



Environmental Statement Chapter 24. Interrelationships



Contents

24.	Interrelationships.....	1
24.1	Introduction	1
24.2	Methodology	1
Table 24.1	Screening of potential interrelations.....	2
24.3	Interrelationships review	3
24.3.1	Overview	3
Table 24.2	Coastal processes, sediment transport and contamination	3
Table 24.3	Marine water quality	9
Table 24.4	Intertidal and subtidal benthic ecology	11
Table 24.5	Fish, including commercial and recreational fisheries	14
Table 24.6	Marine mammals and turtles	16
Table 24.7	Coastal birds.....	17
Table 24.8	Terrestrial ecology	18
Table 24.9	Seascape and landscape visual impact assessment.....	20
Table 24.10	Navigation and marine transport.....	22
Table 24.11	Onshore transport	23
Table 24.12	Air quality	25
Table 24.13	Hydrology and flood risk.....	26
Table 24.14	Land quality and hydrogeology.....	27
Table 24.15	Noise and vibration.....	28
Table 24.16	Cultural heritage: marine archaeology	29
Table 24.17	Cultural heritage: terrestrial archaeology.....	30
24.3.2	Cumulative Interrelationships	31



24. Interrelationships

24.1 Introduction

24.1.0.1 This Chapter provides an overview of the interrelationships assessed for the Project. Paragraph 19 of Part 1 in Schedule 4 to the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 requires that the Environmental Statement contains:

*“A description of the aspects of the environment likely to be significantly affected by the development, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape **and the inter-relationship** between the above factors”.*

24.1.0.2 The Planning Inspectorate Advice Note 9 Rochdale Envelope (2012) states that:

“Inter-relationships consider impacts of the proposals on the same receptor. These occur where a number of separate impacts, e.g. noise and air quality, affect a single receptor such as fauna.”

24.1.0.3 Advice Note 9 emphasises the need for a promoter to explain how interrelationships have been assessed in order to address the environmental impacts of the proposal as a whole. It states:

“It need not necessarily follow that the maximum adverse impact in terms of any one topic impact would automatically result in the maximum potential impact when a number of topic impacts are considered collectively. In addition, individual impacts may not be significant but could become significant when their interrelationship is assessed.”

24.1.0.4 As described in Chapter 2: EIA Process and Assessment of Significance, the “Rochdale Envelope” refers to the assessment of the realistic worst case scenario or option for each individual impact of a Project, so that it can be concluded that lesser options will have less impact.

24.1.0.5 As outlined in Chapter 2, interrelationships have been identified and assessed in detail within each technical chapter (Chapters 6 – 22). This Chapter provides an overview of the interrelationships and a guide indicating where in each technical chapter (Chapter 6 – 22) the interrelationships are discussed.

24.2 Methodology

24.2.0.1 Interrelationships are described taking into account all of the effects that have been identified upon specific receptors. A screening process was initially undertaken to ensure that all potential interrelationships have been identified across the EIA process. This involved examining potential effects identified for individual receptors in each environmental topic and considering them in relation to potential effects from any other environmental topic. Table 24.1 presents the outcome of this screening process. Both adverse and beneficial effects have been examined. Following this exercise, each of these interrelationships is explored further and an assessment of significance presented, in order to determine the requirement for mitigation. For the purposes of this assessment, impacts of ‘major’ or ‘moderate’ significance are considered ‘significant’ under the EIA and are presented in the following Tables 24.2 – 24.17. Section 24.3.1 examines cumulative interrelationships for the environmental topics.



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Table 24.1 Screening of potential interrelations

	Economy, Tourism and Recreation	Cultural Heritage: Terrestrial Archaeology	Cultural Heritage: Marine Archaeology	Noise and Vibration	Land Quality and Hydrogeology	Hydrology and Flood Risk	Air Quality	Onshore Transport Assessment	Navigation and Marine Transport Assessment	Seascape and Landscape Visual Impact Assessment	Terrestrial Ecology	Coastal Birds	Marine Mammals and Turtles	Fish including Recreational and Commercial Fisheries	Intertidal and Subtidal Benthic Ecology	Marine Water Quality Assessment	Coastal Processes, Sediment Transport and Contamination	
Coastal Processes, Sediment Transport and Contamination	X		X		X	X			X	X	X	X	X	X	X	X		
Marine Water Quality Assessment					X				X			X	X	X	X			
Intertidal and Subtidal Benthic Ecology				X	X				X	X		X	X	X				
Fish including Recreational and Commercial Fisheries				X					X									
Marine Mammals and Turtles				X					X	X	X							
Coastal Birds	X			X						X	X							
Terrestrial Ecology	X			X	X	X	X	X	X	X								
Seascape and Landscape Visual Impact Assessment		X						X	X									
Navigation and Marine Transport				X			X											
Onshore Transport	X			X	X	X	X											
Air Quality	X				X	X												
Hydrology and Flood Risk	X				X													
Land Quality and Hydrogeology																		
Noise and Vibration																		
Cultural Heritage: Marine Archaeology		X																
Cultural Heritage: Terrestrial Archaeology																		
Economy, Tourism and Recreation																		

24.3 Interrelationships review

24.3.1 Overview

24.3.1.1 This section briefly provides an overview of the interrelationships identified for individual receptors in Table 24.1.

Table 24.2 Coastal processes, sediment transport and contamination

Environmental Topic: Coastal Processes, Sediment Transport and Contamination	Interrelationship, assessment of significance and mitigation
Marine water quality	Interrelationship • Dredging and construction activities resulting in dispersion of sediment plumes – presence of contaminated sediments and reduction in light penetration thereby affecting bacterial decay rates and water quality within the Bay. • Changes in hydrodynamic processes (water levels, flow speeds and directions, waves) affecting waste water and storm discharges and thus water quality in terms of the Water Framework Directive (WFD) embracing the Shellfish Waters Directive, Bathing Waters Directive and Shellfish hygiene assessment under EC Regulation No. 854/2004. Assessment of significance: No significant adverse effects are predicted with respect to release of contaminants associated with the dispersion of suspended sediments. The effects of increased turbidity on bacteria decay during Lagoon construction would not be expected significantly to affect bathing water class at Swansea Bay, Aberafan or along the Gower coast. Similarly, the effects on shellfish water quality would also be small and would not be expected to affect present shellfish quality or category. Changes in hydrodynamic processes would result in a small general improvement in microbiological water quality within Swansea Bay. No significant adverse effects on water quality or WFD status within the wider Bay. Within the Lagoon, water quality may need assessment on occasion to ensure that it is sufficient for water contact sports due to intermittent storm discharges. Mitigation: Optimisation comprising storm water UV disinfection or extension of the Swansea long sea outfall is proposed to improve water quality within the Lagoon to allow continual use for water contact sports. Given the potential positive effects of the Project on microbiological water quality within Swansea Bay, the optimisation options offer no significant additional benefit, other than within the Lagoon. A water quality strategy would be developed within the Operational Environmental Management Plan to provide guidance on water quality to users of the Lagoon (see Chapter 7 for details).
Intertidal and subtidal benthic ecology	Interrelationship • Dredging and construction activities resulting in dispersion of sediment plumes – presence of contaminated sediments. • Changes in habitat suitability and extent and thus ecological species composition arising from changes in deposition/erosion of sediments, hydrodynamic changes (water levels, flow speeds and directions, waves) and water quality.



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Environmental Topic: Coastal Processes, Sediment Transport and Contamination	Interrelationship, assessment of significance and mitigation
	Assessment of significance: No significant adverse effects with respect to release of contaminants associated with the dispersion of suspended sediments. Moderate adverse effects prior to mitigation as a result of re-deposition of sediments on intertidal ecology (protected features) during construction. Changes in habitat suitability and extent during operation result in significant adverse effects (major adverse) prior to mitigation for subtidal and intertidal protected habitats. Mitigation: Translocation of Sabellaria reef prior to construction. In-built offsetting measures: artificial reef incorporating concepts such as bioblocks and rockpools (Lagoon seawalls) creating ecologically biodiverse new intertidal and subtidal habitat. The potential residual effect of re-deposition of sediments on intertidal ecology (protected features) during construction is minor adverse. The potential residual effect post mitigation for changes in habitat extent for subtidal and intertidal protected habitats is minor to moderate adverse and for changes in habitat suitability, moderate adverse during operation. Monitoring programmes have been developed to examine the effects on protected features (see Chapter 8 and Appendix 23.1, Volume 3 for details).
Fish, including Recreational and Commercial Fisheries	Interrelationship • Dredging and construction activities resulting in dispersion of sediment plumes – presence of contaminated sediments. • Changes in habitats (including habitat fragmentation and isolation) and thus ecological species composition arising from changes in deposition/erosion of sediments, hydrodynamic changes (water levels, flow speeds and directions, waves), water quality. Potentially affecting fish populations and opportunities for recreational and commercial fishing. • Changes in hydrodynamic processes (e.g. resultant effects on olfactory trails, flows, turbulence, salinity, suspended solids) potentially affecting commercial and recreational sea and migratory fish populations and anadromous fish returns and rod-catch. • Changes in hydrodynamic processes and interaction with turbines. • Changes in hydrodynamic processes (water levels, deposition/erosion of sediments, flow speeds and directions, and waves) affecting commercial and recreational fishing vessels. Assessment of significance: No significant adverse effects resulting from sediment plumes or changes in hydrodynamic processes affecting commercial and recreational sea and migratory fish populations and anadromous fish returns and rod catch. Potential significant adverse effects on sea trout (adult) (moderate), other demersal and pelagic species (insignificant to moderate), herring (moderate) as a result of the possible interaction with operational turbines. Potential significant adverse effects (moderate) relating to loss of spawning and/or foraging grounds for some species, but where a significant adverse effect is identified, significant beneficial effects relating to gain in spawning and/or foraging habitats are also identified during the operational phase. Potential moderate adverse effect on herring in relation to noise and vibration during construction. In relation to navigation, significant adverse effects have been identified for potential vessel to structure collision risk during construction (major to moderate) and operation (moderate).



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Environmental Topic: Coastal Processes, Sediment Transport and Contamination	Interrelationship, assessment of significance and mitigation
	Mitigation: Artificial reef (Lagoon seawalls) resulting in increased ecological biodiversity and thus fish populations with resultant opportunities for commercial and recreational fisheries. Lobster hatchery and placement of lobsters on lagoon seawall; 10 year programme to encourage the recolonisation of the native oyster to the Bay. Appropriate acoustic deterrents will be deployed for the Project to mitigate for potential effects relating to operation of the turbines on fish and marine mammals. Soft start procedures for impact piling activities to mitigate potential noise and vibration effects. Construction of permanent dolphin piles and floating boom for temporary cofferdam and operational turbine house outside lagoon, and floating boom around turbine house inside the lagoon. Additional mitigation for navigation includes Aids to Navigation, safety zones around construction, promulgation of information. Residual effects post mitigation for potential effects resulting from operation of the turbines are minor adverse for all species except for herring (moderate) and other demersal and pelagic species (insignificant to moderate). Residual effects from habitat modification in terms of foraging and/or spawning grounds are both minor adverse and moderate beneficial for all species affected. Residual moderate to minor adverse effect during operation for vessel to structure collision risk. Monitoring programmes have been developed to further examine potential effects e.g. changes in ecological biodiversity, interaction with turbines, habitat modification, mariculture mitigation and enhancements (see Chapters 8 and 9, and Appendix 23.1, Volume 3 for details).
Marine mammals and turtles	Interrelationship • Dredging and construction activities resulting in dispersion of sediment plumes – presence of contaminated sediments. • Changes in habitats and thus ecological species composition arising from changes in deposition/erosion of sediments, hydrodynamic changes (water levels, flow speeds and directions, waves), water quality and thus potential effects on prey species. • Changes in hydrodynamic processes and interaction with turbines. Assessment of significance: No significant adverse effects with respect to release of contaminants associated with the dispersion of suspended sediments, habitat loss or change. Moderate adverse effect prior to mitigation from potential risk of collision with turbines. Mitigation: Artificial reef (Lagoon seawalls) and concepts such as bioreefs resulting in increased ecological biodiversity and fish populations thus providing foraging opportunities. Appropriate acoustic deterrents will be investigated for the Project to mitigate for potential effects relating to operation of the turbines on fish and marine mammals. Residual effects post mitigation for potential collision risk with turbines reduced to insignificant to minor. Monitoring programmes have been developed to further examine potential effects (see Chapter 10 and Appendix 23.1, Volume 3 for details).
Coastal birds	Interrelationship • Dredging and construction activities resulting in dispersion of sediment plumes – presence of contaminated sediments. • Changes in habitats and thus ecological species composition arising from changes in deposition/erosion of sediments,

Environmental Topic: Coastal Processes, Sediment Transport and Contamination	Interrelationship, assessment of significance and mitigation
	hydrodynamic changes (water levels, flow speeds and directions, waves), water quality. Potential effects on roosting and foraging sites. Assessment of significance: No significant adverse effects identified. Mitigation: None required. However, mitigation/enhancement measures have been incorporated into the Project. Artificial reef (Lagoon seawalls) and concepts such as bioreefs resulting in increased ecological biodiversity and fish populations thus providing foraging opportunities; and artificial kittiwake roosts on turbine house, other quiet areas to provide roosting opportunities. Monitoring programmes are detailed within Chapter 11 and Appendix 23.1, Volume 3 to monitor potential effects on coastal birds.
Terrestrial Ecology	Interrelationship Changes in hydrodynamic processes resulting in changes in sediment deposition/erosion potentially affecting coastal sand dune habitats and thus species composition. Assessment of significance: No significant adverse effects predicted. Beneficial impacts from sand accretion fronting Crymlyn Burrows SSSI with formation of dune habitat. Mitigation: None required, however, mitigation/enhancement measures relating to foreshore habitat creation (artificial dune, maritime grassland and saltmarsh habitats) have been incorporated into the Project. Creation of artificial dune, maritime grassland and saltmarsh habitats. Monitoring programmes have been developed to examine potential effects further (see Chapter 12 and Appendix 23.1, Volume 3 for details).
Seascape and landscape visual impact assessment	Interrelationship Changes in hydrodynamic processes resulting in changes in sediment deposition/erosion potentially affecting landscape or seascape character or visual amenity. Assessment of significance: No significant adverse effects predicted. Mitigation: None required.
Navigation and marine transport	Interrelationship Changes in hydrodynamic processes resulting in changes to water levels, flow speeds and directions, waves, sediment deposition and erosion (slight increase in wave height off south west area of turbine and sluice gate housing, but reduction of wave height for south easterly waves near the entrance to the River Tawe and the inner sections of the Swansea Channel). Assessment of significance: Potential moderate/minor adverse impacts from increased sedimentation within Swansea navigation channel (no significant adverse effects within Neath or Port Talbot navigational channels) prior to mitigation. Mitigation: Additional maintenance dredging within Swansea, Neath and Port Talbot navigational channels, where necessary, and

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Environmental Topic: Coastal Processes, Sediment Transport and Contamination	Interrelationship, assessment of significance and mitigation
	within the Lagoon. Residual impacts reduce to insignificant post-mitigation.
Hydrology and flood risk	Interrelationships Changes in hydrodynamic processes potentially affecting tidal flooding risk within the Lagoon and in the wider Swansea Bay. Assessment of significance: No significant adverse effects predicted. Slight beneficial effect with respect to tidal flood risk for coastal area within Lagoon. With respect to the wider Swansea Bay, the effects of the Lagoon on both water level and wave height have been assessed as insignificant. Mitigation: None required, although a precautionary freeboard allowance (+0.5m) has been included for permanent buildings associated with the Project within Swansea Port. Flood Warning Plan will be implemented for the Project.
Land quality and hydrogeology	Interrelationships Changes in hydrodynamic processes and managed water levels affecting groundwater discharge flux through the intertidal zone potentially affecting standing groundwater levels, groundwater seepages, groundwater flow regime and saline wedge. Assessment of significance: No significant adverse effects predicted. Mitigation: None required.
Cultural heritage: marine archaeology	Interrelationships Potential changes in hydrodynamic processes resulting in exposure of previously buried maritime, prehistoric, inter-tidal or archaeological sites leading to damage or loss. Assessment of significance: No significant adverse effect predicted. Mitigation: None required.
Economy, tourism and recreation	Interrelationships - Changes in habitats (including habitat fragmentation and isolation) and thus ecological species composition potentially affecting fish populations and opportunities for recreational and commercial fishing. - Changes in hydrodynamic processes (e.g. olfactory trails, flows, turbulence, salinity) and interaction with turbines potentially affecting fish populations for commercial and recreational sea fishing and anadromous fish returns and rod-catch. - Changes in hydrodynamic processes (e.g. water levels, deposition/erosion of sediments, flow speeds and directions, waves) potentially affecting commercial and recreational fishing vessels; and recreational craft (slight increase in wave height off south west area of turbine house, but reduction of wave height for South Easterly waves near the entrance to the River Tawe and the inner sections of the Swansea Channel). - Changes in coastal environment within the Lagoon potentially affecting economy, tourism and recreation (changes resulting in



Tidal Lagoon Swansea Bay plc

Environmental Topic: Coastal Processes, Sediment Transport and Contamination	Interrelationship, assessment of significance and mitigation
	erosion in sands from recreational beaches and affecting surfing waves at Aberafan beach), flooding. Changes in hydrodynamic processes (water levels, flow speeds and directions, waves) affecting waste water and storm discharges and thus water quality in terms of the Water Framework Directive (WFD), Shellfish Waters Directive, Bathing Waters Directive and Shellfish hygiene assessment under EC Regulation No. 854/2004. Assessment of significance: No significant adverse effects on commercial and recreational fishing vessels or recreational craft; surfing waves at Aberafan beach; anadromous fish returns and rod-catch or flooding. Potential benefit for economy, tourism and recreation due to the creation of Lagoon and associated art, education and sporting facilities associated with the coastal environment. General, small improvement in microbiological water quality within Swansea Bay for designated bathing beaches. Potential moderate/ minor adverse localised effect across the upper reaches of the sandy beaches in Blackpill SSSI in the long term caused by a potential reduction in net sand supply (transport) aperiodically from the eastern side of the Bay. Mitigation: Residual localised moderate/ minor adverse impacts across the sandy beaches in the Blackpill SSSI. However, analysis of beach profile data within the Blackpill SSSI will be undertaken and if required, beach nourishment will be carried out. The artificial reef (Lagoon seawalls) will result in increased ecological biodiversity and thus fish populations with potential resultant opportunities for commercial and recreational fisheries. Potential mariculture opportunities (re-introduction of native oyster and lobster). Provision of recreation boating facilities within Lagoon and maintenance dredging to maintain water depth. Monitoring programmes have been developed to examine the potential effects of the Project e.g. analysing beach profile data (see Appendix 23.1, Volume 3).

Table 24.3 Marine water quality

Environmental Topic: Marine Water Quality	Interrelationship, assessment of significance and mitigation
Intertidal and subtidal benthic ecology	Interrelationship • Dredging and construction activities resulting in reduced water quality as a result of dispersion of sediment plumes – presence of contaminated sediments.
Marine mammals and turtles.	• Marine water pollution resulting from discharges or accidental spillages from construction or operation of the Project. • Changes in chemical or ecological water quality affecting classification of waterbodies under the Water Framework Directive.
Coastal Birds	Assessment of significance: No significant adverse effects predicted. Mitigation: None required, but Natural Resources Wales (NRW) (formerly Environment Agency (EA)) Pollution Prevention Guidelines, Construction Industry Research and Information Association Guidance (CIRIA), International Maritime Organisation Conventions will be adhered to during construction and operation as detailed in the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) (see Chapters 4, 14 and 17).
Fish, including Recreational and Commercial Fisheries	Interrelationship • Dredging and construction activities resulting in reduced water quality as a result of dispersion of sediment plumes – presence of contaminated sediments. • Marine water pollution resulting from discharges or accidental spillages from construction or operation of the Project. • Changes in chemical or ecological water quality affecting classification of waterbodies under the Water Framework Directive. • Changes in microbiological water quality affecting Shellfish Waters Directive and Shellfish hygiene assessment under EC Regulation No. 854/2004. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, but optimisation comprising storm water UV disinfection or extension of the Swansea long sea outfall is proposed to improve water quality within the Lagoon for recreational purposes – potential mariculture opportunities also within the Lagoon. NRW (formerly EA) PPG and CIRIA guidance will be adhered to during construction and operation as detailed in the CEMP and OEMP (see Chapter 4). Environmental Liaison Officer (ELO) employed during the construction phase and a warden during the operational phase.
Navigation and marine transport	Interrelationship • Marine water pollution arising from vessels used in construction or operational phases of the Project. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, but International Maritime Organisation Conventions will be adhered to during construction and operation as detailed in the CEMP and OEMP (see Chapters 4 and 14). Marine pollution contingency plans will also be prepared and included within the CEMP and OEMP.



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Environmental Topic: Marine Water Quality	Interrelationship, assessment of significance and mitigation
Hydrology and flood risk Land quality and hydrogeology	Interrelationship Marine water pollution resulting from discharges from works on contaminated land within the coastal environment from onshore construction of the Project.
	Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, NRW (formerly EA) PPG and CIRIA guidance will be adhered to during construction and operation as detailed in the CEMP (see Chapters 4, 17 and 18). ELO employed during the construction phase and a warden during the operational phase.
	Interrelationship - Potential effects on marine water quality affecting fish populations important for recreational or commercial fisheries. - Marine water pollution resulting from discharges or accidental spillages from construction or operation of the Project. - Changes in chemical or ecological water quality affecting classification of waterbodies under the Water Framework Directive. - Changes in microbiological water quality affecting Shellfish Waters Directive, Shellfish hygiene assessment under EC Regulation No. 854/2004 and Bathing Waters Directive.
Economy, tourism and recreation	Assessment of significance: No significant adverse effects predicted. General small improvement in microbiological water quality within Swansea Bay for designated bathing beaches.
	Mitigation: None required, but optimisation comprising storm water UV disinfection or extension of the Swansea long sea outfall is proposed to improve water quality within the lagoon for year round use for water contact sports. NRW (formerly EA) PPG and CIRIA guidance will be adhered to during construction and operation as detailed in the CEMP and OEMP (see Chapters 4, 14 and 17). ELO employed during the construction phase.

Table 24.4 Intertidal and subtidal benthic ecology

Environmental Topic: Intertidal and Subtidal Benthic Ecology	Interrelationship, assessment of significance and mitigation
Fish, including Recreational and Commercial Fisheries	Interrelationship • Changes in subtidal and intertidal ecological biodiversity affecting fish and shellfish populations – food resource, increased pressure from recreational and commercial fishing, increased predation. • Changes in subtidal and intertidal habitat extents resulting from construction or operation of the Project affecting fish populations – food resources, spawning/nursery areas, resting, sheltering, migratory routes. Assessment of significance: Potential significant adverse effects (moderate) relating to loss of spawning and/or foraging grounds for some species, but where a significant adverse effect is identified, significant beneficial effects relating to gain in spawning and/or foraging habitats are also identified during the operational phase - beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species. Mitigation: Enhancement/mitigation measures have been incorporated within the Project: creation of herring spawning habitat as part of the Lagoon seawalls in year 1 of construction; creation of heterogeneous subtidal and intertidal habitats (rock pools, pits, crevices, use of concepts such as bioblocks and bioreefs); translocation of Sabellaria reef prior to construction (Sabellaria reefs create diverse algal and faunal communities); encouragement of the reintroduction of native oyster – oyster spatting ponds; lobster hatchery and introduction of lobsters on seawalls. Residual effects from habitat modification in terms of foraging and/or spawning grounds are both minor adverse and moderate beneficial for all species affected. Monitoring programmes have been developed to examine the enhancement/mitigation measures proposed for the Project (see Chapters 8 and 9, and Appendix 23.1, Volume 3).
Marine mammals and turtles Coastal birds	Interrelationship • Changes in subtidal and intertidal habitats and ecological biodiversity affecting fish and shellfish populations – food resource. Assessment of significance: No significant adverse effect predicted. Beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus prey species for marine mammals and coastal birds. Creation of saltmarsh which provides foraging opportunities for coastal birds. Mitigation: None required.
Seascape and landscape visual impact assessment	Interrelationship • Change in extent and diversity of intertidal and subtidal habitats potentially affecting seascape or landscape character areas or visual amenity. Assessment of significance: No significant adverse effects predicted. Mitigation: None required.



Tidal Lagoon Swansea Bay plc

Environmental Topic: Intertidal and Subtidal Benthic Ecology	Interrelationship, assessment of significance and mitigation
Navigation and marine transport	Interrelationships • Changes in subtidal and intertidal habitats and ecological biodiversity affecting fish and shellfish populations – changes in location, quantity and type of catch for commercial and recreational fishing from vessels. • Potential for introduction of non-native species. Assessment of significance: Insignificant to moderate adverse effect predicted for potential introduction of non-native species prior to mitigation for the operational phase. Beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus commercial and recreational fishing opportunities.
	Mitigation: Vessels associated with the Project will meet guidance and legislative requirements for dealing with ballast waters and hull fouling to minimise the potential for introduction of non-native species. The extent and quality of non-native species will be monitored to determine the composition and distribution of any non-native species on the Lagoon wall during operation (Chapter 23, Appendix 23.1, Volume 3). Good practice measures will be implemented to limit the introduction and spread of non-native species as detailed in Chapter 8. Any non-native species found to be present within the footprint of the Project will be controlled/eradicated where feasible. With these mitigation measures, the residual effect of the Project for the potential introduction of non-native invasive species is insignificant to minor adverse for the construction and operational phases.
Land quality and hydrogeology	Interrelationships • Potential for effect on intertidal and subtidal environments associated with construction activities on contaminated land within the coastal environment (e.g. contaminated surface water run-off, contamination of groundwater affecting seepages onto the intertidal environment, disturbance of contaminated material – dust deposition). Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, NRW (formerly EA) PPG and CIRIA guidance will be adhered to during construction and operation as detailed in the CEMP and OEMP (see Chapters 4, 14 and 17). ELO employed during the construction phase.
Noise and vibration	Interrelationships • Potential effects of noise and vibration on intertidal and subtidal species resulting from construction and operation.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required.



Tidal Lagoon Swansea Bay plc

Environmental Topic: Intertidal and Subtidal Benthic Ecology	Interrelationship, assessment of significance and mitigation
Economy, tourism and recreation	Interrelationships • Changes in subtidal and intertidal habitats and ecological biodiversity affecting fish and shellfish populations – changes in location, quantity and type of catch for commercial and recreational fishing. • Change in amenity resources within the intertidal environment - creation of a beach habitat within the Lagoon footprint and increased access to a coastal resource. • Change in educational resource – changes in intertidal and subtidal habitat and ecological biodiversity with resultant research opportunities. Assessment of significance: No significant adverse effects predicted. Potential benefit for economy, tourism and recreation due to the creation of Lagoon, beach environment and associated art, education and sporting facilities associated with the coastal environment. Potential beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus commercial and recreational fishing opportunities. Mitigation: None required, however, enhancement/mitigation measures have been incorporated within the Project: creation of diverse coastal subtidal and intertidal habitats (lagoon seawalls, beach, saltmarsh); creation of herring spawning habitat as part of the Lagoon seawalls in year 1 of construction; creation of heterogeneous subtidal and intertidal habitats (rock pools, pits, crevices, use of concepts such as bioblock and, bioreefs); translocation of Sabellaria reef prior to construction (Sabellaria reefs can create diverse algal and faunal communities); encouragement of the reintroduction of native oyster – oyster spatting ponds; lobster hatchery and introduction of lobster on the seawalls.

Table 24.5 Fish, including commercial and recreational fisheries

Environmental Topic: Fish including commercial and recreational fisheries	Interrelationship, assessment of significance and mitigation
Marine mammals and turtles	Interrelationship • Potential effects on fish populations resulting in effects on prey species composition and availability for marine mammals. • Potential effects on commercial and recreational fisheries – changes in intensity, location – potential effects on prey species composition and availability for marine mammals and also potential for changes in interactions with fishing vessels (e.g. propeller strike, disturbance). Assessment of significance: No significant adverse effect predicted. Beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus prey species for marine mammals. Mitigation: None required. Assessment of significance: No significant adverse effect predicted. Beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus foraging opportunities for marine mammals. Mitigation: None required. However, monitoring will be undertaken to assess effects of the operation of the Project on fish populations and thus this will consider aspects such as prey species composition for coastal birds (see Chapters 9 and Appendix 23.1, Volume 3).
Coastal birds	Interrelationship • Potential effects on fish populations resulting in effects on prey species composition and availability for fish eating birds. • Potential effects on commercial and recreational fisheries – changes in intensity, location – potential effects on prey species composition and availability for coastal birds. Assessment of significance: No significant adverse effect predicted. Beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus foraging opportunities for coastal birds. Creation of saltmarsh which provides foraging opportunities for coastal birds. Mitigation: None required. However, monitoring will be undertaken to assess effects of the operation of the Project on fish populations and thus this will consider aspects such as prey species composition for coastal birds (see Chapters 9 and Appendix 23.1, Volume 3).
Navigation and marine transport	Interrelationship • Potential effects on fish and shellfish populations – changes in location, quantity and type of catch for commercial and recreational fishing from vessels. Assessment of significance: No significant adverse effect. Beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls)

Tidal Lagoon Swansea Bay plc

Environmental Topic: Fish including commercial and recreational fisheries	Interrelationship, assessment of significance and mitigation
	increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus commercial and recreational fishing opportunities. Mitigation: None required. Access to port channels for commercial and recreational fishing vessels will be maintained throughout the various phases of the Project.
Noise and vibration	Interrelationship • Potential effects of noise and vibration on fish resulting from the construction and operation of the Project. Assessment of significance: Major adverse effect predicted for 'hearing specialist' shad and moderate adverse effect predicted for herring during construction of the temporary cofferdam (impact piling). Mitigation: Vibro piling will be the principal method of constructing the sheet piles for the temporary cofferdam. With the use of soft start procedure for impact piling, the residual effect on shad is minor adverse and on herring, insignificant. Appropriate acoustic deterrents will be investigated for the Project to mitigate for potential effects relating to operation of the turbines on fish and marine mammals.
Economy, tourism and recreation	Interrelationship • Changes in subtidal and intertidal habitats and ecological biodiversity affecting fish and shellfish populations – changes in location, quantity and type of catch for commercial and recreational fishing. • Potential effects on shore based angling. • Potential effects on river angling. • Potential effects on mariculture. Assessment of significance: No significant adverse effects predicted. Potential benefit for economy, tourism and recreation due to incorporation of fishing platforms on the seawalls to accommodate shore based angling. Potential beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus commercial and recreational fishing opportunities. Potential benefit for mariculture within the Bay – encouragement of the reintroduction of native oyster and lobsters. Mitigation: None required, however, enhancement/mitigation measures have been incorporated within the Project: creation of diverse coastal subtidal and intertidal habitats (lagoon seawalls, beach, saltmarsh); creation of herring spawning habitat as part of the lagoon seawalls in year 1 of construction; creation of heterogeneous subtidal and intertidal habitats (rock pools, pits, crevices, use of concepts such as bioblocks and bioreefs); translocation of Sabellaria reef prior to construction (Sabellaria reefs can create diverse algal and faunal communities); encouragement of the reintroduction of native oyster – oyster spatting ponds; lobster hatchery and introduction on seawalls. Shore based angling platforms incorporated within the lagoon seawall design.

Table 24.6 Marine mammals and turtles

Environmental Topic: Marine Mammals and Turtles	Interrelationship, assessment of significance and mitigation
Navigation and marine transport	Interrelationship Changes in vessel activity/type in the area as a result of construction and operation of the Project – potential for visual disturbance, collision with vessels/propellers. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, as vessels will be slow moving, however, the Natural Resources Wales Sea Wise Code (2013) will be followed for vessels working on the Project.
Noise and vibration	Interrelationship Potential effects on noise levels associated with construction and operation of the Project. Assessment of significance: No significant adverse effect predicted with vibro piling, operation of the turbines, vessel activity. Potential for moderate adverse effect during construction associated with percussive piling prior to mitigation. Mitigation: Joint Nature Conservation Committee “Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals during piling” (2010) protocol and an agreed soft start procedure will be implemented for any percussive piling works. Onshore and offshore noise will be managed through the remit of the CEMP. An ELO will be employed during the construction phase and a warden during the operational phase. Monitoring of the effect of noise on marine mammals and the use of acoustic deterrents (to reduce the potential turbine collision risk) are proposed (see Chapter 10 and Appendix 23.1, Volume 3)

Table 24.7 Coastal birds

Environmental Topic: Coastal Birds	Interrelationship, assessment of significance and mitigation
Terrestrial Ecology	Interrelationship Changes in terrestrial habitats and ecological biodiversity affecting roost sites and foraging opportunities. Assessment of significance: No significant adverse effect predicted. Mitigation: None required, however, enhancements/mitigation proposals incorporated within the Project will provide foraging and roosting opportunities for coastal birds: grassland and sand dune habitats.
Seascape and landscape visual impact assessment	Interrelationship Change in coastal environment through creation of landscaped public realm environment. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, enhancements/mitigation proposals associated with the public realm incorporated within the Project will provide foraging and roosting opportunities for coastal birds: grassland, saltmarsh and sand dune habitats, Lagoon seawalls, roost sites for Kittiwakes on Offshore Building.
Noise and vibration	Interrelationship Changes in noise levels associated with construction and operation of the Project. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, temporary disturbance associated with construction activities or personnel or visitors to the Project will be managed within the vicinity of roost site within Crymlyn Burrows Site of Special Scientific Interest. An ELO will be employed during the construction phase and a warden during the operational phase.
Economy, tourism and recreation	Interrelationship Changes in disturbance associated with visitors to/users of the Project. Assessment of significance: No significant adverse effect predicted. Mitigation: None required, however, disturbance associated with visitors to the Project will be managed within the vicinity of roost site within Crymlyn Burrows SSSI. A warden will be employed during the operational phase. Quiet areas set aside within the Lagoon footprint during the operational phase to minimise disturbance from boating and other leisure activities.

Table 24.8 Terrestrial ecology

Environmental Topic: Terrestrial Ecology	Interrelationship, assessment of significance and mitigation
Seascape and landscape visual impact assessment	Interrelationship • Introduction of ecological measures for the Project potentially affecting seascape or landscape character or visual amenity.
	Assessment of significance: No significant adverse effects associated with the construction of ecological measures for the Project on visual amenity or seascape and landscape character areas.
	Mitigation: The Project will provide an improvement to the public realm and an increase in leisure facilities that will contribute in enhancing the areas character. Terrestrial ecological areas are incorporated into the design – coastal grassland habitats, dune system and saltmarsh. Sympathetic lighting regime.
Onshore transport	Interrelationship • Vehicle movements have the potential to cause road traffic related mortality for terrestrial species.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required. However, security fencing with mammal underpasses to inhibit public access but allow connectivity between docks and coastline will be implemented to reduce potential for road traffic related mortality. Speed restrictions for vehicles. Construction, operational and major event travel plans will be prepared.
Air quality	Interrelationship • Potential for dust (contaminated and uncontaminated) to smother vegetation. • Changes in nitrogen deposition at ecological sites. • Potential effects from Aeolian sand processes.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, mitigation measures to reduce any potential effects from dust (e.g. no bonfires, reduce speeds of vehicles tracking across unmade surfaces, use of water as a dust suppressant) will be incorporated within the CEMP. An ELO will be employed during the construction phase. Beach replenishment, where necessary, within the Lagoon footprint to replace sand lost as a result of wind transport.
Hydrology and flood risk	Interrelationship • Potential for changes to surface water affecting ecological habitats and biodiversity. • Potential for pollution of surface water affecting ecological habitats and biodiversity.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, NRW (formerly EA) PPG and CIRIA guidance will be adhered to during construction and

Environmental Topic: Terrestrial Ecology	Interrelationship, assessment of significance and mitigation
Land quality and hydrogeology	operation as detailed in the CEMP and OEMP (see Chapters 4 and 17). ELO employed during the construction phase.
	Interrelationships • Potential for changes to groundwater affecting ecological habitats and biodiversity. • Potential for pollution of groundwater affecting ecological habitats and biodiversity. • Potential for disturbance/storage/movement of contaminated land affecting ecological habitats and biodiversity.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, NRW (formerly EA) PPG and CIRIA guidance will be adhered to during construction and operation as detailed in the CEMP and OEMP (see Chapters 4 and 18). ELO employed during the construction phase. Any works in the area of contaminated land will be managed under the remit of the CEMP.
Noise and vibration	Interrelationship • Potential for noise and vibration to disturb species and encourage localised avoidance.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, noise and vibration will be managed under the remit of the CEMP. ELO employed during the construction phase.
Economy, tourism and recreation	Interrelationship
	• Changes in disturbance, increased litter or other forms of pollution associated with visitors to/users of the Project. • Potential for introduction of species not currently present within the docks estate associated with increased public usage.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, during construction potential transfer of non-native species will be managed under the remit of the CEMP. During operation, monitoring will be undertaken and any new infestations will be treated during routine management under the remit of the OEMP. An ELO will be employed during construction to minimise potential effects on terrestrial habitats resulting from construction personnel. Similarly, during operation, a warden will be employed to work with statutory and non-statutory organisations to manage the environmental aspects of the Project, including minimising disturbance, litter etc. resulting from increased public usage of the area.

Table 24.9 Seascape and landscape visual impact assessment

Environmental Topic: seascape and landscape visual impact assessment	Interrelationship, assessment of significance and mitigation
Navigation and marine transport	Interrelationship • Potential effect of movement of vessels and type of vessels (e.g. jack up barge) associated with Project construction on seascape character Assessment of significance: No significant adverse effects predicted. Mitigation: None required.
Onshore transport	Interrelationship • Potential effect of movement of construction and operational vehicles along access roads adjacent to the coastline on seascape character. • Potential effect of development associated with onshore transport – car and coach parking, cycle and pedestrian routes, bus turning areas. Assessment of significance: No significant adverse effects predicted. Mitigation: None required.
Cultural heritage: terrestrial archaeology	Interrelationship • Potential effects on sites of cultural heritage interest and visual amenity. Assessment of significance: Major adverse significant effects predicted prior to mitigation on Second World War features associated with existing seawall to be removed during construction of access route to Project and to open up views across the Bay. Mitigation: Retention or relocation of key features of cultural heritage importance (Second World War features – gun emplacement, pill boxes, tank cubes associated with the existing seawall) along the access route along southern extent of Queens Dock. Trial trenches and recording prior to construction commencing for Second World War gun emplacement potentially directly affected by construction of access route. Residual effects reduced to negligible to minor adverse post mitigation. Mitigation measures will be detailed in a written scheme of investigation (WSI) which will be agreed with CADW and Glamorgan Gwent Archaeological Trust Ltd. (GGAT), prior to construction commencing.
Economy, tourism and recreation	Interrelationship • Change in landuse within the coastal environment from a Port (partly disused) to a leisure and recreational facility potentially affecting seascape, landscape and visual amenity. • Development of facilities associated with leisure and recreation.



Tidal Lagoon Swansea Bay plc

Environmental Topic: seascape and landscape visual impact assessment	Interrelationship, assessment of significance and mitigation
	• Development of facilities associated with energy generation. • Change in public usage all year round. • Change in lighting associated with the buildings and public realm.
	Assessment of significance: No significant effects associated with the construction of the Project on seascape and landscape character areas. Significant effects on visual amenity during construction within the vicinity of the Project (including immediately surrounding the Project, locations adjacent to Baglan Burrows, within Crymlyn Burrows, and adjacent to the Project within the east of Swansea Bay). Significant effects on seascape and landscape character during operation from a number of areas within the vicinity of the Project (including immediately surrounding the Project, locations adjacent to Baglan Burrows, within Crymlyn Burrows, and adjacent to the Project within the east of Swansea Bay). Neutral or beneficial effects on seascape and landscape character areas in other areas. Significant effect on visual amenity from within Crymlyn Burrows and from elevated areas overlooking the Project; neutral or beneficial effects on visual amenity in other areas.
	Mitigation: The Project will provide an improvement to the public realm and an increase in leisure facilities that will contribute in enhancing the areas character. Lighting of the Project will be sympathetic.

Table 24.10 Navigation and marine transport

Environmental Topic: Navigation and Marine Transport	Interrelationship, assessment of significance and mitigation
Air quality	Interrelationship Potential effects of emissions from increased vessel movements or types of vessel. Assessment of significance: No significant adverse effects predicted. Mitigation: None required.
Noise and vibration	Interrelationship Potential effects of increased noise and vibration from vessels and associated construction activities (e.g. dredging, piling) Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, vessels will follow the NRW Seawise Code (2013).
Economy, tourism and recreation	Interrelationship - Potential effects on economy related to increased vessels working on the Project (e.g. accommodation and general living facilities for personnel, support services for vessels, potential employment opportunities) - Changes in transit routes for commercial and recreational vessels as a result of the Project and potential effects on fuel usage, increased time at sea, transit times. - Potential effects on commercial and recreational fishing vessels as a result of loss of access to fishing grounds following construction of the Project. - Potential increased risk of vessel to vessel collision or vessel to structure collision. Assessment of significance: No significant adverse effects predicted. Beneficial effects resulting from employment opportunities, accommodation and other facilities for workers, and increased requirement for vessel support services. Potential benefit for economy, tourism and recreation due to the creation of Lagoon and associated watersports venue. Potential beneficial effect resulting from the creation of an artificial reef (Lagoon seawalls) increasing habitat heterogeneity, leading to an increase in diversity and abundance of fish and shellfish species and thus commercial and recreational fishing opportunities. Mitigation: None required, however, to reduce the potential for increased collision risk (vessel to vessel and vessel to structure), mitigation including dolphin piles /floating boom operational turbine and sluice gate housing (construction and operation), safety zones around construction activities, navigational aids (e.g. lighting and marking of structures, promulgation of information, Aids to Navigation, guard vessels), safety (co-ordination with emergency services, slipway with emergency response RIB in lagoon) and work procedures planning.

Table 24.11 Onshore transport

Environmental Topic: Onshore Transport	Interrelationship, assessment of significance and mitigation
Air quality	Interrelationship Potential effects of emissions from increased construction vehicles and vehicles accessing operational Project. Assessment of significance: No significant adverse effects predicted. Potential effects from enhancements to pedestrian and cycle access to the port area, and new links along the waterfront to the site of the SUBC. Provision of a pontoon on the western Lagoon seawall to facilitate a water shuttle serving the Project from the west bank of the River Tawe and/or Mumbles. The Project also makes provision for a shuttle bus service from the Park & Ride facility on Fabian Way, subject to investigation of its viability. Mitigation: None required; however, as part of the Project, traffic management plans will be prepared – the Construction Phase Travel Plan and the Operational Phase Travel Plan. In addition, prior to any events occurring a Major Event Travel Plan will also be prepared. All of these plans will be agreed with the local authorities.
Hydrology and Flood Risk	Interrelationship Potential effects of pollution of surface waters arising from construction vehicles or vehicles accessing operational Project. Assessment of significance: No significant adverse effects predicted. Mitigation: None required; however, anti-pollution measures will be implemented during construction under the remit of the CEMP (e.g. control of surface water run-off, use of oil-water interceptors as appropriate, delivery and storage of materials in designated areas). For the operational Project, sustainable urban drainage systems will be employed (e.g. lined swales) typically with cut-off measures that would allow a spill to be contained, so that it can be effectively controlled and managed without leading to off-site impacts. Emergency Spill Response Plans (ESRP) will be incorporated within the CEMP and the OEMP.
Land quality and hydrogeology	Interrelationship - Potential effects of pollution of groundwater arising from construction vehicles or vehicles accessing operational Project. - Potential spread of contaminated material resulting from movement of construction vehicles. Assessment of significance: No significant effects predicted. Mitigation: None required; however, anti-pollution measures will be implemented during construction under the CEMP (e.g. control of surface water run-off, use of oil-water interceptors as appropriate, delivery and storage of materials in designated areas). For the operational Project, sustainable urban drainage systems will be employed (e.g. lined swales) typically with cut-off measures that would allow a spill to be contained, so that it can be effectively controlled and managed without leading to off-site impacts. Emergency Spill Response Plans (ESRP) will be incorporated within the CEMP and the OEMP. Vehicle movements onto contaminated land restricted during construction and appropriate mitigation implemented prior to vehicles leaving site controlled under the remit of the CEMP. Movement of contaminated materials using construction vehicles will comply with appropriate legislation.

Environmental Topic: Onshore Transport	Interrelationship, assessment of significance and mitigation
Noise and vibration	Interrelationship • Potential effects of increased noise and vibration associated with movement of construction vehicles and traffic accessing operational Project. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, noise and vibration will be managed under the remit of the CEMP during the construction phase. Major Event Plans will be prepared prior to any events occurring at the Project (International and National sporting events) for traffic management.
Cultural heritage: Terrestrial Archaeology	Interrelationship • Potential effects on protected cultural heritage features resulting from construction of access route to Project. Assessment of significance: Major adverse significant effects predicted prior to mitigation on Second World War features if removed with the existing seawall to construct the access route and open up views across the Bay. Mitigation: Retention or relocation of features of key cultural heritage importance (Second World War features – gun emplacement, pill boxes, tank cubes associated with the existing seawall) along the access route along southern extent of Queens Dock. Trial trenches and recording prior to construction commencing for Second World War gun emplacement potentially directly affected by construction of access route. Residual effects reduced to negligible to minor adverse post mitigation. Mitigation measures will be detailed in a WSI which will be agreed with CADW and GGAT, prior to construction commencing.
Economy, tourism and recreation	Interrelationship • Potential effects on traffic on access routes to the Project as a result of increases in construction traffic and traffic accessing the operational Project. • Potential increases in usage of public transport services. • Potential effects on existing Port users resulting from construction traffic along existing roads within the Port until the separate dedicated access route is constructed. • Potential effects on SUBC from construction traffic along the haul route to the Eastern Landfall. • Potential changes to public access routes (road, cycling and pedestrian) into and within the Port and Project environment. Assessment of significance: No significant adverse effects predicted. Potential effects from enhancements to pedestrian and cycle access to the port area, and new links along the waterfront to the site of the SUBC. Provision of a pontoon on the western Lagoon seawall to facilitate a water shuttle serving the Project from the west bank of the River Tawe and/or Mumbles. The Project also makes provision for a shuttle bus service from the Park & Ride facility on Fabian Way, subject to investigation of its viability. Mitigation: None required, however, as part of the Project, traffic management plans will be prepared – the Construction Phase Travel Plan and the Operational Phase Travel Plan. In addition, prior to any events occurring a Major Event Travel Plan will also be prepared. All of these plans will be agreed with the local authorities.

Table 24.12 **Air quality**

Environmental Topic: Air Quality	Interrelationship, assessment of significance and mitigation
Hydrology and flood risk Land quality and hydrogeology	Interrelationship Potential for contamination of previously uncontaminated land/surface waters/groundwaters as a result of construction dust.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, mitigation measures to reduce any potential effects from dust (e.g. no reduce speeds of vehicles tracking across unmade surfaces, use of water as a dust suppressant) will be incorporated within the CEMP. An ELO will be employed during the construction phase.
Economy, tourism and recreation	Interrelationship - Potential effects of dust generated as a result of the construction of the Project. - Potential effects of emissions from increased vehicles accessing the Project.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, mitigation measures to reduce any potential effects from dust (e.g. no reduce speeds of vehicles tracking across unmade surfaces, use of water as a dust suppressant) will be incorporated within the CEMP. An ELO will be employed during the construction phase. Traffic management plans will be prepared for all phases of the Project – the Construction Phase Travel Plan and the Operational Phase Travel Plan. In addition, prior to any events occurring a Major Event Travel Plan will also be prepared. All of these plans will be agreed with the local authorities.

Table 24.13 Hydrology and flood risk

Environmental Topic: Hydrology and Flood Risk	Interrelationship, assessment of significance and mitigation
Land quality and hydrogeology	Interrelationship • Potential effects of pollution of groundwater from interaction with contaminated surface waters (leaching). • Potential effects on groundwater levels, groundwater flows, groundwater seepages, saline wedge from tidal flooding. Assessment of significance: No significant adverse effects predicted. Mitigation: None required.
Economy, tourism and recreation	Interrelationship • Potential effects on flood risk from surface or tidal waters. With respect to the wider Swansea Bay, the effects of the Lagoon on both water level and wave height have been assessed as insignificant. Assessment of significance: No significant adverse effects predicted. Slight beneficial effect with respect to tidal flood risk for coastal area within lagoon. Mitigation: None required although a precautionary freeboard allowance (+0.5m) has been included for permanent buildings associated with the Project within Swansea Port. Flood Warning Plan will be implemented for the Project.

Table 24.14 Land quality and hydrogeology

Environmental Topic: Land Quality and Hydrogeology	Interrelationship, assessment of significance and mitigation
Economy, tourism and recreation	Interrelationship • Potential effects of changes in groundwater levels on flood risk. • Potential effects of construction on contaminated land – contaminated material spread to uncontaminated areas within the Port environs on vehicle wheels, dust, pollution of groundwaters used for abstraction, pollution of surface waters used for mariculture (i.e. Queens Dock). • Potential effects relating to the management of contaminated material on and off site.
	Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, anti-pollution measures will be implemented during construction under the remit of the CEMP (e.g. control of surface water run-off, use of oil-water interceptors as appropriate, delivery and storage of materials in designated areas). For the operational Project, sustainable urban drainage systems will be employed (e.g. lined swales) typically with cut -off measures that would allow a spill to be contained, so that it can be effectively controlled and managed without leading to off-site impacts. Vehicle movements onto contaminated land restricted during construction and appropriate mitigation implemented prior to vehicles leaving site controlled under the remit of the CEMP. Movement of contaminated materials using construction vehicles will comply with appropriate legislation.



Table 24.15 Noise and vibration

Environmental Topic	Interrelationship, assessment of significance and mitigation
Economy, tourism and recreation	Interrelationships • Potential effects of noise and vibration arising from construction and operation of the Project both offshore and onshore.
	Assessment of significance: No significant adverse effects predicted.
	Mitigation: None required, however, good practice activities from construction and haulage contractors as per BS5228, regular highway condition surveys (if required, highway maintenance) and noise mitigation (e.g. screening around noise plant, working hours, regular maintenance of construction equipment, soft start procedure for piling) will be implemented through the remit of the CEMP. Traffic management plans for construction, operation and major events will be prepared and agreed with the local authorities.

Table 24.16 Cultural heritage: marine archaeology

Environmental Topic: Cultural heritage: marine archaeology	Interrelationship, assessment of significance and mitigation
Cultural heritage: terrestrial archaeology	Interrelationship • Potential effects on sites of cultural heritage interest and areas of archaeological potential – potential overlap between sites classified as terrestrial or marine due to changes in sea levels. Assessment of significance: No significant adverse effects predicted. Mitigation: None required, however, archaeological watching brief will be undertaken in areas of previously undisturbed ground in the vicinity of the River Neath. Mitigation measures will be detailed in a written scheme of investigation (WSI) which will be agreed with CADW and GGAT, prior to construction commencing.
Economy, tourism and recreation	Interrelationship • Potential effects on sites of cultural heritage interest and areas of archaeological potential. Assessment of significance: Potential major or moderate adverse effects prior to mitigation upon currently unknown maritime, prehistoric and inter-tidal archaeological sites. Mitigation: Exclusion zone around known site of intertidal wreck. A watching brief during dredging will allow for the identification of sites of maritime, prehistoric or archaeologically important previously unknown. Mitigation measures will be detailed in a WSI which will be agreed with CADW and GGAT, prior to construction commencing.

Table 24.17 Cultural heritage: terrestrial archaeology

Environmental Topic: Cultural Heritage: terrestrial archaeology	Interrelationship, assessment of significance and mitigation
Economy, tourism and recreation	Interrelationship • Potential effects on sites of cultural heritage interest. • Potential effects on setting of sites of cultural heritage interest and visual amenity. Assessment of significance: Major adverse significant effects prior to mitigation predicted on Second World War features if removed with the existing seawall during the construction of the access route to Project and to open up views across the Bay. Beneficial effect of Project allowing access to previously inaccessible cultural heritage sites. Mitigation: Retention or relocation of key features of cultural heritage importance (Second World War features – gun emplacement, pill boxes, tank cubes associated with the existing seawall) along the access route along southern extent of Queens Dock. Trial trenches and recording prior to construction commencing for Second World War gun emplacement potentially directly affected by construction of access route. Residual effects reduced to negligible to minor adverse post mitigation. Mitigation measures will be detailed in a WSI which will be agreed with CADW and GGAT, prior to construction commencing.



24.3.2 Cumulative Interrelationships

24.3.2.1 The following potentially significant (i.e. moderate or major) adverse cumulative interrelationships prior to mitigation have been identified:

- i. potential collision risk for marine mammals for operational turbines – *interrelationship between changes in coastal hydrodynamics and operational turbines with marine mammals.*
- ii. potential effect on the introduction of non-native species – *interrelationship between navigation and marine transport with subtidal and intertidal benthic ecology.*
- iii. Potential effect on seascape and landscape character and visual amenity – *interrelationship between seascape and landscape visual impact assessment and economy, tourism and recreation.*

Marine mammals and operational turbines and changes in coastal hydrodynamics

24.3.2.2 There is a possibility of an overall increase in the collision risk of marine mammals from the operation of the Project turbines together with the Tidal Energy Ltd Deltastream Demonstrator Installation turbine (Ramsey Sound) and Tidal Stream Energy Demonstration Array turbines (St Davids Head). The assessment undertaken in Chapter 10: Marine Mammals identifies a **moderate adverse** impact. The assessment identifies that all projects will require an adaptive monitoring and mitigation strategy to be in place. For this Project, an Adaptive Environmental Monitoring Plan together with the Operational Environmental Management Plan fulfils this purpose. The residual impact is therefore assessed as **minor adverse**.

Introduction of non-native species and navigation and marine transport

24.3.2.3 The new piles installed as part of the construction of the new RNLI lifeboat station and slipway and the upgrade to the existing coastal defence of Aberavon West Promenade will provide areas of new colonisation surface for subtidal and/or intertidal species in Swansea Bay which are dependent on hard substrate. Together with the Project, these changes could result in potential cumulative/in-combination impacts in relation to the potential colonisation by non-native species. In addition, the existing shipping and recreational boating activity within the Bay will contribute to this impact pathway via the fouling of vessels' hulls and transport of species in ballast or bilge water. The overall cumulative and/or in-combination impact on all intertidal and subtidal benthic ecology features associated with the potential introduction of non-native species is considered to be **insignificant to major adverse significant**.

24.3.2.4 The residual impact of the potential introduction of non-native species on intertidal and subtidal ecology during operation of the Lagoon can be limited further by following best practice guidelines, in addition to following the guidelines on ballast water exchange and hull fouling described in Chapter 8 Intertidal and Subtidal Benthic Ecology. The application of these best practice mitigation measures will reduce the residual impact to intertidal and subtidal features to **insignificant to minor adverse significant**. In addition, the presence of non-native species will be monitored to determine the composition and distribution of any non-native species on the Lagoon wall during operation. Appropriate



measures will be established for any invasive species found to be present (see Appendix 23.1).

Seascape and landscape visual impact assessment and economy, tourism and recreation

- 13.11.0.1 Cumulative effects on seascape and landscape character are predicted to be significant from locations within or immediately adjacent to the development boundary during the construction phase. To the east of the Lagoon seawalls within Crymlyn Burrows, the increase in development perceptible may lead to a noticeable change in character. The significance of effects on visual amenity will diminish with distance, as construction activity will predominantly be viewed as a component of the wider view.
- 13.11.0.2 Cumulative effects are considered to be significant from locations within the immediate surroundings of the Project boundary during the operational phase. From all other locations cumulative effects are considered to be not significant as development is a key existing feature that defines many of the views within the study area. The developments will positively contribute to the ongoing regeneration of the coastal areas of Swansea, while retaining the key elements that define the existing views. It is therefore predicted that the Project and other cumulative developments can be accommodated into the view, without adversely affecting, or changing the overall nature of views.

24.4 References

Joint Nature Conservation Committee (2010) Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals during piling.

Natural Resources Wales (2013) Sea Wise Code.

Planning Inspectorate (2012) Advice Note 9: Use of the 'Rochdale Envelope, Version 2

Legislation

2009 No. 2263, Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 (http://infrastructure.independent.gov.uk/wp-content/uploads/2009/08/uksi_20092263_en.pdf)

EC 76/160/EEC of 8 December 1975 concerning the quality of bathing water

EC 2000/60/EC - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

EC 854/2004 Regulation (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004, *laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption*.

EC 853/2004 - Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004, *laying down specific hygiene rules for food of animal origin*.

EC 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

EC 2006/113/EC - Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006, on the quality required of shellfish waters.