the species before focusing specifically on the Silvertown and the Greenwich Peninsula study area.

Common seal (*Phoca vitulina*)

- 10.4.68 The common seal (also known as harbour seal) is the smaller of the two native UK seals measuring up to approximately 1.85m in length and typically weighing 80-100kg. Britain is home to approximately 30% of the population of the European sub-species of common seal (having declined from approximately 40% in 2002). Common seals are found in a wide variety of coastal habitats and come ashore in sheltered waters, including on sandbanks, in estuaries and along rocky areas.
- 10.4.69 Common seals normally feed within 40-50km of their haul-out sites (Ref 10-62). Scotland holds approximately 79% of the UK common seal population (Ref 10-62). On the east coast of England, their distribution is more restricted with concentrations in the major estuaries of the Thames, The Wash, Firth of Tay and the Moray Firth (Ref 10-62).

Thames Estuary overview

- 10.4.70 Aerial and boat based surveys in the outer Thames Estuary were undertaken in August and December 2014 to better understand seal populations in the area (particularly at key haul out sites) (Ref 10-64). In total 489 and 345 harbour seals were counted during the August and December surveys respectively. The main coastal haul out locations

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included Pegwell Bay, Hamford Water and approaches to the river Crouch (Foulness Sands, Dengie Flats and Buxey Sands).

- 10.4.71 Satellite tagging of nine common seals in February 2006 by ZSL/SMRU and ten common seals in January 2012 by SMRU from haul out sites in the Thames Estuary showed that common seals travel widely throughout the Thames with high usage recorded. The 2012 tagging survey recorded seals diving up to 85m deep and utilising ranges up to 8,473km² for foraging. In general common seals are not believed to travel as far as grey seals, usually staying closer to haul out sites (typically within 40-60km) (Ref 10-62). However, one of the 2006 tagged animals travelled into the English Channel, hauling-out near Saint-Valery-sur-Somme in France and foraged and hauled out in The Wash, with more than 660km between the southern and northern extent of its movements (Ref 10-70).
- 10.4.72 The Thames Marine Mammal Sightings Survey 2004-2015 has recorded 301 sightings of common seal to date. The sightings ranged from Benfleet and Southend Marshes, Southend-on-Sea and Canvey Island in the outer estuary to the Isle of Dogs, and upstream to Teddington (Ref 10-63; 10-64).

Study Area

- 10.4.73 The nearest haul out sites to Silvertown and the Greenwich Peninsula area are located approximately 50km away from the Order limits of the Scheme around Gravesend and Canvey. However, common seal are frequently recorded foraging within the Silvertown and Greenwich Peninsula area (Drawing 10-1 — *Study area and Sightings Compiled as Part of the Thames Marine Mammal Sightings Survey (2004 to 2015)* (Document Reference 6.2)) (Ref 10-63; 10-64; 10-68).

Grey seal (*Halichoerus grypus*)

- 10.4.74 The grey seal is the larger of the two seal species found in British waters, with males reaching a length of 2.45m and a weight over 300kg (Ref 10-62). Grey seals predominantly inhabit remote islands and coastlines in Wales, breeding on undisturbed beaches of cobble and boulders or within sea-caves along the coast. Pupping time occurs primarily from August through to December with September generally being the busiest month.
- 10.4.75 About 38% of the world's population of grey seal is found in Britain with over 88% of the British grey seals breeding in Scotland (Ref 10-62). During the 2012 breeding season UK grey seal production was estimated

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at 56,988. To estimate the total grey seal population size in 2013, trajectories from a population dynamics model using the 2012 pup counts and population demographic parameters gave a total UK population of 111,600 (Ref 10-62).

Thames Estuary overview

10.4.76 Aerial and boat based surveys in the outer Thames Estuary in August 2014 recorded a total of 449 grey seals (Ref 10-64). Of these counts over 70% (347 grey seals) were recorded in the Goodwin Sands area which is the main grey seal haul out in the region.

10.4.77 A range of studies have shown that grey seals can undertake long distance travel between different haul-out sites but foraging trips are generally much smaller. For example, Ref 10-71 found that four seals tracked from the Moray Firth moved to haul-out sites 125-365km away, and provided evidence of interchange between the Moray Firth and other grey seal breeding areas in Orkney, the Firth of Forth and the Farne Islands (Ref 10-71). While grey seals may range widely between haul out sites, tracking has also shown that most foraging probably occurs within 100 km of a haul-out site (Ref 10-62).

Study Area

10.4.78 Goodwin Sands, the main grey seal haul out site is located well over 100km from the Silvertown and Greenwich Peninsula area with the nearest minor colonies (Maplin Sands and West Barrow) located over 60km away. However, sightings data suggests grey seals are regularly recorded foraging in the Silvertown and Greenwich Peninsula area (Drawing 10-1 – *Study area and Sightings Compiled as Part of the Thames Marine Mammal Sightings Survey (2004 to 2015)* (Document Reference 6.2)) (Ref 10-63; 10-68; 10-64). Some of these sightings relate to the same individual grey seal which has been regularly observed in the area for over ten years, primarily in the Isle of Dogs docks area (particularly Canary Wharf and Billingsgate fish market, where he is often fed by fisherman).

Harbour porpoise (*Phocoena phocoena*)

10.4.79 Harbour porpoise distribution is restricted to temperate and sub-arctic (primarily 5-14°C) seas of the Northern Hemisphere. The harbour porpoise is the most commonly recorded cetacean in UK waters, primarily occurring on the continental shelf (Ref 10-53). The Southern North Sea possible SAC for harbour porpoise is located approximately 75km from

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the proposed Scheme. In coastal waters, they are often encountered close to islands and headlands with strong tidal currents (Ref 10-72; 10-73; 10-53). The seasonal pattern in the southern North Sea appears to be for an early spring peak in numbers in coastal waters, followed by a northward migration towards more offshore waters. Harbour porpoise forage on a range of species including sandeels and gadoids such as whiting and clupeids (herring and sprats) (Ref 10-74; 10-75; 10-72).

Thames Estuary overview

- 10.4.80 Harbour porpoise were found to be the most abundant cetacean during the aerial surveys of the outer Thames Estuary and southern North Sea undertaken as part of the offshore energy SEA between 2002 and 2006, with 952 records, representing an estimated 1,121 porpoises. Recordings from the aerial surveys obtained unadjusted densities of porpoises of up to 0.9 animals/km² (Ref 10-66).
- 10.4.81 The Thames Marine Mammal Sightings Survey 2004-2015 has recorded 241 sightings of harbour porpoise to date. The sightings ranged from the outer estuary at Benfleet and Southend Marshes, Southend-on-Sea to the Isle of Dogs and upstream to Teddington (Ref 10-52; 10-68).

Study Area

- 10.4.82 Occasional sightings of harbour porpoise have also been recorded within the Silvertown and Greenwich Peninsula area with the species expected to only occur relatively infrequently (Drawing 10-1 – *Study area and Sightings Compiled as Part of the Thames Marine Mammal Sightings Survey (2004 to 2015)* (Document Reference 6.2)) (Ref 10-74; 10-68).

10.5 Scheme design and mitigation

- 10.5.1 The following mitigation measures have been identified as part of the assessment process and will be included in Construction Environment Management Plan (CEMP) prepared by the contractor at the detailed design stage. This will incorporate the following measures set out in the CoCP (Document Reference 6.10):
- The application of established industry guidance and protocols throughout the construction phase of the Scheme (see Chapter 16 – Surface Water Quality and Flood Risk) Document Reference 6.1.16).

- The development of a non-native species risk assessment and management plan ([in liaison with the MMO, PLA and EA as necessary](#)).
- The use of soft start procedures during piling for a minimum of 20 minutes. Should piling cease for a period of greater than 10 minutes the soft start procedure must be repeated
- Vibro piling techniques will be used as far as practical to bury the piles for the temporary jetty and percussive piling may be used, for a maximum depth of 12.5m, to achieve the final burial depth;
- No piling between March and October to avoid fish migration periods Percussive piling will be limited to November-March inclusive (unless otherwise agreed with the MMO, PLA and EA);
- Review of the site specific data (including the contamination data) to inform the ~~detailed waste disposal strategy~~ [Site Waste Management Plan](#).
- The lighting on the new temporary jetty will be designed to minimise light levels in the marine environment. The lighting on the new temporary jetty head would have the lamps facing out to the watercourse, to facilitate unimpeded loading and unloading operations. Reflectors, that avoid excessive light pollution to surrounding areas, will be used see CoCP (Document Reference 6.10) for more details.
- The decommissioning programme of the new temporary jetty will adhere to the same seasonal restrictions as advised by the PLA for piling (i.e. ~~between March and October~~) if hydraulic vibratory methods are used.
- Any planned (i.e non-emergency) dredging work must avoid the period of June-August inclusive.

10.6 Assessment of impacts

- 10.6.1 As discussed in Section 10.1, this Chapter assesses the impacts on Marine Ecology exclusively during the construction phase of the Scheme, as the NAABSA and new temporary jetty will be decommissioned and not used for any purpose related to the Scheme during operation of the tunnel itself. This assessment is structured to consider the effects of the

construction, operation and decommissioning of the new temporary jetty for each of the following receptors:

- nature conservation protected areas and species;
- benthic habitats and species;
- fish and shellfish; and
- marine mammals.

Nature conservation protected areas and species

10.6.2 The importance of the marine ecology of the Thames Estuary is recognised through a number of biodiversity initiatives. The Scheme falls within the boundary of Thames Estuary rMCZ; accordingly, a formal MCZ assessment is not required as the designation of the rMCZ is currently on hold (Ref 10-7). There is, however, a potential for features that are cited within the rMCZ to be affected by the Scheme. Similarly the Scheme falls within the Thames and Tidal Tributaries SINC. Further consideration of the potential impacts on each of the cited features of the ecological resource is incorporated within the respective receptor types below. Accordingly, no impact pathways relating to nature conservation receptors have been assessed in this section.

Benthic habitats and species

10.6.3 Site specific data indicate that the community within the study area is highly impoverished, supports low faunal abundances, and is considered to be of limited ecological importance. The value of the benthic habitats and species is therefore described as low.

10.6.4 A number of pathways have been scoped out as requiring no further assessment. These are summarised in Table 10-9.

Table 10-9 Benthic habitats and species – Scoped out pathways

Pathway	Rationale
Noise disturbance (all phases, including tunnelling)	Studies have indicated that crustacean species are able to respond to a wide frequency bandwidth, although their sensitivity to underwater sound and vibration is very much lower than fish (Ref 10-76 and Ref 10-77). It is therefore considered unlikely that noise levels would adversely affect the benthic community

	found in the vicinity of the Scheme. This pathway has therefore been scoped out of the EIA.
Water quality (decommissioning of the new temporary jetty)	Steel piles supporting the new temporary jetty will be either extracted using vibratory methods or if this cannot be achieved cut 1m below bed level and therefore bed disturbance will be negligible (see Appendix 4.A – CMS (Document Reference 6.3.4.1)). Accidental spillages will be negligible through following established industry guidance and protocols (see CoCP (Document Reference 6.10)).
Indirect changes in habitat extent and quality (decommissioning)	The steel piles supporting the new temporary jetty will be either extracted using vibratory methods or if this cannot be achieved cut 1m below bed level and therefore bed disturbance will be negligible from this and removal of the jack up barge feet. (see Appendix 4.A – CMS (Document Reference 6.3.4.1)). The amount of sediment available for deposition is therefore also deemed to be small in the context of the Thames Estuary.

10.6.5 The proposed marine works have the potential to affect benthic ecology receptors during the construction, operation and removal of the new temporary jetty. The potential impact pathways, associated with each of these project stages, are discussed and assessed below. General scientific context for each impact pathway has been provided prior to completing an assessment of the potential effects on the benthic ecology within the study area of the Scheme.

Construction of the new temporary jetty and associated works

Water quality

10.6.6 There is the potential for impacts on benthic habitats and species associated with changes in water quality during the construction works. Construction activities (particularly dredging) may increase suspended sediment concentrations (SSC) and release toxic contaminants bound in sediments. This can cause changes in a range of water quality parameters including turbidity and dissolved oxygen level. There is also the potential for accidental spillages of contaminants during the construction works if it is not adequately controlled.

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Elevated suspended sediments

- 10.6.7 Increased SSC has the potential to reduce light penetration through the water column, restricting the light availability for photosynthesis in primary producers. It may also lead to the clogging of the gills and feeding apparatus of suspension feeders.
- 10.6.8 The removal of the moorings and installation of piles for the new temporary jetty is assumed to result in a negligible amount of sediment suspension particularly in the context of the background concentrations of the Thames (see Chapter 16 - Water Quality and Flood Risk (Document Reference 6.1.16)). Sediments do, however, have the potential to be suspended during the dredge. A maximum of approximately 60,170 m³ of material will be removed over a period of up to two months (this includes an over dredge allowance). Once dredged, the material will not be disposed of at sea and as such there will be no release of suspended sediments at the point of disposal.
- 10.6.9 The dredge pocket consists of scoured gravel, gravelly sand and cobbles in the surface layer with consolidated clay material recorded at depth. The sediment plume from the dredging is expected to cause slightly elevated SSC that will be within the range of natural background variability (see Chapter 16: Water Quality and Flood Risk (Document Reference 6.1.16)).
- 10.6.10 The temporary and highly localised increases in SSC will be of a magnitude comparable to that which occurs naturally in the Thames Estuary (e.g. during storm events). Thus in physical terms, the plumes resulting from any construction dredging activities are expected to have a minimal and local effect on SSC in the vicinity of the works. Therefore, while the probability of a localised change is high, magnitude of change and consequently exposure to change is assessed as negligible.
- 10.6.11 The subtidal and intertidal benthic communities within Thames Estuary are well adapted to living in areas with variable and typically high suspended sediment loads. Their sensitivity to a temporary increase in SSC is therefore considered to be low and consequently vulnerability is assessed as none. Given the lack of species of conservation status, the importance of benthic communities in the vicinity of the Scheme is considered to be low and therefore the overall significance of effects on marine ecology of SSC related to the construction of the new temporary jetty is assessed as **Negligible**.

Dissolved Oxygen

- 10.6.12 The resuspension of sediments containing organic material can cause oxygen depletion within the water column. The subsequent settling of this organic rich sediment can deplete sediment oxygen levels thereby affecting benthic species. The response of benthic species to low concentrations of dissolved oxygen is determined by a range of factors, including the duration of exposure, water temperature and the presence of other pollutants.
- 10.6.13 Increases in SSC associated with the construction of the new temporary jetty will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen. The probability of a localised effect is therefore medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. The sensitivity, vulnerability and importance of benthic features are considered low due to the impoverished communities present, therefore any the significance of effect on marine ecology will be **Negligible**.

Release of contaminants

- 10.6.14 Subtidal and intertidal habitats and species are sensitive to toxic contamination (where concentrations of contaminants exceed sensitivity thresholds). Toxic contamination during construction of the jetty may occur through the accidental release of synthetic contaminants such as fuels and oils or via resuspension of contaminant containing sediment during dredging. These include both toxic contaminants, such as heavy metals, pesticides and hydrocarbons, and non-toxic contaminants, such as nutrients.
- 10.6.15 In particular, there is a risk that any uncontrolled releases of materials or sediments into the water column could make contaminants temporarily available for uptake by marine organisms. Suspension-feeding organisms may be particularly vulnerable due to their dependence on filtration. The accumulation of toxic contaminants can result in both lethal and sub lethal impacts on marine organisms, detrimentally affecting growth, reproduction, physiology, and behaviour. The accumulation of such contaminants may cause ecological harm further up the food chain through bioaccumulation if the affected species become prey for higher trophic level species.
- 10.6.16 Chemical sediment analysis has been undertaken from a number of samples within the area proposed for dredging (see Chapter 16 – Water Quality and Flood Risk (Document Reference 6.1.16)). The majority of contaminants in the samples from the study area were found at low

concentrations compared to UK guidelines (typically below Cefas Action level (AL) 1 or between AL 1 and AL 2). However, there was one exceedance of AL 2 for cadmium (9.0 mg/kg), lead (549 mg/kg), mercury (7.4 mg/kg) and the sum of 25 polychlorinated biphenyl (PCB) congeners (0.344 mg/kg). These exceedances were approximately two times greater than AL 2 for cadmium, mercury and the sum of 25 PCB congeners with a marginal exceedance for Lead.

- 10.6.17 The release of seabed contaminants during construction and dredging activities will be temporary and localised. Furthermore, the strong tidal flows in the area will rapidly disperse contaminants and therefore significant elevations in water column contamination is not expected. In addition, the potential for accidental spillages will also be negligible during this phase of the Scheme through following established industry guidance and protocols as listed in the CoCP (Document Reference 6.10). Therefore, the magnitude of change is considered to be small. Given that the probability of occurrence is low the overall exposure is assessed as negligible. As the sensitivity, vulnerability and importance of benthic communities within the Scheme area are considered to be low the, the significance of effect on marine ecology of the release of contaminants during the construction of the new temporary jetty is considered to be **Negligible**.

Indirect changes in habitat extent and quality

- 10.6.18 A number of the construction related activities (including piling and the associated dredge) will result in increased SSC within the water column. This has the potential to result in localised smothering of benthic habitats and species where the material settles out of suspension back onto the seabed.
- 10.6.19 Habitats within estuarine environments are characterised by highly fluctuating conditions which include the resuspension and deposition of sediments. Organisms inhabiting subtidal and intertidal estuarine habitats are therefore well adapted to such perturbations and are able to survive under fluctuating conditions. However if the amount of sediment deposited is too great survival of benthic species can be impaired.
- 10.6.20 Benthic invertebrates typically live in the top 100 mm of the seabed and must maintain some connection to the sediment-water interface for ventilation and feeding (Ref 10-78). It is this connection that is disturbed by excessive sediment deposition or 'smothering' of benthic invertebrate fauna within sedimentary seabed habitats. This smothering occurs where

individuals are unable to migrate through any deposited sediment and their feeding and respiration apparatus become clogged (Ref 10-79). This blanketing or smothering may cause stress, reduced rates of growth or reproduction and in the worst case, mortality of marine benthic species (Ref 10-80 and Ref 10-81).

- 10.6.21 Sediments dispersed during construction work will resettle over the seabed. Resettlement is dependent on the total amount of suspended sediment and physical parameters such as the hydrodynamic regime and properties of the sediment. In turn, the effect of smothering is dependent on resettlement and the species present within the affected area as certain species may be able to withstand burial to a greater extent than others.
- 10.6.22 The new temporary jetty construction works are predicted to cause some localised accretion of sediment. The dredge pocket consists of scoured gravel, gravelly sand and cobbles in the surface layer with consolidated clay material recorded at depth. The potential for the suspension and re-distribution of sediment is limited and as such any sedimentation would be expected to be in the order of millimetres. This is within the range of background variability for this part of the estuary (see Chapter 16 - Water Quality and Flood Risk (Document Reference 6.1.16)).
- 10.6.23 Given the predicted localised extent and depth of accretion resulting from the dredge, the magnitude of change for smothering is considered to be negligible. Overall exposure to change is negligible despite the high probability of occurrence. The sensitivity of features are considered to be low given that benthic communities in the area are impoverished, have high recoverability rates and are considered to be well adapted to the naturally fluctuating conditions of the Thames. Vulnerability is therefore assessed as none. Given the low ecological value of habitat and species found within the area, the importance of the benthic ecology feature is low. Therefore the overall effect of changes in habitat quality due to the construction of the new temporary jetty on benthic species and habitats is considered to be **Negligible**.

Introduction of non-native invasive species during construction

- 10.6.24 Vessels involved in the construction of the new temporary jetty and associated works have the potential to introduce non-native invasive species in to the study area.

- 10.6.25 Non-native, or invasive, species are described as 'organisms introduced by man into places outside of their natural range of distribution, where they become established and disperse, generating a negative impact on the local ecosystem and species' (International Union for Conservation of Nature (Ref 10-82). The ecological impacts of such 'biological invasions' are considered to be the second greatest threat to biodiversity worldwide, after habitat loss and destruction. In the last few decades marine and freshwater systems have suffered greatly from invasive species as a result of increased global shipping (Ref 10- 83).
- 10.6.26 The introduction and spread of non-native species can occur either accidentally or by intentional movement of species as a consequence of human activity (Ref 10-84 and Ref 10-85). The main pathways for the potential introduction and/or spread of non-native species are via fouling of vessels' hulls, transport of species in ballast or bilge water and the accidental imports from materials brought into the system as a result of a development.
- 10.6.27 The fouling of a boat hull and other below-water surfaces can be reduced through the use of protective coatings applied to the hull. Maintenance of hulls through regular cleaning also minimises the number of fouling organisms present. This will be considered as part of the risk assessment undertaken for this this Scheme (Document Reference 6.10).
- 10.6.28 Non-native invasive species also have the potential to be transported via ship ballast water. Seawater may be drawn into tanks when the ship is not carrying cargo, for stability, and expelled when it is no longer required. This provides a vector whereby organisms may be transported long distances.
- 10.6.29 A number of invasive non-native species are currently present within the Thames, resulting in a high probability that the benthic habitat within the boundary of the proposed Scheme is already inhabited by some invasive non-native species. Two species (*Boccardiella ligerica* and *Potamopyrgus antipodarum*) were found within the site specific survey. The introduction of non-native invasive species into the area is therefore a possibility.
- 10.6.30 The UK is bound by international agreements such as the Convention on Biological Diversity, the United Nations Convention on the Law of the Sea, the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention 1979), the Convention on the Conservation of European Wildlife and Natural Habitat (Bern, 1979) and the Habitats and Birds Directives. All of these aim to protect biodiversity, endangered

species and habitats, and include provisions requiring measures to prevent the introduction of, or control of, non-native species, especially those that threaten native or protected species (Ref 10-86).

- 10.6.31 Additionally, Section 14(1) of the Wildlife and Countryside Act (WCA) (1981) makes it illegal to release or allow to escape into the wild any animal which is not ordinarily resident in Great Britain and is not a regular visitor to Great Britain in a wild state, or is listed in Schedule 9 to the Act. The Schedule 9 list of animal and plant species has been amended by the WCA 1981 (Variation of Schedule 9) (England and Wales) Order 2010.
- 10.6.32 These commitments are expected to be subject to greater international enforcement over time. In 2004 the International Maritime Organisation (IMO) adopted the 'International Convention for the Control and Management of Ships' Ballast Water and Sediments', which involved two performance standards:
- D1: 95% of ships ballast to be exchanged in waters 200 nm from land and at least 200m deep. Where this is not possible ballast must be exchanged no closer than 50nm to land; and
 - D2: Ballast Water Treatment Systems approved by the relevant administration [in each country] which treat ballast water to an efficacy of:
 - < 10 viable organisms per m³ >50 micrometres in minimum dimension; and
 - <10 viable organisms per millilitre <50 micrometres in minimum dimension and >10 micrometres in minimum dimension.
- 10.6.33 This legislation will come into force one year after 30 countries, representing 35% of global merchant shipping tonnage, have signed up to the agreement. The IMO website states that as of 8 March 2016, 49 countries had signed up, representing only 34.82% of world tonnage. However, Morocco, Indonesia and Ghana have since signed the BWM Convention and the IMO are currently waiting to verify whether tonnage figures for these countries secure the 35% of tonnage needed to bring the BWM Convention into force. The ratifying nations' vessel tonnage currently remains just under the amount to trigger the Ballast Water Management Convention's enactment.
- 10.6.34 In addition, a new European Union Regulation came into force on 1 January 2015 which seeks to prevent and manage the introduction and spread of invasive non-native species. It includes policy issues and also

economic and ecological considerations. The legislation centres on a list of invasive alien species of EU concern, which will be drawn up with Member States using risk assessments and scientific evidence by early 2016. Selected species will be banned from the EU, meaning it will not be possible to import, buy, use, release or sell them. The regulation will allow for three types of intervention: prevention; early warning and rapid response; and management (Ref 10-87).

- 10.6.35 In view of these existing legislative commitments and considerations, the probability of the introduction and spread of non-native species from dredging is considered to be low. A risk assessment will, however, be undertaken for the construction phase associated with the marine works to identify measures to minimise the potential for the import of invasive species into the area and to minimise the risk of spreading those which are already present. This will be secured in the CoCP (Document Reference 6.10). Magnitude of change is considered to be negligible, accordingly, the exposure to change is negligible. The sensitivity of habitats within the study area is assessed as low due to an impoverished and low diversity benthic community. Vulnerability is consequently considered to be none. The importance of marine habitats and species is considered to be low, therefore the significance of effects on marine ecology, related to the introduction of non-native species during construction of the new temporary jetty is considered to be **Negligible**.

Operation of the jetty

Direct loss of benthic habitats and species

- 10.6.36 The impact of direct habitat loss (e.g. through the placement of piles) relates to the temporary or permanent physical removal of substratum and associated organisms from the seabed. There will also be a temporary loss of habitat within the footprint of the feet of the jack up barge.
- 10.6.37 Both intertidal and subtidal habitats are sensitive to physical loss at locations where new structures are introduced onto the sea bed (i.e. within the development 'footprint' of these structures). The significance of such losses will vary on a site by site basis in response to differences in the extent and duration of the losses as well as the relative value of the habitats in question. The value of the habitats is, in turn, reflected by the species that are present and the level of statutory and non-statutory protection afforded to them.

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- 10.6.38 The new temporary jetty will involve the installation of 25 piles each with a diameter of up to 1060mm. The total physical loss of habitat due to the footprint of the piles is therefore 22m² which occurs predominantly in the subtidal. The footprint of the jack up barge feet will also be relatively small. It should be noted that the loss of this habitat will be temporary, lasting up to four years as the piles would be removed or cut off 1m below bed level during the decommissioning of the new temporary jetty.
- 10.6.39 Subtidal habitats within the study area are highly impoverished and support low biodiversity. Consequently, subtidal habitat loss of this scale is considered to be negligible in the context of the extent of this habitat type throughout the Thames.
- 10.6.40 Based on the available evidence reviewed above the magnitude of the direct loss to the subtidal habitat and associated benthic species is considered to be negligible and although the probability of occurrence is high the overall exposure is also assessed as negligible. The sensitivity of benthic features are considered to be low, thus vulnerability is assessed as none. The importance of the habitats and associated benthic communities affected by the operation of the new temporary jetty are considered to be low, therefore the overall significance of effect of the operation of the new temporary jetty on marine ecology in terms of loss of habitat is **Negligible**.

Change in habitat quality

- 10.6.41 The potential changes in habitat quality that could arise through the operation of the new temporary jetty and NAABSA berth are related to the dredging (capital and maintenance), scour, removal of moorings and any associated changes to the hydrodynamic and sedimentary transport regimes that result from the construction process. Such activities result in a change of habitats, causing a modification to the existing environment.
- 10.6.42 Dredging causes bathymetric changes by lowering the seabed, effectively increasing water depth. Benthic organisms show different tolerance ranges of physiological stresses caused by exposure and tidal elevation which leads to zonation (Ref 10-88). Bathymetric changes caused by dredging therefore could change the vertical distribution of marine habitats.
- 10.6.43 Placing a structure such as piles in the marine environment leads to a change in flow pattern immediately adjacent to the structure (Ref 10-89). As a result the capacity for local sediment transport usually increases

causing a localised lowering of the seabed around the introduced structure referred to as scour (Ref 10-53). Scour, therefore, has the potential to alter local sediment types, reducing the content of fine material and leaving behind coarse sediment often colonised by opportunistic species fast growing species (Ref 10-90). Additionally, the process of scour is likely to result in the loss of any infauna present prior to the impact (Ref 10-90). Operation of vessel propellers in shallow water can have a similar effect as the turbid flow resulting from propeller operation suspends and redistributes sediment.

- 10.6.44 The speed of recovery of the disturbed areas is dependent on the scale and timing of the disturbance, the life histories of species and the stability and diversity of the benthic community present. Furthermore, a regularly disturbed sedimentary habitat with a low diversity benthic assemblage is likely to recover more quickly (i.e. return to its disturbed or 'environmentally-stressed' baseline condition) than a stable habitat with a pre-existing mature and diverse assemblage.
- 10.6.45 In general, where studies have been undertaken to understand the effects of physical disturbance they have shown recolonisation of deposited sediments by animals to be quite rapid. Sites are initially colonised by short lived, fast growing, opportunistic species ('r-selected') that are tolerant of high levels of disturbance; infaunal species dominate, particularly oligochaete and polychaetes worms. In time, these are succeeded by longer lived, slower growing species with a lower tolerance for disturbance (Ref 10-91; Ref 10-92; Ref 10-93). Rates of recovery reported in reviewed literature suggest that a recovery time of six to nine months is characteristic of many estuarine muds where frequent disturbance of the deposits precludes the establishment of long-lived communities. In contrast, a community of sands and gravels may take two to three years to establish, depending on the proportion of sand and level of environmental disturbance by waves and currents (Ref 10-92; Ref 10-94).
- 10.6.46 Dredging will occur exclusively in subtidal areas. The maximum footprint of the dredge area is 27,200 m² where the bed depth will be lowered by a maximum of 3 m (including 0.5 m over dredge). A dredger will be used to remove the material from the proposed dredge area which is located entirely in the subtidal zone. The operation of vessels will prevent siltation within the dredge berth and as such the requirement for maintenance dredging is expected to be limited.

- 10.6.47 The action of the propellers of operational vessels may result in localised scouring within the dredge pocket. Scour may also occur as a result of localised changes in flow rates around the piles. The new temporary jetty structure will only be present in the Thames for up to four years, after which time piles will be removed. Impacts resulting from the operation of the new temporary jetty will therefore be only temporary in nature.
- 10.6.48 The subtidal habitat present in the study area is composed of an impoverished community. This habitat is considered to be typical of the subtidal areas elsewhere in Thames and well adapted to fluctuating conditions with high levels of disturbance. Given the low species abundance and diversity, recovery to pre disturbed conditions are expected to occur relatively quickly following completion of the works.
- 10.6.49 The temporary nature of the works and the scale of potential change are assessed to be of a low magnitude of change. Hence, although the probability of occurrence is high the overall exposure is assessed as low. Given that the sensitivity, vulnerability and importance of the subtidal habitat and associated benthic communities affected are considered to be low, the significance of effect of the presence and operation of the new temporary jetty relating to potential change to benthic habitat is **Negligible.**

Water quality

- 10.6.50 Activities associated with the operation of the new temporary jetty have the potential to affect water quality. It is unlikely that maintenance dredging will be required throughout the life of the new temporary jetty and the potential for accidental spillages will be negligible as established industry guidance and protocols will be followed. The main potential for a change in water quality will therefore be as a result of increased SSCs and the associated potential release of contaminants caused by propeller wash.
- 10.6.51 The extent of the sediment plume caused by maintenance dredging (if required) and vessel movements would be expected to be localised. Though operational activities will cause the resuspension of sediment, the magnitude of change is assessed as negligible by reason of the limited spatial scope of those activities. The overall exposure to change is therefore negligible despite the probability of occurrence being high. The sensitivity of the affected ecological resource is considered to be low given that benthic communities in the area are impoverished, support a

low biodiversity and are considered to be well adapted to the conditions of the Thames. Vulnerability is therefore assessed as none.

- 10.6.52 Given the low ecological value of habitat and species found within the area the importance of the benthic ecology feature is low. Therefore the overall effect of water quality in the operational phase on benthic species and habitats is considered to be **Negligible**. Consequently no specific mitigation measures are required to conserve water quality during the use of the new temporary jetty other than those of standard industry practice.

Introduction of non-native invasive species during operation of the new temporary jetty – vessel movements

- 10.6.53 Vessels involved in the operational phase of the Scheme have the potential to introduce non-native species into the area.
- 10.6.54 Pathways 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 (Ref 10-95; Ref 10-96). The proposed works will increase the amount of ship movements in the area through the use of the new temporary jetty. The number of vessel movements associated with the new temporary jetty is in the order of four per day.
- 10.6.55 The potential introduction of non-native species is an existing operational risk within the Thames which is managed through adherence to relevant guidelines and best practice measures. Therefore, the operation of new temporary jetty is not considered to pose an additional risk over and above that which is already appropriately managed in the Thames. A Scheme specific risk assessment will be produced to ensure that all operational vessel movements adhere to such best practice measures (see Section 10.5).
- 10.6.56 In view of these existing commitments and considerations, the probability of the introduction of non-native species from vessel movements is considered to be low. Magnitude of change is considered to be negligible, thus the exposure to change is negligible. The sensitivity of all intertidal and subtidal receptors to non-native species introductions is expected to be low within the study area. Vulnerability is consequently considered to be none. The importance of marine habitats and species is considered to be low, therefore the overall significance of effect relating to the introduction of non-native species during the period of the use of the new temporary jetty is considered to be **Negligible**.

Colonisation of new surfaces by non-native invasive species

- 10.6.57 The introduction of a new surface into the marine environment has the potential to facilitate the colonisation and spread of non-native invasive species. The Scheme will introduce new surfaces into the marine environment in the form of new temporary jetty piles.
- 10.6.58 Construction of the new temporary jetty will introduce up to 25 piles into the marine environment. This will provide a substrate that has the potential to be colonised by non-native species.
- 10.6.59 The introduction of a new surface in the marine environment, such as the piles, has the potential to facilitate the colonisation of invasive non-native species. This is because the new surface will provide limited initial competition from indigenous species. Such spread of non-native species could lead to a reduction in population numbers and biodiversity of the region. However, it is noted that there is already a widespread presence of artificial hard substrates in this part of the Thames Estuary which provide a number of surfaces for potential non-native species. Furthermore, as noted in the baseline review (Paragraph 10.4.26) several non-native species are already widespread throughout the estuary, including a range of epifaunal species which attach to hard substrate that occur within this part of the estuary (e.g. zebra mussel *Dreissena polymorpha* and carpet sea squirt *Didemnum vexillum*).
- 10.6.60 Therefore, although the probability of colonisation by non-native species is likely to be high, the magnitude of change will be small, due to the widespread presence of existing hard structures and the prevalence of non-natives throughout the Thames Estuary. Exposure to change is therefore considered to be low. The sensitivity of all intertidal and subtidal benthic receptors to non-native species introductions is expected to range from low given that species already co-exist with the widespread non-natives. Vulnerability is therefore considered to be low. The importance of the habitats and species affected are considered to be low. Consequently, the overall impact related to the possible colonisation of new surfaces by non-native species due to the introduction of the new temporary jetty piles is considered to be **Negligible**.

Removal of the new temporary jetty

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Introduction of non-native invasive species when dismantling the new temporary jetty

- 10.6.61 Vessels involved in the decommissioning of the new temporary jetty have the potential to introduce non-native invasive species in to the study area.
- 10.6.62 The steel piles supporting the new temporary jetty will be extracted using either vibratory methods or, if this cannot be achieved, cut 1m below bed level during the dismantling of the new temporary jetty. Both methods will involve the use of a vessel very similar to that used to install the piles. It is therefore assumed that the potential pathways for the introduction of invasive non-native species during the decommissioning phase will be the same as those identified for construction (see Paragraph 10.6.24).
- 10.6.63 In the view of existing commitments and considerations (as set out in relation to construction which would also apply to decommissioning), the probability of the introduction and spread of non-native species from removal of the piles is considered to be low. Magnitude of change is considered to be negligible, thus the exposure to change is negligible. The sensitivity of all intertidal and subtidal receptors to non-native species introductions is expected to range from low to moderate. Vulnerability is consequently considered to be none. The importance of marine habitats and species affected is considered to be low, therefore the overall impact of the removal of the new temporary jetty on the introduction of non-native species is considered to be **Negligible**.

Fish and shellfish

- 10.6.64 The importance of fish that have been recorded within the vicinity of the Scheme ranges between species. This receptor has therefore been considered to be of high importance on a precautionary basis unless stated otherwise in the assessment. A number of pathways have been scoped out of requiring further assessment. These are summarised in Table 10.10.

Table 10-10 Fish – Scoped out pathways

Pathway	Rationale
Habitat loss during new temporary jetty operation and indirect changes in habitat extent and quality	The footprint of the proposed works will cover a localised area that constitutes a very small fraction of the known ranges of local fish populations. Furthermore, spawning grounds of

	commercially important species such as herring are also considered unlikely to occur in the study area (see Section 10.4). In addition, few shellfish species which are only present at very low levels of abundance have been recorded within the vicinity of the proposed new temporary jetty.
Water quality during new temporary jetty removal	The steel piles supporting the new temporary jetty will be either extracted using vibratory methods or if this cannot be achieved cut 1m below bed level. Only temporary and highly localised increases in suspended sediment concentrations (which are within the range of natural variability) are expected to occur as a result of bed disturbance due to either method. Fish and shellfish are not expected to be sensitive to this level of change. The potential for accidental spillages will also be negligible during this phase of the project through following established industry guidance and protocols (as documented in CoCP (Document Reference 6.10)).
Entrainment during capital and maintenance dredging	Unlike suction dredging in which there is the potential for fish and fish eggs to be entrained by the action of the draghead, fish are considered unlikely to be captured in the backhoe or grab dredger bucket (which is proposed to be used for the capital dredging). Fish species should easily be able to swim away from the direct vicinity of the backhoe or grab dredger and are also likely to avoid dredging areas during operations in response to noise levels and increased turbidity. Injection dredging of the berth pocket will be used if maintenance dredging is required. However, there is as mentioned no risk of entrainment with this technique.
Underwater noise on shellfish (all phases)	Studies have indicated that crustacean species are able to respond to a wide frequency bandwidth, although their sensitivity to underwater sound and vibration is very much lower than fish (Ref 10-76). It is therefore considered unlikely that noise levels would

	adversely affect shellfish species found in the vicinity of the Scheme.
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10.6.65 The proposed marine works have the potential to affect fish and shellfish receptors during construction, operation and removal of the new temporary jetty. The potential impact pathways, associated with each of these project stages are discussed and assessed below. The general scientific context for each impact pathway was established prior to the completion of an assessment of the potential effects of the Scheme on the fish and shellfish within the study area.

Construction of the new temporary jetty and associated works

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Noise disturbance

10.6.66 Elevated underwater noise and vibration levels during marine construction work and dredging can potentially disturb fish by causing physiological damage and/or inducing adverse behavioural reactions. In order to inform the assessment of underwater noise effects on fish, underwater noise modelling a review of scientific evidence has been undertaken which is provided as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)).

10.6.67 To evaluate the potential effects on fish species it is necessary to understand the character of noise propagation underwater and the potential response of fish species to that noise (Ref 10-97; 10-76). The level of sound at any particular point underwater is a function of several factors including: ground geology, ambient background noise, the proximity to anthropogenic noise sources, the level of sound generated by the source (Source Level, SL) and the attenuation of sound as it propagates away from the source. Further information on the principles of underwater noise and the potential responses of fish to underwater noise is provided in detail as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)).

10.6.68 The impact assessment has been split into three sub-sections describing noise impacts associated with new temporary jetty construction, capital dredging and tunnelling works.

New temporary Jetty construction

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10.6.69 The new temporary jetty construction will use 1016mm diameter tubular piles which are 35m in length. The piles will be buried to 25m. Vibro piling will be used for the burial of the first 12.5m and percussive piling will be

used to achieve the final 12.5m depth (Chapter 4 – Scheme Description of the ES (Document Reference 6.1.4)).

- 10.6.70 Percussive piling is known to generate the highest noise Source Levels (SLs) and, therefore, the assessment has focussed on the potential noise effects of this type of piling first as a worst case. The tubular piles are predicted to have an estimated mean unweighted peak-to-peak SL of 232dB re 1µPam (equivalent to a zero-to-peak SL of 226 dB re 1 µPa m). This SL was derived from the model of observed SL versus pile diameter that was developed by the Environment Agency and presented at the Institute of Fisheries Management Conference on the 23 May 2013 (Adrian Fewings, Environment Agency pers. com).
- 10.6.71 The logarithmic noise propagation model was run using the estimated mean unweighted zero-to-peak impact piling SL of 226 dB re 1 µPa m to determine the unweighted received levels with range. These received levels represent unweighted metrics as set out in Ref 10-98. Table 10-11 shows the results of this analysis at various distances from the source of piling. The SL generated by the piles is above the limits presented by Ref 10-99 as having mortality effects and also recoverable injury effects. The distance at which the received level of noise is below these limits is 5m for fish with no swim bladder (e.g. lamprey species) and 12 m for fish with a swim bladder (e.g. Atlantic salmon or herring).
- 10.6.72 The SL generated by the piles is also above the limits presented Ref 10-76 and interim criteria presented by Ref 10-100 as having injury effects in fish. The distance at which the received level of noise is below these limits is 5 m and 13 m respectively.

Table 10-11 Unweighted received levels at various distances from the source of piling

Range (m)	Unweighted Received Levels (dB re 1 μPa m)
1	226
10	208
50	195
100	190
185 (50% width of estuary)	184
370 (full width of estuary)	178

- 10.6.73 The logarithmic noise propagation model was then run to estimate the distance from the source of noise at which different physiological and behavioural dBht response thresholds for high (i.e. allis and twaite shad, herring), medium (i.e. Atlantic salmon, sea trout and bass) and low (i.e. European eel, sea and river lamprey, flounder) hearing sensitive fish species within the inner Thames Estuary are reached. The results of this analysis are shown in Table 10-12 and show that the potential risk of lethal injury only occurs for fish with a high hearing sensitivity at distances of <15 m from the source of piling and for medium sensitive fish at <2 m. There is no risk of lethal injury for fish low hearing sensitivity at any distance from the source of piling.

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Table 10-12 Approximate distances at which physiological and behavioural dB_{ht} response thresholds are reached during impact piling activities

Level in dB _{ht} (Species)	Effect	Fish Hearing Sensitivity		
		High	Medium	Low
Less than 50	Mild reaction by minority of individuals	>5000 m	>3,395 m	>789 m
50 to 75	Mild reaction by majority of individuals	>2,752 m	789-3,395 m	52-789 m
75 to 90	Stronger reaction by majority of individuals	1,164-2,752 m	174-789 m	8-52 m
90 to 130	Strong avoidance reaction by all individuals and increasing risk of physiological injury	15m-1,164 m	2-174 m	<8 m
Above 130	Possibility of traumatic hearing damage from single event	<15 m	<2 m	-

10.6.74 Vibro piling will be used for the first stage of pile burial. This method of piling produces lower source noise levels than percussive piling. Vibro piling techniques will result in an estimated mean unweighted zero-to-peak vibro piling SL of 196 dB re 1 µPa m. There is no risk of lethal or physical injury at any distance from the source of piling using this technique with strong behavioural reactions only predicted within several hundred metres even for hearing sensitive fish.

10.6.75 The effects of piling noise on fish also need to be considered in relation to the duration of exposure. It is proposed that the piling work will take place over approximately eight weeks, with an allowance for adverse weather and tidal conditions. Furthermore, impact piling will not take place continuously. It is currently proposed that any piling activities (vibro or impact) will only take place up to 12 hours per day over a seven day working week (Document Reference 6.10). In this way, the actual proportion of impact piling is estimated to be at worst 50 % (assuming no stoppages) over any given construction week. In other words, any fish occurring in the area at the time of piling will be exposed to a maximum of up to 50 % of a day. Piling will also involve the use of soft start procedures (the gradual increase of piling power, incrementally, until full

operational power is achieved). Soft start piling methods allow fish in the vicinity of the construction work to move away.

- 10.6.76 It is also important to consider that the area in which the construction works will take place already experiences shipping, as well as maintenance dredging. Therefore, fish are likely to be habituated to a certain level of anthropogenic background noise.
- 10.6.77 Furthermore, the construction programme will adhere to piling restrictions which are enforced within the estuary between March and October each year. This will avoid the migratory periods of the majority of fish species of nature conservation interest (i.e. Atlantic salmon, sea lamprey, allis and twaite shad, European eel and European smelt). The sensitivities of these migratory fish to underwater noise is considered to range from low (e.g. for sea lamprey) to medium (e.g. for Atlantic salmon and European eel) to high (allis and twaite shad). On the basis that the construction programme does not overlap with the migratory period for these fish, the exposure to change will be negligible and the features will be not vulnerable during piling activities. Therefore, despite the fact that the overall importance of these migratory fish is considered to be high given their nature conservation interest, the temporary noise effects during the construction of the new temporary jetty on fish and shellfish has been assessed as **Negligible**.
- 10.6.78 River lamprey migrate into fresh water from October to December. The probability of this migratory fish species being exposed to noise during construction is therefore high and the magnitude of change is medium. Consequently exposure to change is medium. The sensitivity of river lamprey is considered to be low and thus its vulnerability to an effect during the piling of the new temporary jetty will be low. The importance of this species is considered to be high due to its nature conservation status. Overall, therefore, noise effects during construction of the new temporary jetty are considered to be likely to have a **minor adverse** effect on river lamprey.
- 10.6.79 Herring is a commercially important species with important spawning grounds known to occur in the outer Thames Estuary. However, only low numbers of herring have been recorded in Environment Agency TraC fish monitoring at Woolwich and Greenwich in recent years and the study area is considered unlikely to support herring spawning ground (See Paragraph 10.4.45). Exposure of herring to change by reason of noise emitted during the construction of the new temporary jetty is therefore considered to be negligible. Therefore, while the sensitivity of herring (including eggs and

larvae) is considered to be high and the importance of the species moderate (due to its commercial importance), marine ecological effects on the species caused by noise during construction of the jetty have been assessed as **Negligible**.

- 10.6.80 In terms of resident fish commonly occurring in the estuary, which have a low importance in terms of nature conservation value, the ecological impact on the resource of construction of the new temporary jetty is considered to be **Negligible**.

Capital dredging

- 10.6.81 A backhoe or grab dredger is proposed to be used to remove the material from the proposed dredge area. Backhoe/grab dredgers have been shown to create low source noise levels in the range of 179 dB re $1\mu\text{Pa}^2\text{m}^2$ (Ref 10-101; Ref 10-102). Impacts on fish are restricted to behavioural changes through avoidance, which are limited to a localised area around the dredger for most species. Injury even at very close range is considered unlikely. As the dredger vessel is moving fish and brown shrimp are not physically constrained, they will be able to move away from the source of the noise and return once dredging activity has ceased.
- 10.6.82 Based on these factors the magnitude of the change due to dredging noise is considered to be negligible. The sensitivity of fish to underwater noise is considered to range from low (e.g. river lamprey) to high (e.g. herring). Taking these factors into account, the overall exposure and vulnerability will be negligible and none respectively. Overall, therefore, the impact of dredging noise is considered to be **Negligible**.

Tunnelling works

- 10.6.83 The proposed tunnelling works have the potential to generate noise and vibration that will impact on fish. The tunnelling will involve the use of boring techniques, which involves no marine works. Predicted noise levels within the hearing frequency range of fish are expected to be in less than 140 dB re $1\mu\text{Pa}$ at the seabed (Chapter 14 – Appendix 14.C - *Vibration, groundborne and underwater sound from the tunnel boring machine* (Document Reference 6.3.14.3). The source levels predicted are above the hearing thresholds of several fish species. However, the levels will be barely audible for fish against existing ambient levels. The levels are also well below the thresholds considered to cause injury with only very localised and mild behavioural responses within a few metres of seabed

directly above the tunnelling works expected to occur for hearing sensitive species.

- 10.6.84 Based on these factors and the relatively low abundances of fish in the area, magnitude of the change due to tunnelling work is considered to be negligible. The sensitivity of fish to underwater noise is considered to range from low (e.g. European eel) to high (e.g. herring). Taking these factors into account, the overall exposure and vulnerability to tunnelling will be negligible and none respectively. Overall, therefore, the effect of tunnelling noise on the marine ecological receptors affected by the Scheme is considered to be **Negligible**.

Water quality

- 10.6.85 There is the potential for impacts on fish and shellfish associated with changes in water quality during construction works. Construction activities (particularly dredging) may increase SSC and release toxic contaminants bound in sediments. This can cause changes in a range of water quality parameters including turbidity and dissolved oxygen level. These changes in turn have the potential to affect the distribution and health of fish and shellfish species (Ref 10-103; Ref 10-104).

Elevated suspended sediments

- 10.6.86 Increased suspended sediments can lead to physiological effects in adult finfish resulting from the abrasion of sediment particles on gill tissues, causing reduced gill function and possible mortality. Such effects on fish are considered to occur at suspended sediment levels of around 10,000 mg/l (Ref 10-103). High SSC levels may impact spawning and nursery grounds through damage to eggs and planktonic larvae, as well as causing abrasion or clogging of the fragile gills of larval and juvenile fish, resulting in mortality or reduced growth rates.
- 10.6.87 Elevated suspended sediments can also influence the movements and migrations of fish. However, fish in high latitude coastal areas typically have to contend with variable turbidity and often poor visual conditions, resulting from fluctuations in ambient light levels, suspended sediments and in the light transmission properties of the water. For example, concentrations as high as 9,000 mg/l, for example, have been recorded in the path of salmon runs in the Usk Estuary (Ref 10-105). Similarly the lamprey and shad species have been known to successfully pass through estuaries with extremely high suspended sediments and, therefore, can be considered tolerant of turbid conditions (Ref 10-106). The mobile

nature of fish species generally allows avoidance of areas of adverse conditions which are unlikely to significantly affect a population provided such conditions are temporary.

- 10.6.88 The dredge pocket consists of scoured gravel, gravelly sand and cobbles in the surface layer with consolidated clay material recorded at depth. The sediment plume from the dredging is expected to cause slightly elevated SSC that will be within the range of natural background variability (see Chapter 16 - Water Quality and Flood Risk (Document Reference 6.1.16)).
- 10.6.89 The temporary and highly localised increases in SSC will be of a magnitude comparable to that which occurs naturally in the Thames Estuary (e.g. during storm events). Thus in physical terms, the plumes resulting from any construction activities (including dredging) are expected to have a minimal and local effect on SSC in the vicinity of the works. Therefore, while the probability of a localised change is high, magnitude of change and consequently exposure to change is assessed as negligible.
- 10.6.90 Fish and shellfish within the Thames Estuary are well adapted to living in an area with variable and typically high suspended sediment loads. Fish feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low. Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the estuary. Commercially exploitable shellfish beds do not overlap with the plumes generated during dredging and are not considered sensitive to the scale of the predicted changes.
- 10.6.91 Sensitivity of fish and shellfish is therefore assessed as low at worst and consequently vulnerability is also assessed as none. Therefore, while the overall importance of certain fish and shellfish species is high (i.e. for fish species of conservation interest such as Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel), the significance of the marine ecological effects of elevated suspended sediments in the river related to the construction of the Scheme on fish and shellfish are considered to be **Negligible**.

Organic enrichment and oxygen depletion

- 10.6.92 The resuspension of sediments containing organic material can cause oxygen depletion within the water column. The subsequent settling of this organic rich sediment can deplete the sediments of oxygen and affect shellfish and benthic prey items used by fish. The response of fish to low

concentrations of dissolved oxygen is determined by a range of factors, including the duration of exposure, water temperature and the presence of other pollutants.

- 10.6.93 Increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen. The probability of a localised effect is therefore medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. Therefore, while the sensitivity of fish and shellfish is low to moderate and certain species have a high nature conservation importance (i.e. Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel) any effects on fish and shellfish as a result of organic enrichment and oxygen depletion attributable to the construction of the Scheme will be **Negligible**.

Release of contaminants

- 10.6.94 The potential release of contaminants during construction and dredging activities may result in them becoming available for uptake by any fish and/or shellfish in the water column or on surface sediments. There is an indirect risk to some finfish species as sediment-bound contaminants may be temporarily bioaccumulated in the tissues of certain fish prey, such as polychaete worms and marine bivalves, and made available for uptake by feeding fish. Demersal fish species, such as dab and flounder, which remain close to the seabed and feed mainly on benthic organisms, would experience a higher exposure to contaminated sediments than pelagic fish such as herring.
- 10.6.95 Chemical sediment analysis has been undertaken from a number of samples within the area proposed for dredging (see Chapter 16 – Surface Water Quality and Flood Risk (Document Reference 6.1.16)). The majority of contaminants in the samples from the study area were found at low concentrations compared to UK guidelines (typically below Cefas Action level (AL) 1 or between AL 1 and AL 2). However, there was one exceedance of AL 2 for cadmium (9.0 mg/kg), lead (549 mg/kg), mercury (7.4 mg/kg) and the sum of 25 polychlorinated biphenyl (PCB) congeners (0.344 mg/kg). These exceedances were approximately two times greater than AL 2 for cadmium, mercury and the sum of 25 PCB congeners with a marginal exceedance for Lead.
- 10.6.96 The release of seabed contaminants during construction and dredging activities will be temporary and localised. Furthermore, the strong tidal flows in the area will rapidly disperse contaminants and therefore

significant elevations in water column contamination is not expected. In addition, the potential for accidental spillages will also be negligible during this phase of the project through following established industry guidance and protocols (see CoCP (Document Reference 6.10). Therefore, the magnitude of change is considered to be small. Given that the probability of occurrence is low the overall exposure is assessed as negligible. Therefore, although the sensitivity of fish and shellfish is considered to be low to moderate and certain species have a high nature conservation importance (i.e. Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel), the significance of the effects of any likely release of contaminants attributable to the construction of the Scheme on fish is considered to be **Negligible**.

Operation of the new temporary jetty

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Noise disturbance

- 10.6.97 During the operational phase of the new temporary jetty there is the potential for noise disturbance to fish species as a result of vessel movements and during any potential localised maintenance dredging that is required in the berth pocket.
- 10.6.98 Information on the principles of underwater noise and the potential responses of fish to underwater dredging noise and shipping is provided in detail as a Technical Note (Appendix 10.C (Document Reference 6.3.10.3).
- 10.6.99 Operational vessels using the new temporary jetty would primarily be barge and dry bulk cargo vessels movements with support from tugs if required. Operational vessel noise is unlikely to be discernible above ambient levels. While maintenance dredging (if required) is likely to produce noise above background conditions, injury even at very close range is considered highly unlikely (Ref 10-99; Ref 10-76; Ref 10-100). Furthermore, strong behavioural reactions are only expected within a few metres of the dredging works (Ref 10-107).
- 10.6.100 Based on these factors and the relatively low abundances of fish and shellfish in the area, magnitude of the change due to vessel movements and dredging noise is considered to be negligible. The sensitivities of fish to underwater is considered to range from low (e.g. river lamprey) to high (e.g. herring). Taking these factors into account, the overall exposure and vulnerability will be negligible and none respectively. Overall, therefore,

the significance of the effects on fish, as a result of noise, during the operation of the new temporary jetty is considered to be **Negligible**.

Water quality

- 10.6.101 There is the potential for impacts on fish and shellfish associated with changes in water quality during new temporary jetty operation. Maintenance dredging and vessel movements may increase SSC and release toxic contaminants bound in sediments. This can cause changes in a range of water quality parameters including turbidity and dissolved oxygen level.
- 10.6.102 Dredging activities and vessel movements have the potential to cause water quality effects either by causing changes to the hydrodynamic and sediment transport regimes or, more broadly, by altering the sediment resource within an estuarine system. Further information on the effects on suspended sediments on fish species has been provided under the respective construction pathway above.
- 10.6.103 The sustained release of sediments and associated organic matter also has the potential to trigger chemically or biologically induced oxygen depletion in the water column. As reviewed in Paragraph 10.6.96 there is also the potential for the release of sediment-bound contaminants where these are present in the materials being disturbed. These changes in turn have the potential to affect the distribution and health of fish and shellfish species (Ref 10-103; Ref 10-104).

Elevated suspended sediment concentrations

- 10.6.104 Vessels movements and potential maintenance dredging in the berth pocket will cause localised and temporary increases in SSC near the bed (leading to a high probability of occurrence). Even when these temporary concentration increases occur, they will be of a similar magnitude to those that occur naturally in the inner Thames Estuary. Thus in physical terms, the plumes resulting from any maintenance dredging of the berth are expected to have a minimal and local effect on SSC in the vicinity of the proposed development. Magnitude of change is therefore assessed as negligible to small, leading to a negligible to low exposure.
- 10.6.105 As noted in the baseline description above, fish and shellfish within the Thames Estuary are well adapted to living in an area with variable and sometimes relatively high suspended sediment loads. Fish feed on a range of food items and, therefore, their sensitivity to a temporary change in the availability of a particular food resource is considered to be low.

Their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the estuary. Commercially exploitable shellfish beds do not overlap with the plumes generated during any maintenance dredging and are not considered sensitive to the scale of these changes. Sensitivity of fish and shellfish is therefore assessed as low at worst and consequently vulnerability is also assessed as none. Therefore, while the overall importance of certain fish and shellfish species is high (i.e. for fish species of conservation interest such as Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel), the significance of effects of the Scheme in relation to elevated suspended sediment concentrations affecting water quality is considered to be **Negligible**.

Organic enrichment and oxygen depletion

- 10.6.106 Increases in SSC will be brief and localised and there is not expected to be a significant reduction in dissolved oxygen. The probability of a localised effect is therefore medium to high but the magnitude of change is considered to be negligible, leading to a negligible exposure to change. Therefore, while the sensitivity of fish and shellfish is low to moderate and certain species have a high nature conservation importance (i.e. for fish species of conservation interest such as Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel) any significance of marine ecological effects of the Scheme will be **Negligible**.

Release of contaminants

- 10.6.107 The release of seabed contaminants during vessels movements and potential maintenance dredging will be temporary and localised. Furthermore, due to the dynamic nature of estuarine environments, in the unlikely event that contaminants should be released such contaminants would be expected to be well mixed/diluted once they enter the water column. In addition, the potential for accidental spillages will also be negligible during this phase of the project through following established industry guidance and protocols (as set out in in the CoCP (Document Reference 6.10)). Therefore, magnitude of change is considered to be small, leading to a low/negligible exposure to change. Therefore, although the sensitivity of fish and shellfish is considered to be low to moderate and certain species have a high nature conservation importance (i.e. for fish species of conservation interest such as Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel), the significance of marine ecological effects related to

water quality attributable to the Scheme works is considered to be **Negligible**.

Light disturbance

- 10.6.108 There is the potential for artificial light from lighting on the new temporary jetty and from operational vessels to modify fish behaviour and potentially disrupt migratory movements.
- 10.6.109 Fish species rely on light for orientation, prey capture and predator avoidance. Generally, most fish have a minimum light threshold level beneath which feeding success and growth are limited (Ref 10-108). The presence of an artificial light source can cause fish to move towards and aggregate around the light source. Functional explanations for such a reaction include predator avoidance and enhancement of feeding efficiency (Ref 10-109). Artificial light can also disrupt migratory movements through delaying and disrupting the dispersal of juveniles (Ref 10-110).
- 10.6.110 The new temporary jetty will be lit for safety and operational purposes. The proposed lighting would have a brightness of no more than 50 lux during loading of barges and ships. Lighting would comprise fixtures on 20 m tall masts on the new temporary jetty bridge and 25 m long masts on the new temporary jetty head. The lighting on the new temporary jetty head would have the lamps facing out to the watercourse, to facilitate unimpeded loading and unloading operations. Cowling and reflectors will be used that avoid excessive light pollution to surrounding areas (see Appendix 4.A – CMS of the ES (Document Reference 6.3.4.1)).
- 10.6.111 The probability of some light disturbance occurring during the operation of the new temporary jetty is considered to be high. For most fish species the lighting will potentially only cause minor changes in behaviour such as increased shoaling in the vicinity of the light source. Such responses could increase the risk of predation but could also have positive effects such as enhancing feeding efficiency. The area of river that will be lit up as a result of the new temporary jetty will only constitute a small fraction of the total width of the river. Therefore, migrating fish will be able to avoid the lighting zone and therefore no disruption or blocking of migratory routes are anticipated. Based on the evidence presented above in the scientific review, sensitivity to lighting disturbance is assessed as low to moderate (with variations depending upon the lighting levels and species affected) and vulnerability is consequently assessed as none. Therefore, while the overall importance of certain fish and shellfish species is high

(i.e. Atlantic salmon, allis and twaite shad, lamprey species, European smelt, short-snouted seahorse and European eel), the significance of lighting effects during construction of the Scheme on marine ecology is considered to be **Negligible**.

Removal of the new temporary jetty and associated works

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Noise disturbance

- 10.6.112 During the removal of the new temporary jetty (which is anticipated to take approximately three months) there is the potential for noise disturbance to fish species as a result of the use of hydraulic vibratory or cutting methods to extract the piles.
- 10.6.113 Information on the principles of underwater noise and the potential responses of fish to underwater noise is provided in detail as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)).
- 10.6.114 The steel piles supporting the new temporary jetty will be either removed using hydraulic vibratory methods or if this cannot be achieved cut 1m below bed level. The type of machinery used for the removal of the piles will be a driver/extractor and underwater source levels are therefore expected to be similar to the vibratory piling methods used during construction (see Appendix 4.A – *CMS* (Document Reference 6.3.10.3)).
- 10.6.115 Based on this assumption there is considered to be no risk of lethal or physical injury at any distance from the source using this technique with strong behavioural reactions only predicted within several hundred metres even for hearing sensitive fish.
- 10.6.116 The decommissioning programme will adhere to the same seasonal restrictions as advised by the PLA for piling (i.e. between March and October) if hydraulic vibratory methods are used (as set out in in the CoCP (Document Reference 6.10)). This will avoid the migratory periods of the majority of fish species of nature conservation interest (i.e. Atlantic salmon, allis and twaite shad, sea lamprey and European eel. The sensitivities of these migratory fish to underwater noise is considered to range from low (e.g. for river lamprey) to medium (e.g. Atlantic salmon and European eel) to high (e.g. allis and twaite shad). On the basis that the decommissioning programme does not overlap with the migratory period for these fish, the exposure to change will be negligible and the features will not be vulnerable during vibro extraction. Therefore, despite

the fact that the overall importance of these migratory fish is considered to be high given their nature conservation interest, the temporary noise significance of effects on these fish caused during jetty removal using vibratory methods has been assessed as **Negligible**.

- 10.6.117 River lamprey migrate into fresh water from October to December. The probability of this migratory fish species being exposed to noise during decommissioning is therefore high and the magnitude of change is medium. Consequently exposure to change is medium. The sensitivity of river lamprey is considered to be low and thus its vulnerability to an effect during vibro extraction will be low. The importance of this species is considered to be high due to its nature conservation value. Overall, therefore, noise during decommissioning of the new temporary jetty is considered to have a **Minor Adverse** significance of effect on river lamprey.
- 10.6.118 In terms of resident fish commonly occurring in the estuary, which have a low importance in terms of nature conservation value, the significance of effects of removing the new temporary jetty is considered to be **Negligible**.
- 10.6.119 Noise levels are anticipated to be low if the steel piles are cut 1m below bed level rather than using hydraulic vibratory methods. Peak source intensities of 148 to 180 dB re 1 μ Pa are reported for a range of underwater tools including cutters, with most energy in the frequency range 200 to 1,000 Hz (Ref 10-111). Based on these source levels, injury even at very close range is considered highly unlikely (Ref 10-99; Ref 10-76; Ref 10-100). Furthermore, strong behavioural reactions are only expected within a few metres of the cutting works (Ref 10-107). On this basis the significance of effects on all fish species of the removal of the new temporary jetty piles using cutting techniques is considered to be **Negligible**.

Marine mammals

- 10.6.120 The importance (or value) of marine mammals has been classified as high, in determining the significance of potential impacts, by reason the high level of marine ecological protection afforded to these species.
- 10.6.121 A number of pathways have been scoped out of requiring further assessment. These are summarised in Table 10.13

Table 10-13 Marine mammals – Scoped out pathways

Pathway	Rationale
Loss of habitat during new temporary jetty operation	Habitat loss and change as a result of the works will only constitute a very small fraction of the known foraging ranges of these highly mobile species.
Collision risk and light/visual disturbance (all phases)	Lighting will be directed away from the river itself where possible, and will be the minimum required for safe operation. In addition there is no evidence to suggest that artificial lighting has any adverse impacts on marine mammals. Vessels involved in all stages will also be mainly stationary or travelling at low speeds making the risk of collision very low. Furthermore, through regular exposure to vessel movements, marine mammals using the Thames area will routinely need to avoid collision and are also expected to be habituated to high levels of disturbance and light stimuli.
Water quality (all phases)	Temporary and localised changes in water quality are considered unlikely to produce lethal and sub-lethal effects in these highly mobile species. The potential for accidental spillages will also be negligible during all phases through following established industry guidance and protocols.
Tunnelling noise	The proposed tunnelling works have the potential for noise and vibration from boring activities to impact upon marine mammals. However, predicted noise levels are expected to be barely audible to marine mammals against existing background conditions (see Appendix 14C - <i>Underwater Noise Assessment</i> (Document Reference 6.3.14.3)).

10.6.122 The proposed marine works have the potential to affect marine mammal receptors during construction, operation and removal of the new temporary jetty. The potential impact pathways, associated with each of these project stages are discussed and assessed below. General scientific context for each impact pathway has been provided prior to

completing an assessment of the potential effects on marine mammals within the study area.

Construction of the new temporary new temporary jetty and associated works

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Noise disturbance

10.6.123 Elevated noise levels and vibration underwater during marine construction work and dredging can potentially disturb marine mammals by causing physiological damage and/or inducing adverse behavioural reactions. An underwater noise assessment of the construction components of the proposed works has been carried out to assess the impacts on common seal, grey seal and harbour porpoise. Other marine mammal species are only rarely recorded in the inner Thames Estuary and have therefore not been included in the assessment (see baseline description above). In order to inform the assessment of underwater noise effects on marine mammals, underwater noise modelling and a review of scientific evidence has been undertaken which is provided as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)). The impact assessment has been split into two sub sections describing noise impacts associated with new temporary jetty construction and capital dredging.

10.6.124 Marine mammals can be vulnerable to noise and visual stimuli which act as a barrier, thereby preventing movement to key foraging or nursery grounds. Piling noise and other activities have been shown to elicit behavioural responses that could lead to displacement in marine mammals (Ref 10-112; Ref 10-113). To evaluate the potential effects of construction activities on feeding seals and harbour porpoise in the study area it is necessary to understand the character of underwater noise propagation and the potential response of marine mammals to that noise. Information on the principles of underwater noise and the potential responses of marine mammals to construction related noise is provided in detail as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)).

New temporary Jetty construction

10.6.125 The new temporary jetty construction will use 1016mm diameter tubular piles which are 35 m in length. The piles will be buried to 25 m. Vibro piling will be used for the burial of the first 12.5 m and percussive piling will be used to achieve the final 12.5 m depth.

- 10.6.126 Percussive piling is known to generate the highest noise SLs and, therefore, the assessment has focussed on the potential noise effects of this type of piling as a worst case. The tubular diameter piles are predicted to have an estimated mean unweighted peak-to-peak SL of 232 dB re 1 μ Pa m (equivalent to a zero-to-peak SL of 226 dB re 1 μ Pa m). This SL was derived from the model of observed SL versus pile diameter that was developed by the Environment Agency and presented at the Institute of Fisheries Management Conference on the 23 May 2013 (Adrian Fewings, Environment Agency pers. comm.).
- 10.6.127 The potential distances at which a significant behavioural response will occur were predicted using the logarithmic noise propagation model and comparing the received sound level with the auditory thresholds of common, grey seal and harbour porpoise. The underwater sound propagation modelling predicts that common seal will exhibit a strong behavioural response at 90dB^{ht} within a maximum range of around 1.9 km from the source of impact piling noise with harbour porpoise and grey seal exhibiting a strong behavioural response within 0.8 km.
- 10.6.128 Comparing the received sound levels derived from the logarithmic noise propagation model with the criteria proposed by Ref 10-114, the occurrence of permanent threshold shift (PTS) and temporary threshold shift (TTS) in seals is predicted to occur within around 3 and 7 metres of impact piling noise respectively. PTS is not predicted to occur in harbour porpoise with TTS predicted to occur within 2 m of impact piling noise. On the rare occasion that harbour porpoise or seals are located in the vicinity of the works, they are likely to be able to swim away and avoid temporary levels of noise that exceed their normal tolerance during construction and return once the disturbance has ceased.
- 10.6.129 Vibro piling will be used for the first stage of pile burial. This method of piling produces lower source noise levels than percussive piling. Vibro piling techniques will result in an estimated mean unweighted zero-to-peak vibro piling SL of 196 dB re 1 μ Pa m. There is no risk of lethal or physical injury at any distance from the source of piling using this technique. Strong behavioural reactions are only predicted within the range of approximately 140 m for common seal and at approximately 30 m for harbour porpoise and grey seal.
- 10.6.130 The effects of piling noise on marine mammals also need to be considered in relation to the duration of exposure. It is proposed that the piling work will take place over approximately eight weeks, with an allowance for adverse weather and tidal conditions. Furthermore, impact

piling will not take place continuously. It is currently proposed that any piling activities (vibro or impact) will only take place up to 12 hours per day over a seven day working week. In this way, the actual proportion of impact piling is estimated to be at worst 50% (assuming no stoppages) over any given construction week. In other words, any marine mammals occurring in the area at the time of piling will be exposed to a maximum of up to 50% of the time.

- 10.6.131 Piling will involve the use of soft start procedures for a minimum of 20 minutes. Should piling cease for a period greater than 10 minutes, then the soft start procedure must be repeated. Soft start piling methods allow marine mammals in the vicinity of the construction work to move away. Furthermore, although harbour porpoise and seal species are recorded relatively frequently in the inner Thames Estuary, they usually only occur in low numbers as described in (see the baseline description above).
- 10.6.132 It is also important to consider that the area in which the construction will take place already experiences shipping traffic and therefore marine mammals are likely to be habituated to a certain level of anthropogenic background noise.
- 10.6.133 Applying the standard impact assessment criteria, the probability of occurrence is high. However, it is important to note that the area is not considered critical habitat for marine mammals and there is no key foraging habitat within the zone of strong behavioural response. Furthermore, this zone is highly localised compared to the full foraging range of these highly mobile receptors. Given these factors and the relatively low densities of marine mammals in the inner Thames Estuary, the magnitude of change is small. Consequently exposure to change is assessed as low.
- [10.6.134](#) The sensitivity of marine mammals is considered to be moderate to the levels of underwater noise that are predicted to be generated by the proposed piling and therefore vulnerability is assessed as low. The importance of marine mammals is considered to be high given the level of protection that they are afforded. Overall, therefore, the temporary noise disturbance caused to marine mammals during construction of the Scheme has been assessed as having a **Minor Adverse** significance of effect.

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During dredging

~~10.6.134~~10.6.135 A backhoe or grab dredger is proposed to be used to remove the material from the proposed dredge area and transferring it into a disposal barge. Backhoe/ grab dredgers have been shown to create low source noise levels in the range of 179 dB re $1\mu\text{Pa}^2\text{m}^2$ (Ref 10-101; Ref 10-102). Impacts on seal species and harbour porpoise are restricted to behavioural changes through avoidance, which are limited to a localised area around the dredger (Ref 10-107). Injury even at very close range is considered unlikely (Ref 10-114). As the dredger vessel is moving marine mammals are not physically constrained, they will be able to move away from the source of the noise and return once dredging activity has ceased.

~~10.6.135~~10.6.136 The probability of a change in underwater noise occurring during construction is considered to be high. However, hearing damage is unlikely to occur at the sound frequencies and intensities associated with capital dredging and the main effect that could be expected in the affected zone would be short-term mild behavioural avoidance. Based on these factors and the relatively low levels of harbour porpoise and seal sightings in the area, magnitude of the change due to dredging noise is considered to be negligible. Sensitivity of harbour porpoise and seals is considered to be moderate to dredging noise generally. Taking these factors into account, the overall exposure and vulnerability of marine mammals will be negligible and none respectively. Overall, therefore, the significance of effect of dredging noise disturbance to marine mammals is considered to be **Negligible**.

Operation of the temporary new temporary jetty

Noise disturbance

~~10.6.136~~10.6.137 During the operational phase of the new temporary jetty there is the potential for noise disturbance to marine mammal species as a result of vessel movements and maintenance dredging of the berth pocket.

~~10.6.137~~10.6.138 Information on the principles of underwater noise and the potential responses of marine mammals to dredging and vessel noise is provided in detail as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)).

~~10.6.138~~10.6.139 Operational vessel noise associated with new temporary jetty activity is unlikely to be discernible above ambient levels in the Thames

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Estuary for marine mammals. While maintenance dredging is likely to produce noise above background conditions, injury even at very close range is considered unlikely (Ref 10-114). Furthermore, behavioural reactions in seals and harbour porpoise are only expected within a localised area in the direct vicinity of the dredging works (Ref 10-107).

~~10.6.139~~10.6.140 Based on these factors and the relatively low levels of harbour porpoise and seal sightings in the area, magnitude of the change due to operational vessel and dredging noise is considered to be negligible. Sensitivity of harbour porpoise and seals is considered to be moderate to underwater noise generally. Taking these factors into account, the overall exposure and vulnerability of marine mammals will be negligible and none respectively. Overall, therefore, the impact of operational noise during construction of the Scheme to marine mammals is considered to be **Negligible**.

Removal of the new temporary jetty and associated works

Noise disturbance

~~10.6.140~~10.6.141 During the decommissioning phase of the new temporary jetty there is the potential for noise disturbance to marine mammal species as a result of the use of hydraulic vibratory methods to extract the piles and vessel movements.

~~10.6.141~~10.6.142 Information on the principles of underwater noise and the potential responses of marine mammals to underwater noise is provided in detail as a Technical Note (Appendix 10.C - *Underwater Noise Assessment* (Document Reference 6.3.10.3)).

~~10.6.142~~10.6.143 The steel piles supporting the new temporary jetty will be either removed using hydraulic vibratory methods or if this cannot be achieved cut 1m below bed level. The type of machinery used for the removal of the piles will be a driver/extractor and so underwater source levels are therefore expected to be similar to the vibratory piling methods used in construction (see Appendix 4.A – *CMS* (Document Reference 6.3.10.3)).

~~10.6.143~~10.6.144 Based on this assumption there is considered to be no risk of lethal or physical injury at any distance from the source using this technique. Strong behavioural reactions are only predicted within the range of approximately 140 m for common seal and at approximately 30 m for harbour porpoise and grey seal.

~~10.6.144~~10.6.145 Given these factors and the relatively low densities of marine mammals in the inner Thames Estuary, the magnitude of change is small. Consequently exposure to change is assessed as low. The sensitivity of marine mammals is considered to be moderate to underwater noise that is predicted to be generated through the removal of the piles. The importance of marine mammals is considered to be high given that the level of protection that they are afforded. Overall, therefore, the significance of the effects of temporary noise disturbance to marine mammals during decommissioning of the new temporary jetty has been assessed as being **Minor Adverse**.

~~10.6.145~~10.6.146 Noise levels are anticipated to be low if the steel piles are cut at bed level rather than using hydraulic vibratory methods. Peak source intensities of 148 to 180 dB re 1µPa are reported for a range of underwater tools including cutters, with most energy in the frequency range 200 to 1,000Hz (Ref 10-111). Based on these source levels, injury even at very close range is considered unlikely (Ref 10-114). Furthermore, behavioural reactions in seals and harbour porpoise are only expected within a localised area in the direct vicinity of the cutting works (Ref 10-107). On this basis the significance of effects on all marine mammal species of the use of cutting techniques to remove the new temporary jetty during the construction of the Scheme is considered to be **Negligible**.

10.7 Cumulative impacts

- 10.7.1 The marine elements of the Scheme will take place alongside other activities and plans or projects (Figure 17.A) (Document Reference 6.2). All activities and plans have the potential to result in impacts on the same ecological receptors as those identified from the marine works in a cumulative and/or in-combination impact.
- 10.7.2 The purpose of the cumulative impact assessment is to take account of the total effects of relevant activities that together with the construction of the Scheme, are likely to have cumulative effects on marine ecological receptors and to assess the significance of those effects. Account has been taken of relevant activities and plans or projects where spatial overlaps of the impacts with the construction of the Scheme are likely to occur (Document Reference 6.1.17). Additionally, consideration has been given to any other activities and plans or projects, including any impacts that do not directly overlap spatially, but may indirectly result in a cumulative/in-combination impact with the construction of the Scheme.

- 10.7.3 Projects identified as of relevance in terms of the assessment of cumulative effects are listed in Table 10-14. The table also identifies the main pathways by which the plans or projects could impact on marine ecology receptors. The cumulative assessment has also included consideration of ongoing activities and the increasing intensity of river usage by in-river services. The cumulative assessment takes into consideration the methodology and timescales of the relevant proposed plans/ projects (where this information is available) alongside those of the marine elements of the Scheme.

Table 10-14 Cumulative impacts

Planning Application Reference	Development Summary	Potential Cumulative Effects
<p>PA/13/02966 (Approved: 24 Dec 2014)</p>	<p>Wood Wharf, Prestons Road: Outline application (all matters reserved) for mixed-use redevelopment of the site known as 'Wood Wharf' comprising of the demolition of existing buildings and structures, including dwellings at Lovegrove Walk and the erection of buildings, including tall buildings and basements comprising of Residential units (C3), a hotel (C1), Business floorspace (B1), Retail (A1-A5), Community and Leisure (D1 and D2), Sui Generis uses including Conference Centres, Theatres, Laundrettes and Data Centres. Associated infrastructure, including the creation of structures in Blackwall Basin, the Graving Dock, and South Dock. Other works incidental to the proposed development include utilities, streets, open spaces, landscaping, bridge links and parking for cars, motorcycles and bicycles</p>	<p>Marine works as part of the proposed basin reclamation including the use of piling and creation of a cofferdam wall have the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.</p>
<p>14/0460/F (Approved: 9 April 2014)</p>	<p>Lovell's, Granite, Badcock and Pipers Wharves, Pelton Road, Greenwich: Revised application for part of Phase 1 and all of Phase 2 (namely blocks 3, 4, 5, 6a, 9, 10 and 11) for a mixed use development comprising 439 residential units (increasing from 282) (Class C3) and changes to non-residential floorspace quantum to provide office use (Class B1), cafe/bar/restaurant (Class A3/A4), ecological centre/community centre (Class D1), medical health centre (Class D1), nursery (Class D1), rowing club (Sui Generis) and health club (Class D2), creation of new areas of open space, play areas, provision of plant and service areas and parking</p>	<p>The scheme includes proposed landscaping works to river wall and foreshore. This has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.</p>

Planning Application Reference	Development Summary	Potential Cumulative Effects
	facilities together with associated works including vehicular access, cycle pedestrian routes, landscaping works to river wall and foreshore.	
11/00856/OUT (Approved: 30 March 2012)	Minoco Wharf, North Woolwich Road: Outline planning application for the comprehensive mixed use redevelopment of the whole site for up to 363,000m ² (GEA) is sought, comprising: Retail (Use Class A1) not exceeding 3,250m ² (GEA); Financial and professional services (Use Class A2) not exceeding 750m ² (GEA); Restaurants and cafes (Use Class A3), Drinking establishments (Use Class A4) and Hot food takeaways (Use Class A5) not exceeding 1,500m ² (GEA); Business (Use Classes B1(a), (b) and (c)) not exceeding 15,000m ² (GEA), of which not more than 5,000m ² (GEA) will be offices (Use Class B1(a)); Residential (Use Class C3) up to 329,900m ² (GEA) and not exceeding 3,385 residential units; Non-residential institutions (Use Class D1) not exceeding 9,600m ² (GEA); Assembly and leisure (Use Class D2) not exceeding 3,000m ² (GEA); together with: Demolition of all existing buildings; Vehicular, cycle and pedestrian access from North Woolwich Road; Public realm, public open space and private amenity space	The proposed scheme includes the construction of a new temporary jetty. This has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.
02/2903/O 2004 Greenwich Masterplan	Land at Greenwich Peninsula Greenwich SE10: Mixed Use including up to 10,010 dwellings, offices, research and development and light industry, retail, food & drink facilities hotel, student accommodation, residential and non-residential	The proposed scheme includes the construction of a riverside pier. This has the potential to impact on marine ecology receptors through a number of

Planning Application Reference	Development Summary	Potential Cumulative Effects
	institutions, education, community facilities, landscaping, open space, transport/highways, parking, riverside pier, walk, cycle ways, helipad, retention of dome for mixed use, and associated works	pathways including noise disturbance, habitat loss and water quality.
14/01605/OUT (Pending Decision)	Silvertown Quays Bounded By Royal Victoria Dock, Connaught Bridge And Mill Road North Woolwich Road: Outline planning application with all matters reserved except for Access for the redevelopment of the site for mixed use purposes, including the alteration, partial demolition and conversion of the Millennium Mills and the construction of buildings across the site to include Brand buildings (Sui Generis), Residential (Use Class C3), Office (Use Class B1), Retail (Use Classes A1-A5), Leisure (Use Class D2), Education (Use Class D1), Hotels (Use Class C1), other Non-Residential floor space such as community use (Use Class D1), provision of public open space, works of repair and restoration of the Dock walls, infilling and excavation of parts of the Dock area, the placing of structures in, on, or over the Dock area, utilities, construction of estate roads and the creation of new accesses to the public highway, works of landscaping and making good, creation of surface and sub-surface car parking areas	The scheme includes infilling of part of the existing dock and repair of the dock walls. These works have the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.
13/1773/F (Approved:16 October 2013)	Charlton Barge Yard: Redevelopment of the site in 2 phases. Phase 1: Demolition of the new temporary jetty and associated infrastructure, office and mess building, provision of new jetty and associated infrastructure, office and welfare accommodation, car park, barge washdown area, replacement	The works associated with the demolition of the existing jetty and provision of new jetty has the potential to impact on marine ecology receptors

Planning Application Reference	Development Summary	Potential Cumulative Effects
	river wall and ancillary development. Phase 2: Demolition of dry dock, fabrication building and workshop, provision of new barge, fabrication and tug boat buildings and replacement river wall and ancillary development.	through a number of pathways including noise disturbance, habitat loss and water quality.
15/0973/F Approved 23 December 2015	Land at Enderby Wharf (Former Alcatel Site) Christchurch Way: Revised application only for the northern element of the Enderby Wharf Development comprising the erection of a cruise liner terminal building, skills academy (Use Class D1), 477 residential units (increasing from 93) (Use Class C3), retail, restaurants and cafes and drinking establishments (Use Classes A1, A3 and A4), vehicular access with associated servicing facilities, car parking, landscaping, public realm (including improvements to the Thames Path), play spaces, infrastructure and associated parking.	The proposed scheme includes the construction of a jetty (to provide docking for cruise liners and the Thames Clipper), improvements to the river wall and dredging works. This has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.
PA/14/03594: Pending decision	Hercules Wharf Castle Wharf And Union Wharf, Orchard Place: Demolition of existing buildings at Hercules Wharf, Union Wharf and Castle Wharf and erection of 16 blocks (A-M) ranging in height from three-storeys up to 30 storeys (100m) (plus basement) providing 834 residential units; Retail / Employment Space (Class A1-A4); Management offices (B1), education space (D1); car parking spaces, bicycle parking spaces, hard and soft landscapes and the repair and replacement of the river wall	The scheme includes replacement and repair of the river wall. This has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.

Planning Application Reference	Development Summary	Potential Cumulative Effects
<p>15/0716/O (Approved: September 2015)</p>	<p>Land at Greenwich Peninsula to the south of the O₂, SE10: Planning permission with all matters reserved for the demolition of buildings and mixed use redevelopment comprising Class C3 (dwellings) use up to 12,678 residential dwellings (or up to 1,171,909sqm) and up to 220 serviced apartments (or up to 20,306sqm); Class A1-A5 use (food and non-food retail, restaurants, bars and cafes) up to 23,475sqm; Class B1(a)(b)(c) (business) up to 59,744sqm; Class C1 (hotel) up to 35,999sqm for up to 500 rooms; Class D1 (education facilities) up to 37,900sqm; Class D1 (health care facilities) up to 1,462sqm; Class D1/D2 (visitor attraction) up to 19,526sqm; sui generis use for Film and media studios up to 38,693sqm; residential and non-residential car parking as well as up to 2000 AEG parking spaces (for the O₂); cycle parking; associated community facilities; public realm and open space; hard and soft landscaping; a new transport hub and associated facilities; works to the river wall; a ferry jetty terminal; a 5km running track traversing the entire site (P5K running track); highway and transport works, including amendments to the Thames Footpath and Cyclepath; and, associated ancillary works.</p>	<p>The proposal includes improvements to the river wall and a ferry jetty terminal. These works have the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.</p>
<p>http://infrastructure.planninginspectorate.gov.uk/document/2705633</p>	<p>Thames Tideway Tunnel: The Thames Tideway Tunnel is a proposed tunnel running mostly under the River Thames through central London, intended to provide storage and conveyance of combined raw sewage and rainwater</p>	<p>Starting in 2016, construction of the project would last for approximately seven years. Construction materials would be transported by river. Barges would be hauled to and from project</p>

Planning Application Reference	Development Summary	Potential Cumulative Effects
	<p>discharges that currently overflow into the river.</p> <p>The proposed scheme involves construction of a tunnel running from Acton in the west of London through to Abbey Mills in the east, controlling 34 of the most polluting combined sewers overflows via transfer tunnels along the way or system modifications. The captured sewage would then be transferred to Beckton Sewage Treatment Works (currently being upgraded to increase capacity) via the Lee Tunnel (already under construction) for treatment before being released. The main tunnel will be approximately 25 km (16 mi) long and have an internal diameter of 7.2 m (24 ft). It will run through the centre of London, at a depth of 30 m (98 ft) in the west through to 70 m (230 ft) in the east.</p> <p>Starting in 2016, construction of the project would last for approximately seven years. Certain construction materials would be transported by river at 11 of the 24 sites and the remaining materials, and all materials at other sites, would be transported by road. Its current planned target completion date is 2023.</p> <p>Barges would be hauled to and from project sites by tugs towing one or two barges at a time. The number of barges towed would depend on barge size, tidal and mooring conditions at each site. The maximum barge requirement across the project would be nine barge deliveries and collections per day, which equates to approximately eight river</p>	<p>sites by tugs towing one or two barges at a time. The number of barges towed would depend on barge size, tidal and mooring conditions at each site. The project has the potential to cause noise disturbance to fish and marine mammals through vessel movement and tunnelling noise.</p>

Planning Application Reference	Development Summary	Potential Cumulative Effects
	<p>transit movements in each direction.</p> <p>The total number of project barge movements at a given point on the River Thames would be greater further downstream.</p> <p>The Thames Tideway Tunnel Transport assessment concludes that there would be a negligible impact on river users upstream of Carnwath Road Riverside, a minor impact between Carnwath Road Riverside and Kirtling Street and a moderate impact downstream of Kirtling Street.</p>	
Unknown	<p>Orchard Wharf: There is a proposed development for a river served aggregates facility, concrete batching plant and cement terminal at Orchard Wharf, which is a Safeguarded Wharf on the River Thames. Access to the safeguarded wharf will be from Orchard Place with road access on to the strategic network via the A1020 link to the A13.</p> <p>The proposals include provision of a new jetty and mooring dolphins extending into the River Thames for river-borne delivery of aggregates and cement, storage bays for aggregates and cement silos.</p> <p>The facility will receive aggregates and cement by river to be used in the on-site concrete batching plant or transferred to other construction projects and concrete batching plants in the London and Thames Gateway areas.</p> <p>The proposed development allows for the importation of ca.</p>	<p>The proposal includes the construction of a new jetty and mooring dolphins extending into the River Thames for river-borne delivery of aggregates. This has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.</p>

Planning Application Reference	Development Summary	Potential Cumulative Effects
	350,000 tonnes of processed aggregate per year by river, of which ca. 200,000 will be used in the on-site concrete batching plant. Barges will deliver to the wharf approximately every 3-4 days.	
07/01561/LTGDC/LBN M	Vanesta wharf: Planning permission was issued in 2012 for the construction of a riverboat pier and riverside walkway at Vanesta wharf to be known as Silvertown Pier.	The proposal includes the construction of a pier. This has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance, habitat loss and water quality.
N/A	In- river services: Vessels such as ferries, charter services and tours could increase as a result of increased demand and improved riverside access.	Increased river usage by vessels has the potential to impact on marine ecology receptors through a number of pathways including noise disturbance and water quality.

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- 10.7.4 Consideration of the potential impacts of the projects highlighted in Table 10-14 for each of the marine ecology receptors considered within this chapter is provided in more detail below.

Benthic habitats and species

- 10.7.5 The proposed projects all involve relatively small scale development such as jetty or pier construction, river wall improvements and localised dredging works. These projects are only expected to result in highly localised habitat loss and temporary changes to water quality. The spatial extent of these impacts would be expected to be restricted to within the immediate vicinity of the developments. In addition, habitats in the area are already generally modified through regular physical disturbance and are typically of low conservation value. Therefore, only negligible cumulative and/or in-combination impacts on benthic habitats and species are expected. It is assumed that all schemes will be subject to controls by the statutory bodies to avoid the potential for any adverse cumulative effects on benthic habitats and species.

Fish and shellfish

- 10.7.6 Several of the proposed projects are likely to use piling techniques in construction (e.g. for jetties and piers) which have the potential to cause physiological damage and/or induce adverse behavioural reactions in fish. However, these developments are likely to require the same mitigation as needed for the Silvertown Tunnel piling works (i.e. soft start procedures and timing restrictions to avoid sensitive marine features). Impacts from other noise sources as a result of the proposed developments (such as vessel movements and dredging) will be restricted to behavioural responses within a localised area. In addition, fish are likely to be habituated to these noise sources through regular exposure to high levels of existing background noise. Based on these assumptions, cumulative and/or in-combination impacts associated with noise are considered to be negligible. It is assumed that all schemes will be subject to controls by the statutory bodies to avoid the potential for any adverse cumulative effects on fish.
- 10.7.7 Cumulative and/or in-combination impacts from habitat loss, water quality and lighting impacts are also considered to be negligible given the expected localised spatial extent of the effects and mobile nature of the receptors.

Marine mammals

- 10.7.8 Several of the proposed projects are likely to use piling techniques in construction (e.g. for jetties and piers) which have the potential to cause physiological damage and/or induce adverse behavioural reactions in marine mammals. However, all the proposed developments are likely to require the use soft start procedures during piling. Furthermore, the area is not considered critical habitat for marine mammals. Impacts from other noise sources as a result of the proposed developments (such as vessel movements and dredging) will be restricted to behavioural responses within a localised area. In addition, marine mammals are likely to be habituated to these noise sources through regular exposure to high levels of existing background noise. Based on these assumptions, cumulative and/or in-combination impacts associated with noise are considered to be negligible. It is assumed that all schemes will be subject to controls by the statutory bodies to avoid the potential for any adverse cumulative effects on marine mammals.
- 10.7.9 Cumulative and/or in-combination impacts from habitat loss, water quality and collision risk are also considered to be negligible given the expected localised spatial extent of the effects and mobile nature of the receptor.

10.8 NPS and MPS Compliance

- 10.8.1 The Government's biodiversity strategy is set out in Biodiversity 2020: A Strategy for England's wildlife and ecosystem services. The National Policy Statement for National Networks (NN NPS) general policy is that 'development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives'. In addition it states that EIA applications 'should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests including through mitigation and consideration of reasonable alternatives'.
- 10.8.2 In accordance with Paragraph 5.22 this chapter of the ES has clearly set out any likely significant effects on internationally, nationally and locally designated sites of ecological or geological conservation importance on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity and that the statement considers the full range of potential impacts on ecosystems.
- 10.8.3 Mitigation and best practice measures have been included within the assessment to minimise the significance of potential effects on marine

ecological receptors (see Section 10.5 of this chapter). This is in accordance with Paragraphs 5.25 and 5.36 of the NN NPS.

10.8.4 The UK Marine Policy Statement's (MPS) high level marine objectives include:

- achieving a sustainable marine economy;
- ensuring a strong, healthy and just society;
- living within environmental limits;
- promoting good governance; and
- using sound science responsibly.

10.8.5 The assessment undertaken within this chapter takes into consideration all of the high level marine objectives stated in the UK MPS. The use of the River Thames to remove excavated material from the tunnelling (as opposed to by land transport) offers a more sustainable solution to this process. The scale of the marine works has been minimised where possible and all assessment work has been completed on the basis of the best available evidence. On analysis all likely significant effects are assessed to be minor adverse at worst taking account of the implementation of appropriate mitigation measures where required (see Table 10-15).

10.8.6 The proposed development falls within the South East Inshore marine plan area. A marine plan has not yet been produced for this area and the timescales for this have not been finalised. A consultation draft of the plan may be published in the examination period and this chapter will be re-considered if necessary in the light of its contents.

10.9 Summary

10.9.1 The principal marine ecology impacts of the Scheme are limited to the period of its construction and include the recommissioning of the existing NAABSA berth facility at the Thames Wharf, or the construction, operation, and decommissioning of a new temporary jetty, along with an associated dredge and the disposal of the dredge arisings. Other impacts relate to the moving of two existing moorings, increased vessel movements during the construction of the tunnel and the possible vibration effects arising from the tunnelling itself.

- 10.9.2 These construction activities of the Scheme have the potential to generate impacts on:
- nature conservation protected areas and species;
 - marine ecology- benthic habitat and species (including invasive non-native species);
 - fish and shellfish; and
 - marine mammals.
- 10.9.3 These include ecological receptors that are considered to be of high value and importance.
- 10.9.4 Impacts on marine ecology receptors could arise through a number of key pathways, including:
- changes in water quality (benthic habitats and species; fish and shellfish);
 - indirect changes in habitat extent and quality (benthic habitats and species);
 - the introduction of non-native species (benthic habitats and species);
 - loss and/or damage to benthic habitats and species (benthic habitats and species);
 - colonisation of new surfaces by invasive non-native species (benthic habitats and species); and
 - noise disturbance (fish and shellfish; marine mammals).
- 10.9.5 The significance of any one of these pathways is considered to be minor adverse at worst taking account of the implementation of the proposed appropriate mitigation measures (see Section 10.5 of this chapter).
- 10.9.6 The projects that have been considered within the cumulative assessment all involve relatively small scale development such as jetty or pier construction, river wall improvements and localised dredging works. These projects are only expected to result in highly localised changes and as such only negligible cumulative and/or in-combination impacts are expected. It is assumed that all schemes will be subject to controls by the statutory bodies to avoid the potential for any adverse cumulative effects.

Table 10-15 Summary

Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
Marine ecology-benthic habitat and species (including invasive non-native species).	<ul style="list-style-type: none"> • Intertidal mudflat and sandflat; • Subtidal mixed sediment ; and • Supported invertebrate assemblages. <p>The presence of non-native species has also been recorded in</p>	No marine species or habitats which are considered nationally scarce or rare recorded in study area and therefore assumed to be low.	Construction.	Water Quality.	<ul style="list-style-type: none"> • Waste disposal strategy <u>SWMP</u>. • CEMP. 	Negligible.	Moderate: The assessment is based on the analysis of sediment samples from the field and detailed modelling. The potential impacts of water quality on benthic receptors are well understood, through a large amount of scientific evidence on this subject.

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
	the vicinity of the Scheme.			Indirect changes in habitat extent and quality.	<ul style="list-style-type: none"> • Waste disposal strategy <u>SWMP</u>. • CEMP. 	Negligible.	Moderate: There is a degree of uncertainty associated with any modelling predictions relating to changes in hydrodynamics and sediment regime.
				Introduction of non-native species.	Non-native species risk assessment.	Negligible.	Moderate: Scientific understanding of the introduction of non-native species is generally good although some uncertainty

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							still surrounds the level of risk associated with the introduction of species.
			Operational	Direct loss of benthic habitats and species.	No mitigation or monitoring required.	Negligible.	High: Baseline conditions and potential impacts on benthic receptors are well understood.
				Changes in habitat quality.	<ul style="list-style-type: none"> CEMP. 	Negligible.	Moderate: The potential impact to benthic habitats from dredging is well documented through a large number

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							of scientific studies on this subject. However there is a degree of uncertainty associated with any modelling predictions relating to scour.
				Water quality.	<ul style="list-style-type: none"> • Waste disposal strategy <u>SWMP</u>. • CEMP. 	Negligible.	<ul style="list-style-type: none"> • Moderate: The assessment is based on the analysis of sediment samples from the field and

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							detailed modelling. The potential impacts of water quality on benthic receptors are well understood, through a large amount of scientific evidence on this subject.
				Introduction of non-native species.	Non-native species risk assessment.	Negligible.	<ul style="list-style-type: none"> Moderate: Scientific understanding of the introduction of non-native species is

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							generally good although some uncertainty still surrounds the level of risk associated with the introduction of species.
				Colonisation of new surfaces by invasive non-native species.	Non-native species risk assessment.	Negligible.	<ul style="list-style-type: none"> Moderate: Scientific understanding of the introduction of non-native species is generally good although some

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							uncertainty still surrounds the level of risk associated with the introduction of species.
			Decommissioning.	Introduction of non-native species via decommissioning vessels.	Non-native species risk assessment.	Negligible.	<ul style="list-style-type: none"> Moderate: Scientific understanding of the introduction of non-native species is generally good although some uncertainty still surrounds the level

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							of risk associated with the introduction of species.
Fish and shellfish.	Range of fish species. Including a number of commercially important and environmentally protected species.	Varying importance depending on species, therefore assumed to be of international importance on a precautionary basis.	Construction.	Noise disturbance.	<ul style="list-style-type: none"> Soft start procedures. Timing restrictions to avoid sensitive marine features. 	Negligible to minor.	<ul style="list-style-type: none"> Moderate: The underwater noise model is based on theoretical parameters and there is limited empirical evidence of the behavioural effects of noise on fish.
				Water quality.	<ul style="list-style-type: none"> Waste disposal 	Negligible.	<ul style="list-style-type: none"> Moderate: The

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
					<p>strategy SWMP.</p> <ul style="list-style-type: none"> • CEMP. 		<p>assessment is based on the analysis of sediment samples from the field and detailed modelling. The potential impacts of water quality on fish and shellfish receptors are well understood, through a large amount of scientific evidence</p>

Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							on this subject.
			Operational.	Noise disturbance.	Specific mitigation measures are considered unlikely to be required.	Negligible.	4. Moderate: The underwater noise model is based on theoretical parameters and there is limited empirical evidence of the behavioural effects of noise on fish.
				Water quality.	<ul style="list-style-type: none"> Waste disposal strategy SWMP. CEMP. 	Negligible .	<ul style="list-style-type: none"> Moderate: The assessment is based on the

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							analysis of sediment samples from the field. The potential impacts of water quality on fish and shellfish receptors are well understood, through a large amount of scientific evidence on this subject.
				Lighting.	<ul style="list-style-type: none"> The use of cowling and 	Negligible.	<ul style="list-style-type: none"> Moderate: The potential impacts of

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
					reflectors Lighting management plan.		lighting on fish receptors are well understood, through a reasonable amount of scientific evidence on this subject.
			Decommissioning.	Noise disturbance.	5. Soft start procedures Timing restrictions to avoid sensitive marine features.	Negligible to minor.	<ul style="list-style-type: none"> Moderate: The underwater noise model is based on theoretical parameters and there is limited empirical

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							evidence of the behavioural effects of noise on fish.
Marine mammals.	The three most commonly occurring marine mammal species in the Thames Estuary include: <ul style="list-style-type: none"> • Common seal; • Grey seal; and • Harbour porpoise 	International importance.	Construction.	Noise disturbance.	6. Soft start procedures.	Minor.	<ul style="list-style-type: none"> • Moderate: The underwater noise model is based on theoretical parameters and there is limited empirical evidence of the behavioural effects of noise on marine mammals.
			Operational.	Noise	No	Negligible.	<ul style="list-style-type: none"> • Moderate:

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
				disturbance.	mitigation or monitoring required.		The underwater noise model is based on theoretical parameters and there is limited empirical evidence of the behavioural effects of noise on marine mammals.
			Decommissioning.	Noise disturbance.	Soft start procedures.	Negligible to Minor.	<ul style="list-style-type: none"> Moderate: The underwater noise model is based on theoretical parameter

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Receptor	Key Receptors	Value	Stage	Impact pathways	Mitigation Required	Residual Impact Significance	Confidence
							s and there is limited empirical evidence of the behavioural effects of noise on marine mammals.

10.10 References

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