

## 8 Marine Ecology

This chapter considers the potential impacts of the proposed scheme on marine species and habitats. The approach to this assessment is based on Design Manual for Roads and Bridges (DMRB) guidance (Volume 11, Section 3, Part 4: Ecology and Nature Conservation) and draws on the Chartered Institute for Ecology and Environmental Management's (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland.

Baseline conditions for marine ecological features were established through a desk-based assessment, consultation and site surveys. This process identified seven ecological features that could potentially be impacted by the proposed scheme. These were intertidal mudflats, saltmarsh, subtidal habitat and communities, non-migratory fish, migratory fish, cetaceans and seals. Four designated sites, the Firth of Forth Special Protection Area (SPA), the Firth of Forth Ramsar site, the Firth of Forth Site of Special Scientific Interest (SSSI) and the River Teith Special Area of Conservation (SAC) were also identified. These designated sites are discussed in the context of this chapter but potential effects on the designated sites are assessed within Chapter 6 (Geology, Soils and Groundwater) and Chapter 9 (Terrestrial Ecology) and the Habitats Regulations Appraisal (HRA) as appropriate.

Assessment of potential impacts and the significance of their effect took into account the nature and magnitude of the impacts and their consequent effects on important ecological features. Prior to the application of mitigation, potential significant effects on ecological features were identified during the construction phase of the proposed scheme, but none were identified during the operational phase.

A hierarchical approach to mitigation was followed to address potential impacts. Where avoidance of impacts has not been possible, mitigation to reduce significant effects has been identified. Measures include the implementation of environmental commitments and best working practices.

The saltmarsh temporarily lost during construction will be subject to measures to aid recovery and the existing National Vegetation Classification (NVC) community is predicted to re-establish in the long-term. It is anticipated that there will be no significant residual effects as a result of construction or the operation of the proposed scheme.

### 8.1 Introduction

- 8.1.1 This chapter presents the assessment of potential impacts on marine ecology and nature conservation for the A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement scheme (hereafter referred to as the proposed scheme) as described in Chapter 3 (The Proposed Scheme).
- 8.1.2 To inform the assessment of potential impacts, this chapter provides an overview of the marine ecology in the vicinity of the proposed scheme. The assessment covers marine ecology features such as marine habitats and their associated communities, fish and marine mammals.
- 8.1.3 The assessments carried out within this chapter acknowledge the activities specific to the marine environment in the construction and operation phase of the proposed scheme (Chapter 3: The Proposed Scheme). In addition to this, a Habitats Regulations Appraisal (HRA) (Jacobs 2020) has been produced to consider the European designated conservation sites and specifically the potential for any likely significant effects on the conservation objectives of these sites.
- 8.1.4 This chapter is supported by the following figures and appendices:
- Figure 8.1 (Designated Sites)
  - Figure 8.2 (Saltmarsh Survey Results)
  - Appendix A8.1 (Detailed Saltmarsh Baseline)
  - Appendix A8.2 (Outline Saltmarsh Management Plan)

## 8.2 Legislation, Policies and Guidance

- 8.2.1 The assessments within the marine ecology chapter are cognisant of relevant legislation and policies, and a summary of these is provided along with guidance relevant to the aquatic environment in Table 8.1.
- 8.2.2 Appendix A4.1 (Assessment of Policy Compliance) provides further information on policies and plans relevant to the proposed scheme as well as detailing the outcomes of a compliance assessment against each policy.

**Table 8.1: Relevant Legislation, Conventions and Guidance**

Legislation, Conventions and Guidance	Summary
<b>International</b>	
The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR)	Annex V of the convention provides a framework for contracting parties 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.
The Habitats Directive (92/43/EEC)	The European Union Directive (92/43/EEC) on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive) is the means by which the Community meets its obligations as a signatory of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). The Directive introduces a range of measures including the protection and surveillance of habitats and species. The main aim of the Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species at a favourable conservation status, introducing robust protection for those habitats and species of European importance. The habitats listed in Annex I of the Directive and the species listed in Annex II, are to be protected by means of a network of sites. Each Member State is required to prepare and propose a national list of sites for evaluation in order to form a European network of Sites of Community Importance (SCIs). Once adopted, these are designated by Member States as Special Areas of Conservation (SACs) and, along with Special Protection Areas (SPAs) classified under the Birds Directive, form a network of protected areas known as Natura 2000.
The Birds Directive (79/409/EEC)	The European Union Directive on the Conservation of wild birds (79/409/EEC) was adopted in 1979. The Birds Directive is a primary tool for delivering EU obligations under the Convention on Biological Diversity (CBD), and the Ramsar and Bonn Conventions. The Birds and Habitats Directives require Member States to take a number of measures/actions in order to protect all bird species, their sites and their habitats. These include measures to conserve and maintain all naturally occurring bird species across the EU through the designation of SPAs for species listed on Annex I of the Directive and migratory species.
Ramsar Convention	The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention or Wetlands Convention) was adopted in Ramsar, Iran in February 1971 and entered into force in December 1975. The Convention covers all aspects of wetland conservation and comprises three elements of activity: the designation of wetlands of international importance as Ramsar sites; the promotion of the wise use of all wetlands in the territory of each country; and international co-operation with other countries to further the wise use of wetlands and their resources.
Water Framework Directive (2000/60/EC) (WFD)	The Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (WFD) was transposed into Scottish domestic law under the Water Environment and Water Services (Scotland) Act 2003 (WEWS). The WFD introduced a system of river basin management planning to protected rivers, estuaries, coastal and groundwater and set targets for waterbodies to achieve Good Ecological Status.
European Eel (Council Regulation (EC) No 1100/2007 establishing measures for the recovery of the stock of European eel)	In response to the decline of European eel ( <i>Anguilla anguilla</i> ) the EU proposed an Eel Management Plan in 2004, which entered into force in 2007. The aim of the plan is to protect and ensure the sustainable use of European eel stocks. A key objective is to ensure that at least 40% of the potential production of adult European eel (potential production refers to pristine conditions) escape to the sea. Under the resulting Council Regulation each Member State is required to create separate management plans for each river basin district. In Scotland the Eel Management Plan for Scotland River Basin District was developed.

Legislation, Conventions and Guidance	Summary
<p>Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)</p>	<p>ASCOBANS was concluded in 1991 under the Bonn Convention and entered into force in 1994. The agreement offers protection of all species and subspecies of the Odontoceti, with the exception of the sperm whale, through the obligation of signatory parties to set up protected areas, promote research, control pollution and increase public awareness (ASCOBANS 2008).</p> <p>The Agreement originally only covered the North and Baltic Sea but as of 3 February 2008 the area has been extended to include the marine environment of the Baltic and North Seas and contiguous areas of the northeast Atlantic. Ten countries have so far become Parties to the Agreement, including the UK.</p>
<b>National</b>	
<p>The Wildlife and Countryside Act 1981 (WCA) as amended</p>	<p>The Wildlife and Countryside Act 1981 (as amended) is the principal mechanism for wildlife protection in the UK. Its aim is to implement the requirements of the Bern Convention and the Birds Directive. The statutory designation of SSSI is the main site protection measure in the UK established under the Act.</p>
<p>Conservation (Natural Habitats, &amp; c.) Regulations 1994 as amended</p>	<p>The Conservation (Natural Habitats, &amp;c.) Regulations 1994 (as amended in Scotland) transpose the EC Habitats Directive into national law. The Regulations provide for the designation and protection of 'European sites', the protection of 'European Protected Species', and the adaptation of planning and other controls for the protection of European sites.</p> <p>Under the Regulations it is an offence (subject to exceptions) to deliberately capture, kill, disturb, or trade in the animals listed in Schedule 2 of the Regulations, or to pick, collect, cut, uproot, destroy, or trade the plants listed in Schedule 4. These actions can however be made lawful through the granting of licences by the appropriate authorities.</p>
<p>Nature Conservation (Scotland) Act 2004</p>	<p>This Act places duties on public bodies in relation to the conservation of biodiversity. It also amends and strengthens existing nature conservation legislation and increases protection for SSSIs.</p> <p>In addition, the Act places a duty on every public body to further the conservation of biodiversity and requires Scottish Ministers to designate one or more strategies for the conservation of biodiversity as the Scottish Biodiversity Strategy. It also requires Scottish Ministers to publish a list of habitats and species considered to be of principal importance for biodiversity. The Scottish Biodiversity List (SBL) is intended to be a tool for public bodies and an important source of information and guidance for all.</p>
<p>Marine (Scotland) Act 2010</p>	<p>The Marine (Scotland) Act 2010 places a duty on Scottish Ministers and public authorities to promote sustainable development, and protection and enhancement of the health of the Scottish marine environment. It does this by providing a framework for statutory marine planning, marine licencing, marine conservation, seal conservation and enforcement.</p> <p>Under this Act, Scottish Ministers are required to produce national and regional marine plans and assess all developments against these plans. The Act also enables Scottish Ministers to designate marine protected areas (MPAs) for the purposes of nature conservation, demonstration and research, and protection of historic features.</p> <p>This Act requires that licences are obtained from the Scottish Ministers for certain activities, including construction work, below the mean high water springs limit. When applying for a marine licence the applicant must provide the ministers with sufficient information to determine the application with regard to protection of the environment, protection of human health and prevention of interference with legitimate uses of the sea.</p>
<p>The Protection of Seals (Designation of Seal Haul-out Sites) (Scotland) Order 2014</p>	<p>The Protection of Seals (Designation of Seal Haul-Out Sites) (Scotland) Order 2014 was created to enact powers specified in the Marine (Scotland) Act 2010 in relation to the protection of seals. The order lists the sites throughout Scotland which, following consultation with the Natural Environment Research Council (NERC), were designated as seal haul-outs which are protected from harassment under the Marine (Scotland) Act 2010.</p>
<p>Water Environment and Water Services (Scotland) Act 2003 (WEWS)</p>	<p>The Water Environment and Water Services (Scotland) Act 2003 transposes the Water Framework Directive into Scottish law. In addition to protecting and enhancing the status of surface and groundwater as required under WFD, WEWS extends these requirements to wetlands. It also places a responsibility on Scottish Water to take responsibility for the on-going maintenance of all SuDS (Sustainable Drainage Systems).</p>
<p>Eel Management Plans for the United Kingdom Scotland River Basin District (2010)</p>	<p>The Scotland River District Eel Management Plan was produced to meet the requirements of the European Eel Recovery Plan (Council Regulation No 1100/2007) and sets management targets and monitoring responsibilities to aid stock recovery and determine effectiveness of management measures.</p>

Legislation, Conventions and Guidance	Summary
<b>Non-Statutory Guidance and Policies</b>	
Marine Scotland – The Protection of Marine European Protected Species from Injury and Disturbance – Guidance for Inshore Waters (Marine Scotland 2014).	This document provides guidance for developers on the assessment of activities for the potential to impact cetaceans and the disturbance licence requirements.
Scottish Biodiversity List (SBL) (Scottish Government 2013; Scottish Ministers 2005).	The SBL details the plants, animals and habitats that are considered by the Scottish Ministers to be of importance for biodiversity conservation in Scotland.
Local Biodiversity Action Plans (BAP)	Second Nature, A Biodiversity Action Plan for the Falkirk Council area (Falkirk Council 2019) identifies 20 local priority habitats, 102 local priority species and includes nine action plans that will benefit local wildlife. The 'Estuary' and 'Water and Wetland' action plans are particularly relevant to the proposed scheme. The Fife BAP (Fife Biodiversity Partnership 2013) includes intertidal communities and saltmarsh as priority habitats. However as this is applicable to the northern shore of the estuary, is not considered relevant to this assessment.
Scottish Priority Marine Features (Scottish Ministers 2014)	Scottish Priority Marine Features (PMFs) are marine habitats and species that are considered by the Scottish Ministers to be priorities for conservation in Scottish waters.

### 8.3 Approach and Methods

8.3.1 This assessment follows the approach recommended in the following guidance documents:

- DMRB Volume 11, Section 3, Part 4: Ecology and Nature Conservation (Highways Agency, Scottish Government, Welsh Assembly Government and the Department of Regional Development Northern Ireland 1993);
- the Chartered Institute for Ecology and Environmental Management’s (CIEEM) Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM 2018);
- DMRB Interim Advice Note 130/10 ‘Ecology and Nature Conservation: Criteria for Impact Assessment’ (Highways Agency, Scottish Government, Welsh Assembly Government and the Department of Regional Development Northern Ireland 2010) (hereafter referred to as IAN 130/10); and
- Scottish Natural Heritage (SNH) Environmental Impact Assessment Handbook (SNH 2018a).

8.3.2 Full details of the consultation process can be found in Chapter 5 (Consultation and Scoping). Key consultees relevant to this chapter are:

- Marine Scotland;
- Scottish Environment Protection Agency (SEPA);
- SNH;
- Falkirk Council;
- Fife Council; and
- Forth District Salmon Fisheries Board.

### Study Area

- 8.3.3 The study area for the assessment was identified based on the distribution of potential features and the likely area of impact associated with a given activity from the proposed scheme, either in the construction or operation phase.
- 8.3.4 CIEEM guidance suggests that the zone(s) of influence for the activities should be considered (CIEEM 2018). The zone of influence is the area over which ecological features may be subject to significant effects as a result of the proposed scheme, or a specific activity associated with the proposed scheme. For the purposes of this chapter the various study areas represent an area that covers, at least, the likely zone of influence for significant effects on the specific marine ecological feature identified.

### Baseline Conditions

#### Desk-based Assessment

- 8.3.5 The key literature and websites used to gather information to inform the baseline assessment include:
- Kincardine Bridge Refurbishment Environmental Review Report (hereafter referred to as 2009 ERR) (Jacobs 2009);
  - Environmental Statement (ES) for the Upper Forth Crossing project (hereafter referred to as 2003 ES) (Scottish Executive 2003);
  - Stage 3 Ecological Impact Assessment of the Proposed Second Forth Crossing at Kincardine on Forth (Northern Ecological Services 2003);
  - A985 Kincardine Bridge Refurbishment: Piled Viaduct Replacement Scoping Report (Jacobs 2018);
  - SNH Information Service (SNH 2018b);
  - SNH Scottish Priority Marine Feature (PMF) list (Scottish Ministers 2014);
  - Marine Scotland National Marine Plan Interactive (NMPi) (Marine Scotland 2018a);
  - Scottish Biodiversity List (SBL) (Scottish Ministers 2005);
  - Marine Life Information Network (MarLIN) habitat and species sensitivity (The Marine Biological Association of the UK 2018); and
  - Feature Activity Sensitivity Tool (FEAST) (Marine Scotland Compliance 2013).

#### Site Survey

- 8.3.6 In June 2018 a saltmarsh survey was conducted encompassing the areas of saltmarsh immediately up and downstream of the existing piled viaduct, extending 100m or more from the Kincardine Bridge along the south bank of the estuary (Figure 8.2). Homogenous habitats were identified within this survey area and five quadrats were surveyed within each habitat to classify them according to the National Vegetation Classification (NVC) (Rodwell 2000) (Appendix A8.1: Detailed Saltmarsh Baseline). The survey was undertaken by surveyors with expert botanical identification skills and extensive experience of NVC surveys.
- 8.3.7 Surveys were not undertaken for any other marine receptors due to the limited potential for direct effects from the proposed scheme, and the availability of sufficient data to conduct the assessment. This approach followed that set out in the Scoping Report (Jacobs 2018) which was sent to relevant stakeholders for consultation (Chapter 5: Consultation and Scoping).

### Impact Assessment

- 8.3.8 The assessment has been undertaken through interpretation of baseline data, review of relevant literature, relevant websites, application of relevant legislation, undertaking consultation and use of

professional judgement. The assessment has been based on the information provided in Chapter 3 (The Proposed Scheme) and Appendix A3.1 (Construction Information). The principles and approach of the CIEEM guidance (CIEEM 2018) have been acknowledged and standard impact assessment terms have been used, where appropriate, to provide consistency with the other assessments in this Environmental Impact Assessment (EIA) Report.

8.3.9 In making this assessment, the ecological feature (receptor) is defined as the habitat, species or ecosystem within the receiving environment that may be influenced by the change. The impact represents the actions resulting in changes to an ecological feature.

8.3.10 An assessment of effect significance is carried out by first determining the baseline conditions and value/sensitivity (importance) of the feature, followed by characterising the impact on the feature; the effect significance being a combination of these variables.

Feature Importance

8.3.11 The importance of an ecological feature is considered within a defined geographical context (e.g. international, national, regional, estuarine system and local) and based on conservation designations (Table 8.2) in accordance with CIEEM (2018). Factors taken into account in determining the importance of an ecological feature included its:

- rarity and uniqueness;
- ability to resist or recover from environmental change;
- function/role within an ecosystem; and
- level of legal protection or designation.

**Table 8.2: Importance Criteria for Ecological Features**

Feature Importance	Criteria
International	<p><b>Ecosystems and Habitats</b>                      Ecosystems or habitats essential for the maintenance of:</p> <ul style="list-style-type: none"> <li>• internationally designated areas or undesignated areas that meet the criteria for designation; and/or</li> <li>• viable populations of species of international conservation concern.</li> </ul> <p><b>Species</b>                      Species whose presence contributes to:</p> <ul style="list-style-type: none"> <li>• the maintenance of qualifying habitats, communities and assemblages that occur within internationally designated sites or within undesignated areas that meet the criteria for such designation.</li> </ul>
National	<p><b>Ecosystems and Habitats</b>                      Ecosystems or habitats essential for the maintenance of:</p> <ul style="list-style-type: none"> <li>• qualifying communities and assemblages that occur within nationally designated sites or within undesignated areas that meet the criteria for such designation; and/or</li> <li>• viable populations of species of national conservation concern.</li> </ul> <p><b>Species</b>                      Species whose presence contributes to:</p> <ul style="list-style-type: none"> <li>• the maintenance of qualifying habitats, communities and assemblages that occur within nationally designated sites or within undesignated areas that meet the criteria for such designation; or</li> <li>• the maintenance and restoration of biodiversity and ecosystems at a national level, as defined in the Scottish Biodiversity Strategy (SBS) (Scottish Government 2013; Scottish Executive 2004).</li> </ul>
Regional	<p><b>Ecosystems and Habitats</b>                      Ecosystems or habitats essential for the maintenance of:</p> <ul style="list-style-type: none"> <li>• communities and assemblages that occur within regionally important sites or localities listed as being of conservation importance in the Falkirk Biodiversity Action Plan (BAP) (Falkirk Council 2019) or within undesignated areas that meet the criteria for such designation;</li> <li>• key habitat systems listed in the Falkirk BAP; and/or</li> </ul>



Feature Importance	Criteria
	<ul style="list-style-type: none"> <li>• viable populations of species of regional conservation concern.</li> </ul> <p><b>Species</b>                      Species whose presence contributes to:</p> <ul style="list-style-type: none"> <li>• the maintenance and restoration of biodiversity and ecosystems at a regional level, as described in the Falkirk BAP (Falkirk Council 2019).</li> </ul>
Estuarine	<p><b>Ecosystems and Habitats</b>                      Ecosystems or habitats essential for the maintenance of:</p> <ul style="list-style-type: none"> <li>• populations of species of conservation concern within the Forth Estuary.</li> </ul> <p><b>Species</b>                      Species whose presence contributes to:</p> <ul style="list-style-type: none"> <li>• the maintenance and restoration of biodiversity and ecosystems of importance to the Forth Estuary.</li> </ul>
Local	<p><b>Ecosystems and Habitats</b>                      Ecosystems or habitats essential for the maintenance of:</p> <ul style="list-style-type: none"> <li>• populations of species of conservation concern within the local area of the Kincardine Bridge.</li> </ul> <p><b>Species</b>                      Species whose presence contributes to:</p> <ul style="list-style-type: none"> <li>• the maintenance and restoration of biodiversity and ecosystems at a local level.</li> </ul>

8.3.12 Whilst biodiversity should be protected in its entirety wherever possible, 'it is not necessary to carry out detailed assessment of features that are sufficiently widespread, unthreatened and resilient to project impacts' (CIEEM 2018). Only features considered important and potentially affected by the proposed scheme are subject to impact assessment. Therefore, features that do not meet the criteria for at least local importance are not considered in detail in this assessment.

Characterisation of Impact

8.3.13 For the purposes of this assessment, the characterisation of impacts in Table 8.3 are taken to summarise the overall characterisation of positive or negative impacts in accordance with CIEEM guidelines (CIEEM 2018), considering:

- impact extent/scale (e.g. entire habitat loss, partial habitat loss or indication over specific area affected);
- direct or indirect impact (e.g. direct loss of a habitat under the works footprint, or indirect mortality of individuals from reduced prey resources due to pollution of watercourses);
- reversibility of impact (reversible or irreversible);
- frequency and timing of impact (single event, recurring or constant, occurrence during a critical life-stage);
- duration of impact (short-term, medium-term, long-term or permanent); and
- likelihood of occurrence (certain/near certain, probable, unlikely or extremely unlikely).

8.3.14 For potential impacts on marine ecological features, duration is considered as short-term (<1 year); medium term (1 – 5 years); or long term (>5 years or permanent).

8.3.15 With the use of professional judgement and the criteria outlined in Table 8.3, impacts on marine ecological features were characterised as major, moderate, minor and negligible.

**Table 8.3: Impact Characterisation for Marine Ecological Features**

Characterisation of Impact	Criteria
Major	<p>The activity is likely to permanently affect the integrity of a feature in terms of the coherence of its ecological structure and function to the ecosystem; and affect the conservation status and/or objectives of a feature.</p> <p>The feature is degraded to the extent that populations and/or habitats are destroyed, or sensitive life stages are affected. Features experience continuous, irreversible, long-term change.</p> <p>The feature has low capacity to adapt to change. Recovery, if it occurs, would be expected to be long-term, i.e. &gt;5 years after the source of impact has been removed.</p> <p>Impacts not limited to areas proximal and adjacent to the development, with impacts possibly detectable beyond the study area.</p>
Moderate	<p>The activity is not likely to permanently affect the integrity of a feature but may be substantial in terms of its effect on ecological structure and function and may affect the conservation status and/or objectives of a feature.</p> <p>The feature is degraded to the extent that populations and/or habitats experience a reduction in number or range in the medium to short-term. Features experience regular intermittent change which may affect sensitive life stages.</p> <p>The feature has medium capacity to adapt to change. Recovery would be expected to occur in the medium-term, i.e. 1 - 5 years after the source of impact has been removed.</p> <p>Impacts generally limited to areas proximal and/or adjacent to the development.</p>
Minor	<p>The activity would not permanently affect the integrity of the feature, but features may experience some limited degradation.</p> <p>Disturbance is detectable but experienced within the range of natural variability in the medium to short-term. Features experience intermittent irregular change and sensitive life stages are not affected.</p> <p>The feature has high capacity to adapt to change. Recovery would be expected to occur in the short-term, i.e. &lt;1 year after the source of impact has been removed.</p> <p>Impacts limited to area proximal to development.</p>
Negligible	<p>The activity would not permanently affect the integrity of the feature and there would be little or no degradation.</p> <p>The change to baseline conditions is not detectable. Disturbance is experienced within the range of natural variability in the short-term. Features experience occasional change and sensitive life stages are not affected.</p> <p>The feature has very high capacity to adapt to change. Recovery would be expected relatively quickly, i.e. less than six months after the source of impact has been removed.</p> <p>Impacts limited to area proximal to development.</p>

**Significance of Effects**

- 8.3.16 The level of significance of an effect is determined as a function of the importance assigned to the ecological feature and the characterisation of impact. Professional judgement is the principal factor in determining which effects would be significant, however it is generally considered that where impacts on internationally, nationally or regionally important ecological features are characterised as ‘moderate’ or ‘major’, the effects are considered to be potentially significant under the terms of The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017 (hereafter referred to as the Roads EIA Regulations) and mitigation would be developed to reduce impacts where feasible.
- 8.3.17 Impacts on internationally important features characterised as ‘minor’, and impacts characterised as ‘major’ on features of estuarine importance, can also have potentially significant effects. There may be an additional number of impacts on a feature that, whilst not of a character to result in significant effects in themselves, may cumulatively result in a significant effect on that feature.
- 8.3.18 Significant effects are those that impact on structure and function of defined sites, habitats or ecosystems and the conservation status of important habitats and species (CIEEM 2018).



### **Mitigation**

- 8.3.19 Under section 20C of the Roads EIA Regulations the EIA Report should provide '*a description of the measures envisaged to avoid, prevent, reduce or, if possible, offset any identified significant adverse effects on the environment and, where appropriate, of any proposed monitoring arrangements.*'
- 8.3.20 Following the baseline assessment, if a given impact is identified as having significant effects, consideration is given to the identification and application of mitigation. Mitigation will follow a hierarchical approach, seeking to avoid, reduce, and if a residual effect remains, compensate significant adverse effects.
- 8.3.21 Mitigation of an environmental impact may be achieved through adherence to good practice management measures, embedded mitigation and/or the application of additional mitigative measures specific to an impact which form part of essential mitigation for the proposed scheme. Embedded mitigation and essential mitigation measures are detailed within Section 8.5 (Potential Impacts) and Section 8.6 (Mitigation) respectively.

### **Residual Effects**

- 8.3.22 Having taken mitigation into account, the residual effects provide a description of any remaining effects that are still significant. Residual effects on ecological features are detailed within Section 8.7 (Residual Effects).
- 8.3.23 Where relevant to further understanding and/or validation of a given assessment, consideration of potential monitoring of a feature has also been identified.

### **Limitations to Assessment**

- 8.3.24 Baseline conditions for marine species, as described in Section 8.4 (Baseline Conditions), have been informed predominantly by desk-based information. It is acknowledged that more recent data or location specific information would be preferable, however, given the limited potential for the proposed scheme to impact these species, the intensive and intrusive nature of the surveys required to gather such data is considered to outweigh the benefits provided. The data collected were sufficient for the purpose of this assessment in compliance with DMRB and CIEEM guidelines for EIA.

## **8.4 Baseline Conditions**

- 8.4.1 This section summarises the existing ecological conditions that have been determined through desk-based assessment, consultation and site surveys. Where relevant, reference is given to focussed reports specific to the area, or more generic scientific literature.

### **Overview**

- 8.4.2 The Firth of Forth is an inlet of the North Sea, which extends from the estuary of the River Forth (the tidal limit being at Stirling) to Bass Rock near North Berwick. Sometimes a distinction is made between the Firth of Forth and the Forth Estuary, with the Estuary generally considered to be from Stirling to the Forth road and rail bridges and the Firth downstream of these bridges. However, unless a specific distinction is made, any reference to the Firth of Forth should be taken to include the Forth Estuary and vice versa.
- 8.4.3 The Firth of Forth is a busy waterway with a large petrochemical complex at Grangemouth, commercial docks at Leith, oil rig construction yards at Methil, a ship-breaking facility at Inverkeithing and the Rosyth Dockyard. Maintenance dredging is regularly carried out at a number of locations in the Firth of Forth, with a dredge spoil disposal site located mid channel between Bo'ness and Culross.

- 8.4.4 The proposed scheme is within the following overlapping statutory designated sites (Figure 8.1) (see Chapter 6 (Geology, Soils and Groundwater) and Chapter 9 (Terrestrial Ecology) for further details and assessment):
- Firth of Forth SPA - designated for the protection of an internationally important population of waders and wildfowl which visit the area during winter, and for Sandwich tern (*Thalasseus sandvicensis*) migration.
  - Firth of Forth Ramsar Site – designated for protection of waterfowl assemblages and certain bird species populations of international importance.
  - Firth of Forth SSSI - designated for a variety of features including breeding shelduck (*Tadorna tadorna*), ringed plover (*Charadrius hiaticula*) (which breeds at Skinflats, located downstream of the proposed scheme), eider duck (*Somateria mollissima*), saltmarsh habitats and geological features.
- 8.4.5 The River Teith Special Area of Conservation (SAC), designated for sea lamprey (*Petromyzon marinus*), brook lamprey (*Lampetra planeri*), river lamprey (*Lampetra fluviatilis*) and Atlantic salmon (*Salmo salar*), is approximately 20km upstream of the proposed scheme. Although it is a significant distance from the proposed scheme, the conservation features of this designated site have been included in the assessment due to the potential for works to affect migratory fish species. An assessment of potential impacts on the SAC is detailed in the HRA report (Jacobs 2020).
- 8.4.6 Non-statutory designated sites are also present in the Firth of Forth. Immediately downstream of the proposed scheme, on the southern bank of the estuary, is Skinflats RSPB Reserve which encompasses saltmarsh and mudflat habitats, offering important bird habitat particularly for over-wintering and passage birds. Also, on the southern side of the estuary, on the upstream side of the proposed scheme, lies the Pow Burn and Estuary Wildlife Site, designated for saltmarsh habitat and associated flora and fauna (Falkirk Council 2016). Part of the land made available for temporary works and construction lies within the Pow Burn and Estuary Wildlife Site. Torry Bay Local Nature Reserve (LNR) is located on the northern bank of the estuary, approximately 3.5km downstream of the Kincardine Bridge and encompasses a large area of intertidal mudflat habitat. All of these sites overlap with the internationally and nationally designated Firth of Forth SPA, Ramsar site and SSSI. As the features of interest and site boundaries overlap with the statutory designated sites, these non-statutory sites are not considered further in this assessment.

### **Intertidal Habitats**

#### Baseline Conditions

- 8.4.7 The Firth of Forth contains several intertidal habitats including saltmarsh and mudflats.

#### *Mudflats*

- 8.4.8 Mudflats are important habitats which not only absorb wave energy providing natural sea defences but are a sink for organic material, while providing an important food resource for wading birds and wildfowl, and juvenile fish habitat (Baxter, Boyd, Cox, Donald, Malcom, Miles, Miller and Moffat 2011). The approximate areal extent of mudflats in the Firth of Forth Ramsar site is 4672.12ha, with Skinflats being one of three notable mudflat areas (JNCC 2005). The mudflats directly under and adjacent to the proposed scheme are comparatively narrow, approximately 30m in width from the seaward margin of the saltmarsh habitat to the infralittoral fringe (Figure 8.2), and minimal in areal extent when compared to the extensive mudflats further upstream (Kennet Pans and around the mouth of Pow Burn) and downstream (Skinflats) from the bridge. However, this narrow band of mudflat provides connectivity to the more extensive mudflat habitats.
- 8.4.9 During a saltmarsh survey in 2018 (paragraph 8.3.6) a discrete and small (~5m<sup>2</sup>) patch of bare mud was recorded under the Kincardine Bridge. The mud is largely devoid of vegetation despite being adjacent to saltmarsh habitat. The extensive shading under this section of the bridge is considered to account for

the lack of saltmarsh vegetation. The mud is located at the mid to upper extent of the shore and, as with the surrounding saltmarsh, only subject to seawater immersion on high spring tides. Its small size, position up the shore and under the bridge, combined with the potential for freshwater runoff means it is not part of the wider estuarine mudflat feature that pervades throughout the upper and mid estuary. Nor does it provide the same food resource to fish or birds as the estuarine mudflats that receive regular seawater immersion.

- 8.4.10 The mudflat invertebrate fauna in the Kincardine area was previously reported to be dominated by oligochaete worms, with the polychaete *Hediste diversicolor*, the burrowing crustacean *Corophium volutator* and the molluscs *Limecola* (formerly *Macoma*) *balthica* and *Hydrobia ulvae* providing almost all the remaining biomass (McLusky 1987). The abundances of these species between Alloa and Kincardine were found to be lower than might be expected from comparison with similar estuaries elsewhere in Scotland, it being suggested that this was due to high organic loading in this area which would tend to favour oligochaetes over other macrofaunal species (McLusky 1987). More recent work by Lyndon, Kingston and Moore (2000) supports the findings of McLusky (1987), with fairly low species diversity found on the mudflats in the vicinity of Kincardine but high abundances of oligochaetes.

#### *Saltmarsh*

- 8.4.11 The SNH-commissioned Scottish saltmarsh survey (Haynes 2016) encompassed 7,704ha of saltmarsh and associated habitats throughout Scotland. A total of 119ha of saltmarsh was recorded in the Forth. Small areas of pioneer saltmarsh were recorded in the Firth of Forth at Grangemouth and Skinflats. The Habitat Map of Scotland (SNH 2018c) records an almost continuous thin band of saltmarsh (Habitats Directive Annex I habitat - H1330 Atlantic salt meadow) from 14km upstream of the Kincardine Bridge to 7km downstream. Communities of note recorded in the Firth of Forth include pioneer saltmarsh (Habitats Directive Annex I habitat - H1310 *Salicornia* and other annuals colonising mud and sand) which has restricted distribution in Scotland, and the NVC sub-community SM12a (coastal stands of rayed *Aster tripolium*) which is rare in Scotland. NVC sub-community SM16d (tall *Festuca rubra* dominated sub-community), which is widespread and common in Scotland, covered large areas of Skinflats (Haynes 2016).
- 8.4.12 To inform the 2003 ES a survey was carried out on the saltmarsh around the Kincardine Bridge (Northern Ecological Services 2003) using NVC (Rodwell 2000). The results of this study are provided in Appendix A8.1 (Detailed Saltmarsh Baseline). This area of saltmarsh was considered typical of those within the wider Firth of Forth with the vegetation communities recorded common or relatively common to the Forth Estuary. The vegetation communities were generally low in species diversity, with localised increases in diversity recorded in the well-developed creeks. The six NVC communities listed below were recorded from the areas up and downstream of the Kincardine Bridge. Of these SM13 (*Puccinellia maritima* low marsh) and SM16 (*Festuca rubra* mid marsh) were the most abundant.
- SM8 – *Salicornia pioneer* low marsh
  - SM10 – *Puccinellia maritima* – *Salicornia* transitional low marsh
  - SM11/SM12 – *Aster tripolium* low marsh
  - SM13 – *Puccinellia maritima* low marsh
  - SM16 – *Festuca rubra* mid marsh
  - SM28 – *Elymus repens* high marsh
- 8.4.13 The 2009 ERR highlighted that the sparse saltmarsh habitat under the existing piled viaduct has been affected by previous bridge construction and maintenance activities. Habitat is fragmented in the vicinity of the hardcore ramp which was built around 1990 and removed following construction of the Clackmannanshire Bridge.

- 8.4.14 Results of the saltmarsh survey around the Kincardine Bridge in June 2018 are presented in Figure 8.2 and Appendix A8.1: (Detailed Saltmarsh Baseline. Overall) the survey confirmed the findings of previous reports (Haynes 2016; Northern Ecological Services 2003) i.e. that the vegetation communities had relatively low diversity and were typical of those found throughout the wider Firth of Forth. Similar to the survey undertaken for the 2003 ES, the NVC communities SM13 and SM16 were found to be the dominant communities both up and downstream of the existing bridge.
- 8.4.15 The area of saltmarsh previously within the footprint of the hardcore ramp had an identical species list to the adjacent and surrounding saltmarsh area, with the main differentiator being a notably lower abundance of sea arrowgrass (*Triglochin maritima*) within the historic footprint (3% coverage compared to 29% coverage in the adjacent marsh). However, this species is known to be slow at recolonising disturbed areas (Erfanzadeh, Garbutt, Petillion, Maelfait and Hoffman 2010). The dominant species, sea plantain (*Plantago maritima*), was recorded at 36% coverage in both the area of the historic footprint and the adjacent and surrounding saltmarsh area; however, a greater coverage of scurvy grass (*Cochlearia officinalis*) and common saltmarsh grass (*Puccinellia maritima*) was recorded within the area of the historic footprint.
- 8.4.16 No species of conservation interest, determined by presence on the SBL, were recorded during the saltmarsh survey.

#### Feature Importance

##### *Mudflats*

- 8.4.17 Mudflats and sandflats not covered by seawater at low tide are listed on Annex I of the Directive 92/43/EEC on the conservation of natural habitats and wild flora and fauna (Habitats Directive) and although not a qualifying feature of the Firth of Forth SPA, the conservation objectives for the site include avoiding deterioration of and maintenance of the distribution and extent of habitat supporting the qualifying species. Intertidal mudflats are included on the SBL and are a Scottish PMF. The Estuary Action Plan, part of the Falkirk Council Biodiversity Action Plan (BAP), lists intertidal mudflats as a priority habitat (Falkirk Council 2019).
- 8.4.18 The mudflats around the Kincardine Bridge contribute to a complex of habitats supporting international populations of waders and wildfowl, however the mudflats directly adjacent to the Kincardine Bridge are limited and do not provide important habitat.
- 8.4.19 Mudflats in the study area are considered to be of national importance.

##### *Saltmarsh*

- 8.4.20 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) are listed on Annex I of the Habitats Directive. As with mudflats, saltmarsh is not a qualifying feature of the Firth of Forth SPA, but it is a notable feature of the SSSI. The conservation objectives for the SPA and SSSI include avoiding deterioration of, and maintenance and enhancement of, the distribution and extent of habitat supporting the qualifying species. Coastal saltmarsh is also included on the SBL and as a priority habitat on the Estuary Action Plan, part of the Falkirk Council BAP (Falkirk Council 2019).
- 8.4.21 While the saltmarsh around the Kincardine Bridge is relatively species poor and does not contain any species of conservation interest, it is typical of saltmarsh throughout the wider estuary and is important for maintenance of the habitat on a broader scale.
- 8.4.22 Saltmarsh habitat around the bridge is considered to be of national importance.

## Subtidal Habitats

### Baseline Conditions

- 8.4.23 The Forth Estuary covers an area of approximately 1,670km<sup>2</sup> in extent. This can be divided into three key sections, lower, mid and upper estuary, based on varying physical and biological parameters. The desk-based assessment encompasses the subtidal benthic environment adjacent to and under the Kincardine Bridge with some extension up and downstream, thus allowing a greater understanding of the faunal communities characterising the mid to upper region of the estuary.
- 8.4.24 The estuarine waters of the Forth have long been subjected to industrial discharges, dredging and spoil dumping. This has led to a number of benthic ecology studies over several decades. The characterisation of the subtidal benthic environment of the mid to upper estuary specifically around the Kincardine Bridge is derived from these studies, in particular a comprehensive study of the sublittoral benthic fauna of the estuary by Elliott and Kingston (1987).
- 8.4.25 The estuarine sediments of the Forth are predominantly silt, muds and clays; however, where the estuary constricts at the Kincardine Bridge, for example, there are areas of coarser mixed sediments. The silt and clay content (material <63µm) is generally >40% and in some areas >85%, within the estuary; however, around the Kincardine Bridge the scouring effect of the water means the silt and clay content is <5% (Elliott and Kingston 1987). Subtidal areas of fine muds are found adjacent to Kinneil and Skinflats mudflats on the south bank of the estuary.
- 8.4.26 The naturally high turbidity of the estuary, especially in the mid to upper reaches of the estuary, prohibits the establishment of any notable algal communities, with faunal assemblages instead characterising the benthic habitat.
- 8.4.27 Work by Elliott and Kingston (1987) found that the benthic fauna from the Kincardine Bridge to Grangemouth was dominated by the polychaete *Polydora ciliata* with >10,300 ind.m<sup>2</sup>. The faunal group recorded from this region of the estuary was assigned as a *Polydora*-oligochaete association, characterised by the polychaete (spionid) worms *Polydora ciliata* and *Marenzelleria wireni* and the oligochaetes *Tubificoides* spp., with associated species recorded as *Capitella capitata*, *Limecola balthica* and *Gammarus salinus*. The faunal composition suggests that the communities here are representative of a mid to upper estuarine community. When compared to the lower estuarine benthic communities, the area from Kincardine Bridge to Grangemouth had notably lower diversity and biomass.
- 8.4.28 From the Kincardine Bridge upstream, as Alloa is approached, there is a transition from polychaete (spionid) dominated to oligochaete dominated communities. The faunal communities are notably poorer than those found in the intertidal; a consequence of the low and fluctuating salinities, a history of high organic inputs and in some areas, including around the bridge, a coarser substratum (McLusky 1987).
- 8.4.29 From the findings of historical studies (Elliott and Kingston 1987; McLusky 1987) it is considered that the subtidal habitat around the Kincardine Bridge encompasses a mosaic of biotopes, these potentially including:
- *Aphelochaeta* spp. and *Polydora* spp. in variable salinity infralittoral mixed sediment (SS.SMx.SMxVS.AphPol);
  - *Polydora ciliata* and *Corophium volutator* in variable salinity infralittoral firm mud or clay (SS.SMu.SMuVS.PolCvol); and
  - *Capitella capitata* and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment (SS.SMu.SMuVS.CapTubi).
- 8.4.30 These biotopes are taken from the Joint Nature Conservation Committee (JNCC) marine habitat descriptions (JNCC 2015).

#### Feature Importance

- 8.4.31 No subtidal benthic communities of conservation importance have been recorded in the mid to upper reaches of the Forth Estuary. The subtidal communities recorded from around the Kincardine Bridge are not thought to contribute to biodiversity other than at a highly localised level.
- 8.4.32 Desk-based assessment results have found fish populations to be particularly impoverished in the vicinity of the Kincardine Bridge (see section below) (Lyndon, Kingston and Moore 2000; SEPA 2014). It is considered that the subtidal invertebrate communities in this part of the estuary are of limited value as a feeding resource for fish species.
- 8.4.33 Subtidal benthic communities are considered to be of local importance.

#### **Fish**

#### Baseline Conditions

- 8.4.34 This section considers fish populations and their utilisation of mid to upper estuarine intertidal and subtidal habitats in the Forth. Particular focus is given to migratory (diadromous) fish, qualifying features of the River Teith SAC (see paragraph 8.4.5) and Scottish PMF species that are likely to be present in this part of the estuary.
- 8.4.35 The Forth's fish population is fairly typical of northern temperate estuaries with variable environmental conditions. Fish species richness is relatively low, but the Forth is an important nursery area for gadoid species such as Atlantic cod (*Gadus morhua*), and as an overwintering area for clupeid species such as sprat (*Sprattus sprattus*) and Atlantic herring (*Clupea harengus*) (Elliott, O'Reilly and Taylor 1990). The estuary is also used by a number of migratory fish (diadromous) species such as sparling (also known as European smelt) (*Osmerus eperlanus*), European eel, sea trout (*Salmo trutta trutta*), Atlantic salmon, sea lamprey and river lamprey.
- 8.4.36 Consideration of available feeding resource is important to help understand the utilisation of estuarine habitats by fish. Intertidal estuarine mudflats are generally considered to be more important feeding areas than subtidal estuarine areas. For example, it has been estimated that although the intertidal areas on the Forth comprise less than one third of the total estuarine area, they may support more than half of the fish diet (McLusky, Bryant and Elliot 1992).
- 8.4.37 The findings of this desk-based assessment are derived from multiple sources spanning almost two decades, encompassing intertidal and subtidal fish surveys. These include a number of references to SEPA data sets from intertidal and subtidal fish studies (SEPA 2014).
- 8.4.38 Recognising that this part of the estuary can be defined as mid to upper estuarine and is therefore subject to low and fluctuating salinities distinguishes it from the true middle and lower estuarine environments and their constituent fish assemblages.
- 8.4.39 This study focusses on fish that use the intertidal saltmarsh and mudflat habitats adjacent to the Kincardine Bridge, primarily on the south bank, and those fish that potentially utilise the subtidal channel running under the bridge. These areas of the estuary form the immediate study area. However, as there are also a number of migratory fish species that use the estuary, an extended study area is used to understand their migrations up and down stream, with detail on these species covered in a separate subsection.

#### *Fish (non-migratory)*

- 8.4.40 Historical intertidal fish surveys carried out on saltmarsh and mudflats to the north and south of the Kincardine Bridge have recorded similar results with samples comprising European eel, herring, sparling,



sprat, trout, cod, whiting (*Merlangius merlangus*), saithe (*Pollachius virens*), three-spined stickleback (*Gasterosteus aculeatus*), common goby (*Pomatoschistus microps*), sand goby (*Pomatoschistus minutus*), eelpout (*Zoarces viviparus*), pipefish (*Syngnathinae* sp.), flounder (*Platichthys flesus*) and plaice (*Pleuronectes platessa*) (Lyndon, Kingston and Moore 2000; SEPA 2014). The most abundant species recorded downstream of the bridge were herring, flounder and sand goby; and upstream of the bridge, flounder, common goby and three-spined stickleback. Flounder, a common estuarine species, dominated in terms of biomass; however, herring were numerically dominant during the summer sampling of the downstream sites. Numbers of juvenile gadoids and trout were low when compared to estuarine species, with small trout recorded on just a few occasions.

- 8.4.41 Work by Lyndon Kingston and Moore (2000) found that upstream of the Kincardine Bridge the most abundant sites for fish were just west of Pow Burn and at Kennet Pans. Conversely, sites closer to the Kincardine Bridge supported notably lower numbers of fish. Reasons hypothesised for this drop in numbers were the comparatively narrower area of mudflat fronting the marsh and the highly scoured nature of the adjacent subtidal channel around the bridge, where historic trawl sampling by SEPA has consistently given the lowest returns of any of the trawl sampling areas in the Forth estuary (Northern Ecological Services 2003).
- 8.4.42 More recent data collected by SEPA in 2014 (SEPA 2014), did not record any fish in two subtidal trawls carried out at the Kincardine sampling location; although at the immediate upstream and downstream sites (Dunmore and Longannet respectively), several fish species were recorded in the trawls, with flounder being numerically dominant.
- 8.4.43 Although intertidal studies have shown that a number of fish species may use saltmarsh areas during particularly high spring tides (5.6m above chart datum or more), it is considered that the unfavourable conditions in the channel running under the Kincardine Bridge lead to the reduction in use of the saltmarsh by fish when compared to other saltmarsh habitat further up or downstream (Lyndon, Kingston and Moore 2000; Northern Ecological Services 2003). The mudflats under and immediately adjacent to the bridge are narrow when compared to the extensive flats at Pow Burn, Kennet Pans and Skinflats and also the wider mudflats on the opposite northern bank.
- 8.4.44 The constriction of the estuary at the Kincardine Bridge scours the seabed, resulting in coarser mixed sediments, rather than the fine muddy material that predominates the estuary (Elliott and Kingston 1987). Hence, the available subtidal food resource is especially limited in the vicinity of the bridge when compared to other parts of the estuary.

#### *Migratory Fish*

- 8.4.45 The following diadromous fish species all migrate through the Forth: sea lamprey, river lamprey, European eel, Atlantic salmon, anadromous brown trout (sea trout) and sparling (smelt). These species are found in varying abundances throughout the estuary, utilising the freshwater rivers feeding into the estuary, such as the River Teith, at some stage in their life history.
- 8.4.46 On account of their migratory activity these species will, at certain points in their life history, pass through the estuary. For the purposes of this assessment it is assumed that all the species listed above will at some time during the year use the channel running beneath the Kincardine Bridge.
- 8.4.47 Information on each of the diadromous species, including likely migration periods over a typical annual cycle, is given below. Where available, information on both the upstream and downstream migrations is provided; however, this is only a guide and acknowledgement should be given to the annual variability of migrations.
- 8.4.48 Historical intertidal fish surveys that have been carried out in the vicinity of the Kincardine Bridge recorded occasional European eel, small sparling and trout from the marsh areas. It is assumed that these three species all utilise the mid to upper estuarine intertidal habitats to some degree. Conversely,

the absence of any lamprey or Atlantic salmon from any of the fish surveys (including subtidal) suggest that these species do not utilise this part of the estuary other than for migration.

*Sea Lamprey*

- 8.4.49 Adult sea lamprey, the largest of the three lamprey species, live mainly in coastal waters as adults but are also thought to spend some time in the lower reaches of the estuary.
- 8.4.50 Migration of adult sea lamprey, from the sea to the river, mainly occurs between February and May (Maitland 2003), but information on run timing within the Firth of Forth and to the River Teith is limited.
- 8.4.51 Young sea lamprey live in marginal riverine silt beds feeding for several years, after which time, from approximately September and into the winter, they begin to travel downstream whilst undergoing metamorphosis to a silvery form, known as a transformer, whose physiology becomes adapted to life in saline conditions.
- 8.4.52 The River Teith represents part of the east coast range of the sea lamprey in the UK. A survey in 2000 (Maitland and Lyle 2000; Maitland 2003) recorded young sea lamprey at six sites at and downstream of Callander, on the River Teith. Spawning appears restricted to the Callander area and suitable stretches below. Sea lamprey are a qualifying species of the River Teith SAC.

*River Lamprey*

- 8.4.53 River lamprey adults live primarily within estuaries feeding on a number of estuarine fish species. Both feeding and migrating stages of river lamprey were entrained regularly at Longannet Power Station and many thousands of individuals were killed here each year prior to closure of the power station in 2016 (Maitland, Morris, East, Schoonoord, Van der Waal and Potter 1984; Maitland 1998). While no specific data are available for the Firth of Forth as a whole, it is suggested that river lamprey occupy most parts of the estuary. River lamprey are a qualifying species of the River Teith SAC.
- 8.4.54 Migration of adult river lamprey from the sea to the river occurs mainly from October to December (Maitland 2003). Migration upstream to spawning grounds generally occurs during the hours of darkness with migrants hiding under stones and vegetation during the day. During March and April, river lamprey spawn in many of the main watercourses draining into the Forth (Morris and Maitland 1987; Maitland 2003).
- 8.4.55 Young river lamprey live in marginal riverine silt beds feeding for three to five years, after which time, between August and November, they undergo metamorphosis to the silvery transformer (Maitland 1980). Transformers migrate downstream during the hours of darkness. Lamprey transformers migrating to the estuary from the rivers are believed to follow the areas of greater flow to assist their passage and are therefore usually found in the deeper middle sections of the river (Maitland, Morris, East, Schoonoord, Van der Waal and Potter 1984).

*European Eel*

- 8.4.56 Although the general life-cycle of European eel is well known with spawning thought to occur in the Sargasso Sea, it has never been observed.
- 8.4.57 Both juvenile (glass eel) and adult (silver eel) migrations have a seasonal component but, in each case, the season is thought to be quite protracted. The peak of glass eel arrival along the east coast of mainland Scotland is reported to occur around December but with low numbers potentially arriving throughout the year. Glass eels are then thought to remain in coastal regions until April or May before river temperatures rise sufficiently for them to enter freshwater. The bulk of the returning silver eel migration is thought to take place from September to January (Malcolm, Godfrey and Youngson 2010).

- 8.4.58 Runs of silver eel typically occur at night, with migratory movements thought to be correlated with environmental factors that result in increased discharge (e.g. rainfall, flood events) and low light conditions (e.g. increased turbidity, moon phases) (Okamura, Yamanda, Mikawa, Tanaka, and Oka 2002); whilst glass eel have often been observed at the mouth of estuaries, waiting for darkness before commencing their migration upstream.

*Atlantic Salmon*

- 8.4.59 Over the last 20 years, rod and line catch data in the Forth district shows an overall decline in summer and autumn Atlantic salmon catches (Marine Scotland Science 2015). However, the River Forth is known to carry a substantial population of Atlantic salmon that run throughout the year and spawn in the upper reaches and tributaries including the River Teith. Atlantic salmon are a qualifying species of the River Teith SAC. In the Firth of Forth, Atlantic salmon exhibit an early upstream migration, from early February to March followed by runs through the summer until early autumn, although the end of season run is not as pronounced as on some other east coast river systems (e.g. River Tweed). Salmon smolts run to sea in a relatively narrow window between mid-April and mid-June.
- 8.4.60 The use of slow flowing marginal areas for upstream migration is less critical to salmon (as compared to lamprey) due to their stronger swimming capabilities. They are therefore less likely to be affected by obstacles in marginal areas and, if encountered, they would have greater ability to navigate around the obstacle.

*Anadromous Brown Trout (Sea Trout)*

- 8.4.61 Rod catches indicate that the number of sea trout returning to Scottish rivers has probably been in decline for much of the period 1952-2017 (Marine Scotland 2018b). Whilst catches of sea trout in many areas of Scotland are at historically low levels, there have also been notable declines in the last 20 years in south-west, north-west and central-eastern areas of the country including in the Forth and Tay district (Marine Scotland Science 2015).
- 8.4.62 Sea trout exhibit a wide range of migratory behaviour influenced by genetics and environment. At the extreme, brown trout can migrate to the marine environment where they are then known as sea trout. In contrast to salmon, sea trout post-smolts do not migrate rapidly out to sea from inshore coastal areas, instead having a much more protracted migration period over several months.
- 8.4.63 There is only limited information on the timing of migration for both juvenile and adult trout for specific locations on the Scottish coast (Malcolm, Godfrey and Youngson 2010). However, there is anecdotal evidence to suggest that juvenile sea trout run to sea later than salmon, from mid-May onwards.
- 8.4.64 Some trout display intermediate behaviour between freshwater residency and sea migration, 'slob trout'. Though not technically presenting full metamorphosis to 'sea trout' these are considered sea trout for the purposes of this assessment. These estuarine fish are thought to move daily with the tide and utilise flooded intertidal habitats, such as has been evidenced by intertidal fish surveys (e.g. Lyndon, Kingston and Moore 2000). Unlike their true sea trout counterparts, these 'slob trout' reside in the estuary.

*Sparling*

- 8.4.65 The population of sparling, known elsewhere in the UK as smelt, in the Firth of Forth estuary almost died out during the 1980s but has been recorded in reasonable numbers from fish trawls as well as the screens at Longannet power station (Maitland and Lyle 1996; Greenwood 2008).
- 8.4.66 During spring, coastal and estuarine sparling are generally thought to migrate up rivers to spawn. Historically, this was true within the Forth population, when the population there was large; however, since its recovery the present spawning grounds in the Forth have not been located, despite searches there from 1991 to 1994 (Maitland and Lyle 1996). It is suspected that the sparling spawn, unseen, in

relatively inaccessible freshwater parts of the upper estuary. The intertidal survey by Lyndon, Kingston and Moore (2000) recorded a few small sized sparling in areas to the north of the Kincardine Bridge; their small size suggesting that these individuals were not spawning.

8.4.67 There exists very little information about the ecology of sparling, especially that which is particular to the Forth estuary population. Extrapolating data from the River Cree population on the west coast of Scotland would suggest that sparling spawn in March/April (Maitland and Campbell 1992). During this period the sparling migrate to freshwater and lay eggs which adhere to the substrata and vegetation. After hatching the young sparling are swept downstream and reside in the estuary where they feed until reaching maturity.

8.4.68 Table 8.4 highlights the main migratory periods for species in the area around the Forth Estuary. For all species, with the exception of European eel, adult migration is in the upstream direction and juvenile fish migrate downstream; the opposite is true for European eel. The dearth of literature on sea trout migration means this species has been excluded from the table; however, it is thought to migrate for protracted periods throughout the year.

**Table 8.4: Main Fish Migration Periods in the Forth Estuary (grey shading represents key period of migration).**

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sea lamprey (adults)												
Sea lamprey (juv.)												
River lamprey (adults)												
River lamprey (juv.)												
European eel (adults)												
European eel (juv.)												
Atlantic salmon (adult)												
Atlantic salmon (smolt)												
Sparling (adult)												
Sparling (juv.)												

**Feature Importance**

*Fish (Non-migratory)*

8.4.69 This desk-based assessment has identified a number of non-migratory (non-diadromous) fish species of national conservation importance (Scottish PMFs) that are likely to be found within the intertidal area

around the Kincardine Bridge. These are: herring, saithe, cod, whiting, and sand goby; all of which are commonly recorded species throughout the estuary.

8.4.70 The subtidal fish surveys carried out by SEPA (SEPA 2014) indicate that this area of the estuary (around the Kincardine Bridge) is not important in terms of feeding or as a resident fish habitat. However, further consideration is given below to the importance of the channel as a migratory corridor for certain fish species.

8.4.71 Non-migratory fish populations are considered to be of regional importance.

#### *Migratory Fish*

8.4.72 All the migratory fish species are on the SBL and PMF list. River and sea lamprey, and Atlantic salmon are also listed on Annex II of the Habitats Directive and are all qualifying features of the River Teith SAC, which is approximately 20km upstream of the Kincardine Bridge.

8.4.73 European eel are critically endangered and on the International Union for Conservation of Nature (IUCN) Red List, with numbers having declined significantly so that recruitment of current populations is 95% less than that of the 1980s.

8.4.74 All migratory fish populations are assigned international importance.

### **Marine Mammals**

#### Baseline Conditions

##### *Cetaceans*

8.4.75 A previous desk-based assessment to support the 2003 ES stated that although bottlenose dolphins (*Tursiops truncatus*) are occasionally seen from the Kincardine Bridge, the sightings are rare and most cetacean sightings are concentrated in the lower estuary (Northern Ecological Services 2003). This was confirmed in a report prepared for the Rosyth International Container Terminal (RICT) ES (Evans and James 2015; Jacobs 2017) which indicated that the number and diversity of cetaceans in the Firth of Forth is low, with only bottlenose dolphin, harbour porpoise (*Phocoena phocoena*) and minke whale (*Balaenoptera acutorostrata*) recorded regularly. The majority of cetacean sightings were in the outer Firth. Bottlenose dolphin were reported to be scarce in the Firth of Forth proper and rarely recorded within 35km of the Kincardine Bridge. Similarly harbour porpoise sightings were widespread in the outer Forth, but uncommon west of Queensferry, 20km from the Kincardine Bridge. It was reported that Minke whale do not generally enter the Firth of Forth proper with the majority of sighting around the Isle of May, Inchmickery and Incholm, 30km or more from the Kincardine Bridge (Evans and James 2015).

8.4.76 Two incidental sightings of a harbour porpoise were recorded during 26 days of wetland bird surveys (Table 8.5). Both sightings were on the same day so may have been the same individual. Observations were recorded in the mid-channel immediately upstream of the Kincardine Bridge and, on the same day, adjacent to the jetty on the northern shore of the estuary, approximately 400m upstream of the bridge.

##### *Seals*

8.4.77 Scottish waters are estimated to contain 36% of the European population (90% of the UK population) of Grey seals (*Halichoerus grypus*) and 29% of the European population (83% of the UK population) of harbour (common) seals (*Phoca vitulina*) (SNH 2017). The closest designated seal haul-out site is at Inchmickery Island, 30km downstream of the proposed scheme.

8.4.78 Data on seal populations in and around the Forth Estuary were provided in a report by the Sea Mammal Research Unit (SMRU) (Plunkett 2018) and a summary of the main points in this report is provided in this section. The East Scotland seal management unit (SMU), which covers the area between Fraserburgh

and North Berwick, is estimated to contain only 1.2% of the harbour seals and 9.4% of the grey seals in Scotland.

- 8.4.79 Harbour seal haul-out surveys from 1996 to 2013 have only recorded a single harbour seal upstream of the Kincardine Bridge, at Tullibody Inch near Alloa in 2007. Telemetry data were available for 45 adult harbour seals tagged in the Tay and Eden Estuary and at Kinghorn Rocks in the Firth of Forth. Only two individuals recorded any time upstream of the Queensferry Crossing and only one of these travelled up past the Kincardine Bridge.
- 8.4.80 No grey seals have been recorded at haul-out sites upstream of the Kincardine Bridge. There are four haul-out sites between the Kincardine Bridge and Queensferry Crossing where grey seals have been recorded in low numbers (less than 10). Out of 85 adult grey seals and 21 grey seal pups with telemetry data in the Firth of Forth none recorded any time upstream of the Queensferry Crossing. However, it is noted that there is a lack of telemetry data for seals tagged in the Firth of Forth and as such this is likely an under-representation. It is also highlighted that the most recent count in the Firth of Forth is from 2013 and as such may not represent current conditions.
- 8.4.81 Four incidental sightings of grey seals were recorded during 26 days of wetland bird surveys (Chapter 9: Terrestrial Ecology) and these are represented in Table 8.5. These sightings were all recorded close to the southern bank of the estuary and in relatively close proximity to the Kincardine Bridge.

**Table 8.5: Incidental Sightings of Marine Mammals during Wetland Bird Surveys.**

Date	Approximate National Grid Reference	Species	Tidal State	Approximate Distance from Bridge	Notes
04/12/2017	NS 92523 86930	Grey seal	Low	175m	Single individual
09/03/2018	NS 92369 87166	Grey seal	High	75m	Single individual
10/04/2018	NS 92540 87277	Harbour porpoise	Low	100m	Single individual
10/04/2018	NS 92490 87629	Harbour porpoise	Low	430m	Single individual
18/04/2018	NS 92145 86642	Grey seal	High	250m	Young seal hauled out on mudflat
12/10/2018	NS 92412 86648	Grey seal	Low	390m	Hauled out on mudflat

Feature Importance

*Cetaceans*

- 8.4.82 Bottlenose dolphin and harbour porpoise are listed on Annex II of the Habitats Directive requiring designation of protected areas to maintain or restore the species. All cetaceans in Scottish waters are classed as European Protected Species (EPS) and are given protection under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), making it an offence to intentionally or recklessly kill, injure or capture a cetacean or disturb or harass a cetacean. Many cetaceans, including the harbour porpoise and bottlenose dolphin are also listed on the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), which requires signatories to set up protected areas and promote research and public awareness to protect the species. Twenty-one species of cetacean are listed on the SBL and 13 species are listed as Scottish PMFs, including bottlenose dolphin and harbour porpoise.
- 8.4.83 Although records are relatively rare in the vicinity of the proposed scheme, cetaceans are assigned international importance.



*Seals*

- 8.4.84 Both species of seal are listed on Annex II of the Habitats Directive requiring designation of protected areas to maintain or restore the species. In Scotland seals are protected under Part 6 of the Marine (Scotland) Act 2010, which makes it an offence to intentionally or recklessly kill, injure or take seals with the exception of alleviating suffering or under licence. It is also an offence to intentionally or recklessly harass a seal at a designated haul-out site as listed in The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014. Both species of seal are Scottish PMFs and harbour seals are listed on the SBL.
- 8.4.85 Seals are assigned international importance.

**Evaluation Summary**

- 8.4.86 A summary of importance assigned to each marine ecological feature is shown in Table 8.6.

**Table 8.6: Summary of Marine Ecology Feature Importance**

Feature	Importance
<b>Benthic Habitats</b>	
Intertidal mudflats	National
Coastal saltmarsh	National
Subtidal habitats and communities	Local
<b>Fish</b>	
Non-migratory fish populations of conservation importance	Regional
Migratory fish populations of conservation importance	International
<b>Marine mammals</b>	
Cetaceans	International
Seals	International

**8.5 Potential Impacts**

**Introduction**

Embedded Mitigation

- 8.5.1 Throughout the proposed scheme design process, a number of embedded mitigation features have been included to avoid or reduce potential impacts. These embedded mitigation features are considered within the context of the impact assessment. The measures are detailed in Chapter 3 (The Proposed Scheme).
- 8.5.2 The following embedded mitigation feature has the potential to avoid or reduce impacts on the marine environment:
  - piled viaduct design: The proposed piled viaduct replacement structure will comprise spans of a similar size and appearance to the existing 15m spans of the adjacent Kincardine Bridge structure. This will result in minimal potential for local alterations to flow patterns, increased erosion and sedimentation, and flood storage losses.

Identification of Impacts

- 8.5.3 Consideration was given to the construction and operation activities from the proposed scheme and whether these could conceivably result in an impact pathway on any marine ecological receptors. This

resulted in several impact pathways being taken forward for consideration. In the construction phase these pathways are:

- temporary loss of intertidal habitat due to the works;
- underwater noise from construction activities and the potential to affect marine ecology receptors;
- changes in visual stimuli leading to species disturbance; and
- changes to water quality and the potential to affect marine ecology receptors.

8.5.4 As the proposed scheme will become part of the existing operational Kincardine Bridge, the effects on marine ecological features during the operational phase are not envisaged to vary detectably from the baseline conditions.

#### **Assessment of Effects (Construction)**

8.5.5 The assessment is feature-led and considers each of the features listed in Table 8.8 before the application of any mitigation.

#### Intertidal Habitats

8.5.6 During the construction phase a working area will cover a footprint of up to 3.87ha (the area of the land made available for temporary works and construction shown on Figure 8.2). This footprint includes all temporary access tracks and the temporary raised working platform.

#### *Mudflats*

8.5.7 No direct impacts are anticipated on the mudflats as the land made available (LMA) for temporary works and construction is restricted to the saltmarsh. There is however potential for pollution of the mudflats should there be a spillage in the works area or on the temporary bridge. This would lead to deterioration of the mudflats as habitat for benthic species and as a feeding resource for birds and fish. The area of mudflats around the Kincardine Bridge is small and does not represent a valuable feeding resource compared to other mudflats in the Firth of Forth and the habitat is not considered to be sensitive to pressures of pollution and has a high recoverability rate (Tillin 2016). However, depending on the magnitude of the incident this would be a moderate impact resulting in a significant effect due to the habitat's importance as a qualifying feature of the SPA and Ramsar sites.

#### *Saltmarsh*

8.5.8 There will be temporary loss of up to 2.99ha saltmarsh habitat under the footprint of the land made available for temporary works and construction. This represents up to 2.5% of the saltmarsh recorded in the Firth of Forth (Haynes 2016). This area will be lost for the duration of the construction period which is expected to be between 18 and 24 months. Due to compression of the sediments under the working platform, the ground level will be lowered, leading to the natural geomorphic processes being compromised. This may affect the natural recovery of the saltmarsh in this location. Due to the national importance of the feature and the potential long-term recovery rate this would be a major impact and significant effect.

8.5.9 There is the potential for impacts of pollution on the saltmarsh during construction from runoff or accidental spillages. Saltmarsh communities are identified as highly sensitive to hydrocarbon pollution as they trap sediments, adsorb oil and occur in sheltered areas where oils persist (Tyler-Walters 2014). Due to the localised nature of the works and the relatively small scale of a potential pollution event it is considered that this would be a moderate impact but a significant effect.

- 8.5.10 The presence of the temporary raised working platform will result in localised changes in hydrology on the saltmarsh which could alter erosion and deposition in the immediate area. As the saltmarsh has a naturally dynamic system of creeks this would be a minor impact and the effect would be not significant.

#### Subtidal Habitats and Communities

- 8.5.11 There would be no loss or fragmentation of subtidal habitats during the construction or operation of the proposed scheme.
- 8.5.12 It is possible that some mobile benthic fauna (e.g. crabs) in the subtidal communities would migrate away from the noise source(s) (i.e. intertidal piling) for the duration of the construction activity. The distance of this movement would be dependent on the magnitude of the noise source, the propagation of the sound waves through water, the distance to the original location of the receptor and the amount of disturbance caused to each species.
- 8.5.13 The habitats in the vicinity of the bridge are considered a mosaic of impoverished mud and coarse mixed sediment. The habitats and their constituent communities (paragraph 8.4.29) are not sensitive to changes in underwater noise or visual disturbance according to the MarLIN sensitivity review, which listed the sensitivity of these communities as either 'not relevant' or 'not sensitive' in all cases to these pressures (The Marine Biological Association of the UK 2018).
- 8.5.14 Given that there would be no readily detectable change from the baseline conditions on subtidal habitats and communities from any of the impact pathways, the impact would be negligible in all cases and the effect therefore not significant.
- 8.5.15 The impact of pollution and/or sedimentation is also considered to be negligible and the effects not significant due to the relatively small scale of the works and position of the works outside the subtidal habitat.

#### Fish

- 8.5.16 Anthropogenic noise is known to cause behavioural (avoidance) and physiological (barotrauma - tissue injury due to rapid changes in pressure) effects on fish. However, the effects vary among different species and the following broad categories of sensitivity can be applied (Popper, Hawkins, Fay, Mann, Bartol, Carlson, Coombs, Ellison, Gentry, Halvorsen, Lokkeborg, Rogers, Southall, Zeddies and Tavalga 2014):
- fish with no swim bladder or other gas chamber are least susceptible as they detect only particle motion.
  - fish with swim bladders in which the swim bladder is not involved in hearing are more susceptible to barotrauma, but the hearing still only detects particle motion, not sound pressure.
  - fish which utilise the swim bladder or other gas volume for hearing are most susceptible to barotrauma as they detect particle motion and sound pressure.
- 8.5.17 The effects of underwater noise on fish are also related to a number of factors such as the source of noise and the distance between the source and the receptor. Transmission of sound waves through water varies with water depth and substrate type, and in general shallow estuarine environments, like the Forth Estuary, sound is more readily absorbed due to greater interaction with the seabed compared to deeper areas (Mason and Collett 2011).

#### *Non-migratory*

- 8.5.18 A number of the gadoid (cod and saithe) and clupeid (herring and whiting) species have been recorded around the Kincardine Bridge and fall within the category of fish most sensitive to anthropogenic noise (Popper, Hawkins, Fay, Mann, Bartol, Carlson, Coombs, Ellison, Gentry, Halvorsen, Lokkeborg, Rogers, Southall, Zeddies and Tavalga 2014). However, considering the evidence that the area directly adjacent

to the Kincardine Bridge is a poor foraging resource for fish compared to the rest of the estuary, and the width of the estuary being almost 600m at this location, any disturbance from construction noise would be a minor impact and the effect would be not significant.

- 8.5.19 The impact of pollution and/or sedimentation is also considered to be a minor and the effects not significant due to the relatively small scale of the works and any potential pollution event, and the limited use of the area in the vicinity of the works by non-migratory fish species.

*Migratory*

- 8.5.20 Of the migratory fish transiting under the Kincardine Bridge, lamprey species do not contain swim bladders and, although little is known about their hearing abilities, are likely to fall into the least sensitive category. Sparling are likely to be the most sensitive migratory fish species, with Atlantic salmon and European eel somewhere in between the two.
- 8.5.21 A study on the effects of piling (914mm and 508mm steel tubular piles) on caged salmonids (brown trout) in Southampton Water found no response, behavioural or physiological, at distances of 400m during impact piling and 50m during vibro-piling (Nedwell, Turnpenny, Langworthy, and Edwards 2003). A study in the Humber Estuary predicted, for the 'loudest' impact piling (2.1m diameter steel tubular pile and 400kJ hammer), distances of 20m for physical injury and 490m for avoidance behaviour in Atlantic salmon (Mason and Collett 2011). Data presented in the Rosyth International Container Terminal Environmental Statement (Jacobs 2017) indicated that cumulative impact piling operations would have the potential to cause mortality of sparling within 20m of the works but a considerable migratory corridor would remain where the noise and vibration would be undetectable.
- 8.5.22 The construction of bored concrete piles will generate less noise and vibration than the alternative, driven piles (Daniels and Loven 2014). Typical source levels of over 240 dB re 1  $\mu$ Pa are reported from underwater impact piling operations (Bailey, Senior, Simmons, Rusin, Picken and Thompson 2010, Mason and Collett 2011) whereas source sound pressure levels of between 121.0 and 184.5 dB re 1  $\mu$ Pa have been reported during underwater pile drilling (boring) operations (Dazey, McIntosh, Brown and Dudzinski 2012). Published guidelines on noise exposure (Popper, Hawkins, Fay, Mann, Bartol, Carlson, Coombs, Ellison, Gentry, Halvorsen, Lokkeborg, Rogers, Southall, Zeddies and Tavolga 2014) indicate that, for the most sensitive fish species exposed to a continuous noise, the risk of behavioural changes is high in the near field (10s metres), moderate in the intermediate field (100s metres) and low in the far field (1000s metres). It is also suggested that exposure to sound levels of 158 dB rms for 12 hours could result in a temporary threshold shift and continuous exposure to levels of 170 dB rms for 48 hours could cause recoverable injury. The potential for mortality is low for all fish species when exposed to a continuous noise.
- 8.5.23 Given the lower noise levels produced by bored piling and the presumption against night-time works (the period during which migratory fish are thought to be most active), any effect on migratory fish species would result in a minor impact which is not significant. In addition, the duration of sheet piling operations is anticipated to be short and 24-hour working is not anticipated. Therefore, any impact on migratory fish would again be minor and the effects not significant.
- 8.5.24 A pollution or sedimentation event at the site has the potential to cause mortality or avoidance of the area by migratory fish. However, it is considered that, given the scale of the works, a pollution or sedimentation event would be localised and any impact would be minor and the effects would be not significant.

Mammals

*Cetaceans*

- 8.5.25 Underwater noise and vibration as a result of construction works, specifically piling, has the potential to cause disturbance and physical injury to cetaceans. A study of the effects of subtidal impact piling on marine mammals in the Moray Firth found that the zone with the potential to cause auditory damage to cetaceans was up to 100m around the piling activity (1.8m diameter tubular steel piles). A strong behavioural response could potentially be elicited in harbour porpoise, which are thought to be more sensitive than bottlenose dolphin (Southall, Bowles, Ellison, Finneran, Gentry, Greene, Kastak, Ketten, Miller, Nachtigall, Richardson, Thomas and Tyack 2007), up to 20km away and a weaker response up to 70km away (Bailey, Senior, Simmons, Rusin, Picken and Thompson 2010).
- 8.5.26 Given the small number of cetaceans recorded within 20km of the Kincardine Bridge works area and indeed in the wider Forth Estuary, and the proposed use of bored piling rather than impact piling and short duration of sheet piling, underwater noise and vibration would be a minor impact and any effect would be not significant.
- 8.5.27 Pollution and/or sedimentation related to the construction of the proposed scheme has the potential to result in a deterioration in habitat and water quality and a corresponding reduction in prey species for cetaceans. However, as noted above, the area around the works does not represent an important resource for cetaceans in the Forth Estuary and the relatively small scale of the works means that any potential pollution event is unlikely to be large-scale, therefore any effects of pollution and/or sedimentation are considered to be negligible and therefore not significant for cetaceans.

*Seals*

- 8.5.28 There is potential for the works to cause disturbance to seals through visual disturbance from the construction site and the noise and vibration created by construction activities. Monitoring of harbour and grey seals on Carlingford Lough found that the survey boat had to maintain distances of 200m and 170m to prevent 'flushing' of harbour and grey seal colonies respectively (Wilson, O'Malley, Cassidy and Clarke 2011).
- 8.5.29 Piling has the potential to result in temporary or permanent damage to the hearing of seals in close proximity to the works in addition to eliciting avoidance behaviour further afield. The study of impact piling of 1.8m diameter tubular steel piles in the Moray Firth estimated zones of influence of 215m for major disturbance and up to 14km for minor disturbance (Bailey, Senior, Simmons, Rusin, Picken and Thompson 2010). By comparison, a study of noise generated during pile drilling activities in Strangford Lough (Nedwell and Brooker 2008) reported that drilling, through predominantly bedrock substrate, resulted in source levels of 162 dB re 1  $\mu$ Pa, which were predicted to be imperceptible to seals above background noise levels at a distance of 100m.
- 8.5.30 The baseline data indicates that, although seals are occasionally recorded in the vicinity of the Kincardine Bridge, the area around the Kincardine Bridge does not provide an important resource for either grey or harbour seals. The closest recorded haul-out site is at Culross, 8.5km downstream, with the closest designated haul-out site being 30km away. With the use of bored piling and the short duration of sheet piling operations it is therefore considered that the effects of visual disturbance on the seal population of the Forth Estuary will be negligible and the impact of underwater noise and vibration will be minor with no significant disturbance or physical injury effects.
- 8.5.31 Pollution and/or sedimentation related to the construction of the proposed scheme has the potential to result in a deterioration in habitat and water quality and a corresponding reduction in prey species for seals. However, as noted above the area around the works does not represent an important resource for the seals in the Forth Estuary and any potential pollution event is not likely to be large-scale, therefore

any impact of pollution and/or sedimentation are considered to be a minor and the effects not significant.

#### Assessment of Effects (Operation)

8.5.32 Although pier locations and sizes will differ from the existing piled viaduct the overall footprint and operation of the bridge is considered to be mostly consistent with existing conditions and therefore no operational impacts are anticipated on marine ecological features.

## 8.6 Mitigation

### Introduction

8.6.1 Mitigation will follow a hierarchical approach in the following order (CIEEM 2018; SNH 2018a):

- avoid adverse impacts in the first instance;
- where avoidance is not possible, reduce the adverse impacts through appropriate design and mitigation; and
- where significant adverse residual effects remain, measures to offset the adverse impacts at a site-specific level may be required (compensation).

8.6.2 The proposed mitigation is designed to enhance and produce a net gain for biodiversity where practicable in line with policy and guidelines (CIEEM 2018).

8.6.3 This section includes mitigation that aims to avoid or negate impacts on ecological features in accordance with best practice guidance and UK, Scottish and local government environmental impact, planning and sustainability policies. Where these impacts can be fully mitigated, they would not be considered significant under the terms of the Roads EIA Regulations.

8.6.4 Potential significant ecological impacts as shown in Table 8.8 are expected to be mitigated through a combination of best practice/typical mitigation methods and mitigation targeted to specific marine ecology features ('ME' Mitigation Item references). Some mitigation measures from Chapter 9 (Terrestrial Ecology) ('TE' Mitigation Item references) and Chapter 7 (Road Drainage and the Water Environment) are also applicable to marine ecology impacts. These measures are also detailed in Chapter 17 (Schedule of Environmental Commitments).

8.6.5 The assessment incorporates essential mitigation required to reduce significant adverse effects which are critical for the delivery of the proposed scheme. Essential mitigation measures for marine ecological features are described in the following sections.

### Construction

8.6.6 Construction mitigation commitments have been produced which set out the actions required during the construction phase of the proposed scheme to avoid or reduce environmental impacts. Construction mitigation items relevant to Marine Ecology are detailed in Table 8.7 below and in Table 17.4 in Chapter 17 (Schedule of Environmental Commitments).

8.6.7 The mitigation commitments include the requirement for the Contractor to develop a Construction Environmental Management Plan (CEMP), including an Ecological Management Plan (**Mitigation Item ME1**). This will be developed by the Contractor from the mitigation and environmental commitments identified in this assessment (Table 8.8) and will include, for example:

- any Habitat or Species Management Plans produced prior to construction;
- details of proposed protection measures and exclusion zones to avoid any unnecessary encroachment into adjoining areas; and



- appropriate watching briefs during construction.

- 8.6.8 The Ecological Management Plan will be prepared to ensure that essential mitigation strategies required for safeguarding protected species and habitats are implemented as part of the contract. These will be updated as appropriate if amendments to the agreed mitigation are identified. The plans will be developed in consultation with relevant stakeholders including SNH.
- 8.6.9 The Saltmarsh Management Plan (see Appendix A8.2 (Outline Saltmarsh Management Plan), developed in consultation with SNH, will outline the mitigation measures to be implemented specifically to minimise damage and encourage recovery of the saltmarsh.
- 8.6.10 It will be the contractual responsibility of the Contractor to ensure that mitigation is implemented during the works and that all relevant licences, should they be required, are in place prior to commencement of works. Monitoring of ecological features, and the implementation of the CEMP and Ecological Management Plan, will be undertaken by the ecologist, acting on behalf of Transport Scotland, to audit compliance and record the outcome of the mitigation commitments.
- 8.6.11 No mitigation is required for non-significant impacts, however, Mitigation Items which are to be applied across the proposed scheme will also reduce the effects of these non-significant impacts. These have been referenced against the relevant ecological features in Table 8.8

#### **Operation**

- 8.6.12 As no significant impacts were identified during operation of the proposed scheme no mitigation is required.

#### **Monitoring**

- 8.6.13 The Contractor's ECoW will be responsible for ensuring compliance with protected species legislation and commitments stated in this assessment during construction. This will include adherence to the Ecological Management Plan, the Saltmarsh Management Plan (**Mitigation Item ME6**) and appropriate Mitigation Items. Compliance will be monitored by an ecologist acting on behalf of Transport Scotland.
- 8.6.14 Post-construction monitoring will be undertaken in accordance with the Saltmarsh Management Plan which is to be developed in consultation with SNH (see Appendix A8.2: Outline Saltmarsh Management Plan). This monitoring will determine the effectiveness of the mitigation employed and inform whether further mitigation, maintenance or changes in mitigation approach are required to maintain the conservation status of ecological features. Post-construction monitoring will be the responsibility of the Contractor and, in the longer term, of the relevant trunk road operating company.

#### **Schedule of Environmental Commitments**

- 8.6.15 A summary of the essential mitigation measures, to be implemented in constructing and operating the proposed scheme relevant to marine ecology, is provided in Table 8.7. Chapter 17 (Schedule of Environmental Commitments) contains the complete schedule of measures for the proposed scheme.

**Table 8.7: Schedule of Environmental Commitments - Marine Ecology**

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
ME1	Contractor	Pre-construction & Construction	Prior to construction the Contractor will develop a Construction Environmental Management Plan (CEMP), including an Ecological Management Plan, which will detail the mitigation to be implemented and how this will be monitored.	To provide a framework for the implementation of construction activities in accordance with the environmental commitments and mitigation measures relating to the aquatic environment.	Consultation with SNH	CEMP requirement will be included as an Employer's Requirement in Contract.
ME2	Contractor	Pre-construction & Construction	<p>Prior to construction a suitably qualified Ecological Clerk of Works (ECoW) will be appointed by the Contractor and will be responsible for implementation of the Ecological Management Plan. The ECoW will:</p> <ul style="list-style-type: none"> <li>provide ecological advice over the entire construction programme;</li> <li>in collaboration with the ecologist acting on behalf of Transport Scotland, undertake or oversee pre-construction surveys for protected species in the areas affected by the proposed scheme;</li> <li>ensure mitigation measures are implemented to avoid and reduce impacts on ecological features; and</li> <li>monitor the implementation of the mitigation measures during the construction phase to ensure compliance with protected species legislation and commitments within the EIA Report.</li> </ul> <p>The ECoW will be a member of CIEEM and will have previous experience in similar ECoW roles. All ECoWs will be approved by Transport Scotland to be appropriately qualified for the role and compliance will be monitored by an ecologist acting on behalf of Transport Scotland. The ECoW will be appointed in advance of the main construction programme commencing to ensure pre-construction surveys are undertaken and any advance mitigation measures required are implemented, in collaboration with the ecologist acting on behalf of Transport Scotland.</p>	To ensure that the mitigation strategies required for safeguarding protected species and habitat are implemented.	ECoW approved by Transport Scotland	Ecologist acting on behalf of Transport Scotland will monitor the Contractor's ECoW to ensure compliance with mitigation. Requirement for ECoW supervision will be included as an Employer's Requirement in Contract.

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
ME3	Contractor	Construction	Best practice construction methods (CIRIA 2015) will be used including the use of appropriate pollution controls (i.e. Guidance for Pollution Prevention (GPPs)), such as construction drainage, a strict re-fuelling protocol and removal of all loose materials from the intertidal area.	To avoid pollution being discharged into the marine environment and impacting on protected species and habitats.	None required	N/A
ME4	Contractor	Construction	The footprint of the working area will be minimised as far as possible and vehicles, plant and personnel will be constrained to this area through the use of temporary barriers to minimise the damage to habitats and potential direct mortality and disturbance to animals located within and adjacent to this footprint. The access track and working platforms on the saltmarsh will be created through use of geotextile layer under aggregate material.	To minimise damage to habitat and disturbance of aquatic and marine species.	None required	N/A
ME5	Contractor	Post-construction	On completion of the works all access tracks and working platforms will be removed in their entirety from the saltmarsh.	To minimise damage to habitat and disturbance of aquatic and marine species.	None required	Contractor's ECoW to monitor compliance and requirement for removal of tracks and platforms will be included as an Employer's Requirement in the Contract.
ME6	Contractor	Pre-construction, Construction & Post-Construction	Prior to construction the Contractor will develop a Saltmarsh Management Plan. This will include measures to reduce damage and encourage recovery of the saltmarsh and will include a period of post-construction monitoring.	To monitor potential impacts and encourage recovery of the saltmarsh.	Consultation with SNH	Monitoring required during and post-construction to ensure efficacy of the Saltmarsh Management Plan. Development of the Saltmarsh Management Plan will be included as an Employer's Requirement in the Contract.
ME7	Contractor	Construction	With the exception of temporarily realigning the existing SuDS outfall, no works will be undertaken on the saltmarsh outside the footprint of the working platform and access tracks. This includes	To minimise damage to habitat and disturbance of aquatic and marine species.	None required	This mitigation item will be detailed in the CEMP. Contractor's ECoW to monitor compliance

Mitigation Item	Party Responsible for Implementation	Timing of Measure	Description	Mitigation Purpose/Objective	Specific Consultation or Approval Required	Monitoring/ Compliance
			provision of drainage or water treatment facilities for construction runoff.			
ME8	Contractor	Construction	The Contractor will take cognisance of Marine Scotland guidance on the protection of marine European Protected Species (Marine Scotland 2014) and JNCC guidance on minimising the risk of injury to marine mammals from piling noise (JNCC 2010).	To minimise disturbance or potential for injury of cetaceans.	None required	This mitigation item will be detailed in the CEMP. Contractor's ECoW to monitor compliance
TE3	Contractor	Construction	The Contractor will employ a 'soft-start' to all noisy activities to avoid sudden and unexpected disturbance. Each time the activity is started up after a period of inactivity, the noise levels will be gradually increased over a period of 30 minutes to allow birds (and other animals) to relocate. This will apply year-round.	To avoid sudden and unexpected disturbance to ecological receptors.	None required	This mitigation item will be detailed in the CEMP. Contractor's ECoW to monitor compliance
TE12	Contractor	Pre-construction & Construction	Licences in respect of works necessary to construct the proposed scheme that are likely to breach applicable conservation legislation will be obtained. The Contractor will comply with the requirements or conditions of any granted licence. Licensing may be for the UK and/or European Protected Species.	To comply with conservation legislation.	Approval from SNH and Marine Scotland	The requirement to obtain licences will be included as an Employer's Requirement in Contract. The Contractor's ECoW will monitor compliance.

## **8.7 Residual Effects**

- 8.7.1 As set out in Table 8.8, with appropriate mitigation in place no significant residual effects on marine ecology features are anticipated from the proposed scheme. Implementation of a Saltmarsh Management Plan will assist the natural recovery of the saltmarsh habitat and annual saltmarsh species are expected to establish relatively quickly due to the presence of the surrounding saltmarsh. However, re-establishment of slower colonising species, such as sea arrowgrass will take longer and full recovery to the current NVC community is anticipated in the long-term.

**Table 8.8: Summary of Impacts of the Proposed Scheme and Residual Effects on Marine Ecological Features**

Ecological Feature	Feature Importance	Potential Impact	Potential Effect	Characterisation of Impact (pre-mitigation) & Significance	Mitigation Item	Summary of Residual Effect & Significance (post-mitigation)
<b>Construction</b>						
Intertidal mudflats	National	Pollution	Habitat deterioration and reduction in quality of habitat for species inhabit the mudflats	Moderate (significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Use of best practice construction methods including pollution controls (GPPs) (ME3).	No significant residual effects predicted
Coastal saltmarsh	National	Temporary habitat loss and damage	Reduction in habitat available to species that use the saltmarsh due to the requirement for works and vehicle tracking on the saltmarsh	Major (significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Minimise footprint of working area and restriction of plant and vehicles to marked working corridor (ME4), Geotextile layer and aggregate used to create track and working platform (ME4), With the exception of temporarily realigning the existing SuDS outfall, no works will be undertaken on the saltmarsh outside the footprint of the working platform and access tracks. This includes provision of drainage or water treatment facilities for construction runoff (ME7). Implementation of a Saltmarsh Management Plan to aid recovery of the habitat upon completion of the works (ME5, ME6).	No significant residual effects predicted
		Temporary changes in hydrology	Changes in erosion and deposition around the edge of the raised working platform	Minor (not significant)	With the exception of temporarily realigning the existing SuDS outfall, no works will be undertaken on the saltmarsh outside the footprint of the working platform and access tracks. This includes provision of drainage or water treatment facilities for construction runoff (ME7). Production of a Saltmarsh Management Plan which will include a requirement to monitor changes in erosion (ME6).	No residual effect
		Pollution	Habitat deterioration and reduction in quality of	Moderate (significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2).	No significant residual effect predicted



Ecological Feature	Feature Importance	Potential Impact	Potential Effect	Characterisation of Impact (pre-mitigation) & Significance	Mitigation Item	Summary of Residual Effect & Significance (post-mitigation)
			habitat for species that use the saltmarsh. Potential change in saltmarsh vegetation communities in response to changes in habitat characteristics		Use of best practice construction methods including pollution controls (GPPs) (ME3). With the exception of temporarily realigning the existing SuDS outfall, no works will be undertaken on the saltmarsh outside the footprint of the working platform and access tracks. This includes provision of drainage or water treatment facilities for construction runoff (ME7).	
Subtidal habitats and communities	Local	Underwater noise and vibration	Species disturbance, avoidance of area	Negligible (not significant)	No mitigation is required for this effect however soft-start techniques used to protect otter and bird species (TE3) will minimise any effect on mobile subtidal species.	No residual effect
		Pollution/sedimentation	Habitat deterioration and changes in communities in response to changes in habitat quality	Negligible (not significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Use of best practice construction methods including pollution controls (GPPs) (ME3).	No residual effect
Non-migratory fish	Regional	Underwater noise and vibration	Species disturbance, avoidance of area (habitat fragmentation), physical injury/mortality	Minor (not significant)	No mitigation is required for this effect however soft-start techniques used to protect otter and bird species (TE3) will minimise any effect on fish.	No residual effect
		Pollution/sedimentation	Habitat and water quality deterioration, mortality	Minor (not significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Use of best practice construction methods including pollution controls (Guidelines for Pollution Prevention (GPPs)) (ME3).	No residual effect
Migratory fish	International	Underwater noise and vibration	Species disturbance, avoidance of area (habitat fragmentation), physical injury/mortality	Minor (not significant)	No mitigation is required for this effect however soft-start techniques used to protect otter and bird species (TE3) will minimise any effect on fish.	No residual effect
		Pollution/sedimentation	Habitat and water quality deterioration, mortality	Minor (not significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Use of best practice construction methods including pollution controls (GPPs) (ME3).	No residual effect

Ecological Feature	Feature Importance	Potential Impact	Potential Effect	Characterisation of Impact (pre-mitigation) & Significance	Mitigation Item	Summary of Residual Effect & Significance (post-mitigation)
Cetaceans	International	Underwater noise and vibration	Species disturbance, avoidance of area (habitat fragmentation), physical injury/mortality	Minor (not significant)	No mitigation is required for this effect however the contractor will take cognisance of relevant guidance to protect cetaceans (ME8) (TE12). In addition, soft-start techniques used to protect otter and bird species (TE3) will minimise any effect on cetaceans.	No residual effect
		Pollution/sedimentation	Habitat and water quality deterioration	Negligible (not significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Use of best practice construction methods including pollution controls (GPPs) (ME3).	No residual effect
Seals	International	Underwater noise and vibration	Species disturbance, avoidance of area (habitat fragmentation), physical injury/mortality	Minor (not significant)	No mitigation is required for this effect however soft-start techniques used to protect otter and bird species (TE3) will minimise any effect on seals.	No residual effect
		Pollution/sedimentation	Habitat and water quality deterioration	Minor (not significant)	Production of a CEMP (ME1) and presence of an ECoW (ME2). Use of best practice construction methods including pollution controls (GPPs) (ME3).	No residual effect
		Changes in visual stimuli	Species disturbance, avoidance of area (habitat fragmentation)	Negligible (not significant)	n/a	No residual effect
<b>Operation</b>						
No operational effects anticipated.						

## **8.8 Assessment of Policy Compliance**

- 8.8.1 DMRB LA 104 'Environmental assessment and monitoring' (Highways England, Transport Scotland, Welsh Government and Department for Infrastructure Northern Ireland 2019) states that environmental assessment, reporting and monitoring shall meet the requirements of the national planning policy for each relevant Overseeing Organisation.
- 8.8.2 Appendix A4.1 (Assessment of Policy Compliance) provides a review of national and local policy documents which are of relevance to the assessment undertaken and reported in this chapter in accordance with DMRB guidance.
- 8.8.3 National planning policy of relevance to this assessment include Scottish Planning Policy (SPP) themes *Promoting Rural Development and Valuing the Natural Environment*, in addition to Scottish National Marine Plan (SNMP) Policy GEN 9 (Natural Heritage). In addition, Falkirk Local Development Plan 2 (FLDP2) Policies PE19 (Biodiversity and Geodiversity), PE22 (The Water Environment) and PE23 (Marine Planning and the Coastal Zone) are of relevance (Falkirk Council 2020). A full policy compliance assessment can be found in Table 3 of Appendix A4.1 (Assessment of Policy Compliance), however it is assessed that the proposed scheme, once mitigation is included, adheres to the requirements of policies relevant to Marine Ecology.

### **Summary of Policy Compliance**

- 8.8.4 Overall, the design and assessment of the proposed scheme has had regard to and is compliant with policy objectives to minimise impacts on marine ecology. A full policy compliance assessment can be found in Table 3 of Appendix A4.1 (Assessment of Policy Compliance).

## **8.9 Statement of Significance**

- 8.9.1 Following successful implementation of the Saltmarsh Management Plan, recovery of the habitat will be long-term but re-establishment to the current NVC community is predicted. It is not anticipated that there will be any significant residual effects as a result of either the construction or operation of the proposed scheme.

## 8.10 References

### European and National Legislation

- Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS).
- Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland), SI1994/2716.
- Convention on Wetland of International Importance especially as Waterfowl Habitat (Ramsar Convention).
- Eel Management Plans for the United Kingdom (2010). Scotland River Basin District.
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- European Union (2007). Council Regulation 1100/2007. Establishing measures for the recovery of the stock of European eel.
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- Marine (Scotland) Act 2010.
- Nature Conservation (Scotland) Act 2004.
- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention).
- The Convention for the Protection of the Marine Environment of the North East Atlantic (OPSPAR).
- The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017, SI2017/115
- The Protection of Seals (Designation of Seal Haul-out Sites) (Scotland) Order 2014, SI2014/185.
- The Roads (Scotland) Act 1984 (Environmental Impact Assessment) Regulations 2017, Draft SI.
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