



Grangemouth Flood Protection Scheme
Habitats Regulations Appraisal

August 2025

Falkirk Council

Grangemouth Flood Protection Scheme

Project No: B2487700
Document Title: Habitats Regulations Appraisal
Date: August 2025
Client Name: Falkirk Council
Project Manager: Alan McGowan
Author: Rosanna Mooney
File Name: GFPS HRA V1.10_CLEAN_May 2025

Jacobs U.K. Limited

95 Bothwell Street
Glasgow
G2 7HX
United Kingdom
T +44 (0)141 243 8000
F +44 (0)141 226 3109
T +44 (0)131 659 1500F +44 (0)131 228 6177
www.jacobs.com

© Copyright 2025 Jacobs U.K. Limited. The concepts and information contained in this document are the property of Jacobs. Use or copying of this document in whole or in part without the written permission of Jacobs constitutes an infringement of copyright.

Limitation: This document has been prepared on behalf of, and for the exclusive use of Jacobs' client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this document by any third party.

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1.10	August 2025	Updates to address EIA review comments	RM	PS	PS/RiM	AMcG

Contents

1.	Introduction.....	1
1.1	Project Background.....	1
1.2	The HRA Process	2
2.	The Scheme.....	7
2.1	Introduction	7
2.2	Existing Conditions.....	8
2.3	Description of the Scheme.....	9
2.4	Construction.....	11
2.5	Operation and Maintenance	20
2.6	Decommissioning	21
3.	Stage 1 (Screening).....	22
3.1	Introduction	22
3.2	European Sites with Potential Effects from the Scheme	22
3.3	Screening	33
3.4	Screening Conclusion.....	46
4.	Stage 2 (Appropriate Assessment).....	47
4.1	Introduction	47
4.2	Aims.....	47
4.3	Ornithological Assessment Approach	47
4.4	Bird Monitoring During Ground Investigation Works	57
4.5	Noise Assessment.....	62
4.6	Biotope Mapping.....	69
4.7	Effects Pathways: Firth of Forth SPA and Ramsar Site	73
4.8	Effects Pathways: Loch Leven SPA and Ramsar site.....	81
4.9	Assessment of Impacts	81
4.10	Mitigation	82
4.11	AA Conclusion	116
5.	Provisions of Article 6(4): Statement about Alternative Solutions, Imperative Reasons of Overriding Public Interest and Compensatory Measures.....	117
6.	Stage 3 (Alternative Solutions).....	118
6.1	Introduction	118
6.2	Scheme Objectives	118
6.3	Assessment of Alternative Solutions	119
6.4	Stage 3 (Alternative Solutions) Conclusion	125
7.	Stage 4 (Imperative Reasons of Overriding Public Interest).....	126
7.1	Introduction	126
7.2	Policy and Legislation	126
7.3	Imperative Need	127
7.4	Public Interest	127

7.5	Imperative Reasons of Overriding Public Interest.....	130
8.	Compensation.....	131
8.1	Introduction	131
8.2	Design Considerations for Roosting Bird Habitats.....	131
8.3	Compensation Proposals.....	135
8.4	Compensation Conclusion	145
	References	147

1. Introduction

1.1 Project Background

Jacobs has been commissioned by Falkirk Council to undertake an environmental assessment, including a Habitats Regulations Appraisal (HRA), for the Grangemouth Flood Protection Scheme (FPS) (hereafter referred to as 'the Scheme'). A separate Environmental Impact Assessment Report (EIA Report) (Jacobs, 2024) has been conducted for the Scheme.

The flood risk management process in Scotland is driven by the Flood Risk Management (Scotland) Act 2009 (referred to as 'the FRM Act') and the legislative framework outlined within. It established a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity. The Scheme is being promoted by Falkirk Council as a flood protection scheme pursuant to Section 60 and Schedule 2 of the FRM Act to address flood risk predominately in Grangemouth and the surrounding areas, which include Wholeflats, Glensburgh, Langlees, Carron, Carronshore and Camelon (Stirling Road).

The FRM Act requires the production of two sets of complementary flood risk management plans: Local Flood Risk Management Strategies (led by Scottish Environment Protection Agency (SEPA)) and Local Flood Risk Management Plans (produced by Lead Local Authorities). The Grangemouth area falls within the Forth Estuary Local Plan District and has been identified in the Forth Estuary Flood Risk Management Strategy (SEPA, 2015) as a Potentially Vulnerable Area (PVA) with respect to flooding. This strategy identified the Scheme as the highest priority flood protection scheme of 42 identified across Scotland. It estimated that the Scheme would benefit 1,261 residential properties and 99 non-residential properties at risk of flooding and avoid damages of approximately £6 billion (SEPA, 2015). More recent analysis has identified that the Scheme will protect 2,760 residential properties, 6,025 people, 23km of roads and 1,200 non-residential properties including a refinery, petrochemical plant, a major port and associated nationally important infrastructure (Falkirk Council and Jacobs, 2023a) and avoid £2.4 billion of flood related damages.

The Local Flood Risk Management Plan for the Forth Estuary Local Plan District was first published in June 2016 (The City of Edinburgh Council, 2016). This includes details on the Scheme and lists the following objectives:

- Reduce risk to people in Bonnybridge, Denny, Carron and Grangemouth from river and coastal flooding.
- Reduce economic damages to residential and non-residential properties in Grangemouth caused by river flooding and coastal flooding.
- Reduce economic damages to residential and non-residential properties in Falkirk caused by flooding from the River Carron.
- Reduce economic damages to residential and non-residential properties in Carron and Carronshore caused by flooding from the River Carron and coastal flooding.

The Local Flood Risk Management Plan for the Forth Estuary Local Plan District was updated in 2023 (Falkirk Council, 2023) and the Grangemouth area falls within PVA 02/10/10 (Falkirk and Grangemouth). For this PVA, a number of target areas have been identified, with the following outlining the Scheme as the key action to manage flood risk in the area:

- Carron and Carronshore (target area 211).
- Falkirk (target area 228).
- Grangemouth West (target area 232).
- Larbert and Stenhousemuir (target area 243).
- Polmont, Redding and Westquarter (target area 308).

- The Grangemouth area further extends into PVA 02/10/11 (Bo'ness) and includes Grangemouth East (target area 262), which also references the Scheme as a key action for managing flood risk.

For each target area, further information about the development of the Scheme (including a description, funding and coordination details) are described in the Local Flood Risk Management Plan. The main features deemed as being at risk of flooding from flood events include:

- residential and non-residential properties;
- Falkirk Council infrastructure including buildings, roads, bridges and public spaces;
- utility infrastructure;
- commercial port;
- nationally important infrastructure in the refinery and petrochemical plant; and
- environmentally sensitive sites.

The Scheme will provide protection against coastal, fluvial, seepage (groundwater) and secondary (overland flows trapped behind defences) flood sources and will consist of flood defence walls and embankments, flood gates and demountable barriers, drainage including pumping stations, lock gates (port entrance) and control structures to provide a 1 in 200-year standard level of protection as stated in the Flood Risk Management Strategy (SEPA, 2015). Further information on the Scheme objectives is provided in Section 6.2 (Scheme Objectives) and Section 7.2 (Policy and Legislation).

It is anticipated that the Scheme maybe consented in 2026. Subject to obtaining the relevant permissions and funding being secured, the detailed design will then commence, followed by the construction phase. The Scheme will be constructed in phases over an approximate 10-year period, which is expected to commence in 2028 and continue until 2038. Further construction details are provided in Section 2.4 Construction.

The Scheme is not directly connected with, or essential for, the management of any European or Ramsar site.

1.2 The HRA Process

1.2.1 Introduction

The EU Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (hereafter referred to as the Habitats Directive) was adopted in 1992 (as amended). The primary aim of the Habitats Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species of European interest listed in the Annexes to the Directive at a favourable conservation status. It also introduces robust protection for those habitats and species of European importance.

The Habitats Directive includes, under Article 3, provision for the designation of Special Areas of Conservation (SACs) for habitats listed on Annex I and for species listed on Annex II. SACs make up the European site network of nature protection areas within the EU, together with Special Protection Areas (SPAs) which are classified under Article 4 of the Birds Directive (Directive 2009/147/EC on the conservation of wild birds (codified version of Directive 79/409/EEC)). The Habitats Directive provides protection for SPAs and SACs from degradation and damaging activities through a hierarchical system of assessment.

Whilst not a European site designation, wetland sites designated under the Convention on Wetlands of International Importance, named as Ramsar sites, are also relevant as they are afforded the same level of protection as European sites under domestic policy, and are treated in the same way as the European site¹ network. Scottish Government policy states that *'Where Ramsar interests coincide with Natura qualifying interests protected under an SPA or an SAC, as the case may be, the interests are thereby given the same level*

¹ As of 01 January 2021, upon the UK's exit from the EU, Natura 2000 sites in Scotland are now referred to as European sites (NatureScot 2023b).

of (legal) protection as Natura sites' (Scottish Government, 2019). Most Ramsar sites in Scotland are also designated as either SPAs or SACs (NatureScot, 2023a), although not always sharing the same qualifying species.

In Scotland, the Habitats Directive is translated into specific legal obligations by the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). This piece of legislation is hereafter referred to as the Habitats Regulations. The Habitats Regulations require that an Appropriate Assessment (AA) be undertaken by a Competent Authority where any plan or project not directly connected with or necessary to the management of the European/Ramsar site (i.e. a SAC or SPA, or candidate or potential SAC/SPA, or a Ramsar site), is likely to have a significant effect either individually or in combination with other plans or projects. The Habitat Regulations remain in place post 31 December 2020 with only minor changes introduced by the Conservation (Natural Habitats, &c.) (EU Exit) (Scotland) (Amendment) Regulations 2019.

HRA is the process, which includes an AA, whereby a Competent Authority comes to a conclusion as to whether there is no adverse effect on site integrity (AESI) from a plan or project. HRA refers to the process that includes the Competent Authority's conclusions with respect to the AA test concerning site integrity, and the AA must be undertaken *'in view of the site's conservation objectives'*. With respect to this HRA, the Competent Authority will be Falkirk Council.

The application of the precautionary principle is implicit in the Habitats Directive, which requires that the conservation objectives of European sites should prevail where there is uncertainty (European Commission, 2001). Where scientific information is insufficient, inconclusive, or uncertain, the precautionary principle is applied.

The HRA process establishes whether the proposal:

- is directly connected with or necessary for site management for nature conservation;
- is likely to have a significant effect on the site; and
- will not adversely affect the site's integrity.

If the assessment cannot ascertain that the proposal would not adversely affect site integrity and yet the Competent Authority still wish to consent the proposal, a consideration of alternative solutions is required. If no alternative solutions are available, a proposal may be approved for Imperative Reasons of Overriding Public Interest as indicated by Article 6(4) of the Habitats Directive. Compensatory measures *'should be considered only when the application of other safeguards, such as mitigation measures, is not sufficient'* (European Commission, 2007).

The four stages of the HRA process are as follows:

- Stage 1: Screening.
- Stage 2: Appropriate Assessment.
- Stage 3: Assessment of alternative solutions.
- Stage 4: Assessment where no alternative solutions exist and where adverse impacts remain (Imperative Reasons of Overriding Public Interest (IROPI)).

It should be noted that not all stages may be necessary in the HRA process. If the screening stage determines that a plan or project is unlikely to have significant effects on a European/Ramsar site, subsequent stages are not required.

1.2.2 Stage 1: Screening

Screening identifies the potential effects on a European/Ramsar site from a project or plan and considers whether these effects are likely to be significant.

The screening is a test of the 'likelihood' of effects occurring rather than a 'certainty' of effects occurring. In accordance with the Waddenzee Judgement [ECJ case C-127/02], a likely significant effect is one that cannot be ruled out on the basis of objective information. This is underpinned by the precautionary principle which is enshrined in law in the Habitats Directive, and the test of something as being '*beyond reasonable scientific doubt*', as presented in the Waddenzee Judgement. Paragraph 49 of the same judgement adds '*...where a plan or project... is likely to undermine the site's conservation objectives, it must be considered likely to have a significant effect on that site. The assessment of that risk must be made in the light inter alia of the characteristics and specific environmental conditions of the site concerned by such a plan or project*'.

The People over Wind and Sweetman ruling [ECJ case C-323/17] rules out from consideration at the screening stage any measures embedded in a plan or project designed to avoid or mitigate potentially harmful impacts on the European site. The court ruled that '*...it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site*'. The ruling requires competent authorities to, at the HRA screening stage, distinguish clearly between mitigation measures specifically designed to avoid or reduce harmful impacts on the European site, and those which are not related to the integrity of the European site. Should there be a need for measures to be specifically designed to avoid or reduce impacts on the European site, the HRA should proceed to Stage 2.

1.2.3 Stage 2: Appropriate Assessment (AA)

If the Stage 1 Screening process determines that the project or plan (either alone or in combination) is associated with impacts which are 'likely to have a significant effect' upon a European/Ramsar site, the HRA proceeds to Stage 2.

An AA considers the effect of the project or plan, either alone or in combination with other projects or plans, on the integrity of the European/Ramsar site, with respect to the site's structure and function, and its conservation objectives. Under the provisions of Article 6(3) of the Habitats Directive, the objective is to ascertain whether the plan or project will have an adverse effect on the integrity of the site, alone or in combination.

Site integrity is defined as '*the coherence of the site's ecological structure and function, across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified*' (European Commission, 2000a). The decision as to whether a site is not adversely affected focuses on and is limited to the conservation objectives for the site (European Commission, 2000a; 2018).

In carrying out an AA, mitigation measures, aimed at minimising or avoiding the negative effect of a plan or project during its operation or after its completion, may be considered as an integral part of the plan or project (European Commission, 2000a; 2018). The Competent Authority has to be certain that the mitigation proposed would remove/avoid the negative effects of the plan or project. It must be clear, therefore, what the mitigation measures are, how they would reduce or avoid the effects, and the details of how and by whom they would be implemented/managed and the timescale involved. In addition, the mitigation measures would require monitoring and enforcement, and procedures to rectify effects where measures have not been successful.

1.2.4 Stage 3: Alternative Solutions

Stage 3 is required when an AESI cannot be ruled out. It examines alternative ways of achieving the objectives of the project or plan, that may avoid an AESI on the European/Ramsar site. Guidance (European Commission, 2007) indicates that all alternatives have to be analysed. This could involve alternative locations, different scales or designs of development, or alternative processes.

1.2.5 Stage 4: Assessment Where no Alternative Solutions Exist and Where Adverse Impacts Remain (Imperative Reasons of Overriding Public Interest (IROPI)).

Where no alternative solutions exist and where adverse effects remain as a result of the project or plan, an assessment is undertaken to ascertain whether there are imperative reasons of overriding public interest

(IROPI) and determine whether a project or plan should proceed. Where it is determined that there are IROPI it would be necessary to design, implement, manage and monitor compensation measures '*to offset the negative impact of a project and to provide compensation corresponding precisely to the negative effects...*' (European Commission, 2007).

1.2.6 Guidance

In undertaking this HRA the following guidance was referred to:

- Assessing Connectivity with Special Protection Areas (SPAs) (Scottish Natural Heritage² (SNH), 2016a);
- Assessment of plans and projects significantly affecting Natura 2000 sites: Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC (European Commission, 2001);
- Communication from the Commission on the Precautionary Principle (European Commission, 2000b);
- Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC. Clarification of the Concepts of: Alternative Solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall Coherence, Opinion of the Commission (European Commission, 2007);
- Guidelines on the Implementation of the Birds and Habitats Directives in Estuaries and Coastal Zones, with particular attention to port development and dredging (European Commission, 2011);
- Habitats Regulations Appraisal of Plans: Guidance for Plan-making Bodies in Scotland, Version 3.0 January 2015 (David Tyldesley and Associates, 2015);
- Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators (SNH, 2016b);
- Managing Natura 2000 Sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (European Commission, 2000a);
- Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC (European Commission, 2018); and
- NatureScot's web guidance: Habitats Regulations Appraisal (HRA) (NatureScot, undated).

1.2.7 Structure of this Report

This HRA fulfils the requirements of Article 6(3) and Article 6(4) of the Habitats Directive and covers all four stages of the HRA process:

- Stage 1 (Screening): The outcome of the assessment and identification of Likely Significant Effects (LSEs) from the Scheme (Section 3: Stage 1 (Screening));
- Stage 2 (Appropriate Assessment): The assessment of the Scheme's implications for European/international sites in view of the sites' conservation objectives to ascertain if the integrity of the sites would not be adversely affected (Section 4: Stage 2 (Appropriate Assessment)).
- Stage 3 (Alternative Solutions): Details of possible alternative solutions to the Scheme and whether they would deliver the overall objectives of the Scheme and/or be less damaging to the integrity of the site(s) affected (Section 6: Stage 3 (Alternative Solutions));
- Stage 4 (Imperative Reasons of Overriding Public Interest (IROPI)): Information to demonstrate that there are imperative reasons of overriding public interest that justify the consent of the Scheme despite the adverse effects it could cause (Section 7: Stage 4 (Imperative Reasons of Overriding Public Interest (IROPI))).

Details of designated sites discussed within this report are presented in Appendix A (European and Ramsar Site Details), and detailed survey data which has been used to inform the assessment is presented in Appendix B (Ornithological Information).

² SNH changed their name to NatureScot as of 24th August 2020

An assessment of the Scheme in combination with other plans and projects is provided in Section 3.4 (In-Combination Effects) and Appendix E (In-Combination Assessment).

Following confirmation of no alternative solutions and that there are imperative reasons of overriding public interest, compensatory measures to ensure that the overall coherence of the European site network is protected have been developed and are described in Section 8 (Compensation).

Thirty-four figures have been prepared to support this HRA and these are referenced where appropriate throughout this document. The figures have been grouped below with a brief description of their contents:

- Figure 1: Scheme overview
- Figures 2 to 7: Flood defence designs within each Flood Cell
- Figure 8: Typical cross sections of flood defences
- Figure 9: European sites that could be impacted by the Scheme
- Figure 10: Bird survey areas
- Figures 11 and 12: GI works and associated noise monitoring locations
- Figures 13 to 18: Construction noise contours
- Figures 19 to 21: Habitat information
- Figures 22 to 32: Wintering bird survey data
- Figure 33: In-combination projects and plans
- Figure 34: Compensation site details

2. The Scheme

2.1 Introduction

The Grangemouth area has an extensive history of flood events that have occurred since the 1920s. Details of the more notable flood events are provided in Table 2.1. Whilst none of the more recent flood events have reached the level of the major flood event in 1959, the frequency of events has notably increased since the beginning of the twenty first century.

Table 2.1: History of key known flooding events around Grangemouth

Source of flooding	Date	Description of flooding/event
Snow melt and rainfall	2022	Flooding around Dorrator Bridge and Falkirk Golf Course and various other locations along the River Carron. Grange Burn very high and surface water flooding to Zetland Park.
High intensity thunderstorm	2020	Flooding from the Polmont/Westquarter Burns at Cadgers Brae/Klondye and Beancross resulted in properties being inundated. Disruption to roads and railway network, flooding from the River Avon on Wholeflats Road. Highest ever flow recorded on the River Avon at Polmonthill. Surface water flooding in parts of Grangemouth.
River Carron	2020	Widespread flooding of the River Carron catchment, closure of Stirling Road and properties at Threepwood were flooded.
High intensity thunderstorm	2019	Flooding from the Polmont Burn at Klondyke resulted in the Premier Inn and Brewers Fayre being flooded. Disruption to roads and railway network.
Grange Burn	2018	Predicted tide level of 3.93m Above Ordnance Datum (AOD) caused water levels in the Grange Burn to rise significantly and come within centimetres of bank top and bridge structure.
Tidal Surge	2014	Tidal surge coupled with high tide was predicted to affect the Forth Estuary, very high water levels on the Grange Burn.
Grange Burn	2013	Tidal surge coupled with high tide was predicted to affect the Forth Estuary, very high water level in the Grange Burn and some flooding within the Port and Petrochemical complex.
River Carron	2011	Blocked culvert at the Chapel Burn led to flooding of properties in the vicinity.
Westquarter Burn/ Polmont Burn	2011	Significant flooding across the Falkirk Grangemouth area, flooding at Beancross/ Klondyke and Reddoch Road.
River Carron	2006	Widespread flooding throughout the Falkirk area with residential and business properties affected. Larbert bus depot impacted and Anchor Burn footbridge was washed away. Closure of A883 at Checkbar, five properties flooded at Threepwood (River Carron). Carronside Place in Dunipace evacuated amid fear of flooding. Flooding of the Tor Burn affected Bogend Road.
River Carron/Chapel Burn	2002	22 properties flooded on Alloa Road in Stenhousemuir.
Forth Estuary	1959	Major flood event in the Grangemouth area. Grangemouth Docks flooded with highest tide recorded at 4.47m.
Grange Burn	1927	Abbots Road, Kerse Road and Jackson Avenue flooded.
Grange Burn	1926	Sudden rise of 1.67m of water level in Grange Burn, flooding was recorded on Jackson Avenue at Grangemouth, rising approximately 0.9m above the ground level.

Following the 1959 major flood event, a 2,040m long flood relief channel was constructed to alleviate flood risk: this commences at an overflow weir on the Grange Burn and terminates at the downstream confluence with the River Avon. Additionally, embankments were raised along the Grange Burn. Other existing flood

protection measures within the area include earth embankments, gabion baskets, rock revetments, rock groynes, masonry/concrete walls, sheet piles and rubble causeways.

A detailed flood risk mapping study undertaken by Jacobs was developed initially in 2011-2012 and has been updated, with the most recent version completed in 2023 (Jacobs, 2023). This assessed a combination of flood events from fluvial sources and tidal sources, surge events and wave overtopping. The study revealed the potential for extensive and deep inundation during a 1 in 200-year event (0.5% annual probability of occurrence).

Flood modelling was used to estimate the likelihood and extent of flooding to inform the area requiring protection by the Scheme. The Scheme has been designed to manage the risk from fluvial and tidal flooding in six discrete Flood Cells, as shown in Figure 1. The cells were delineated based on the geographical location and extents of the catchment area.

2.2 Existing Conditions

2.2.1 Site Location

The Scheme is located within the Falkirk Council area and is centred around the town of Grangemouth, which is approximately 5km northeast of the town of Falkirk and 30km west of the city of Edinburgh. Some sections of the Scheme extend into the boundaries of smaller settlements including Glensburgh, Langlees, Carron, Carronshore and Larbert. Three main water courses flow through Grangemouth and the surrounding area into the Forth Estuary (River Carron, River Avon and Grange Burn), which is designated as an SPA and Ramsar site due to its importance to nature conservation.

Grangemouth has a population of approximately 15,991 (Scottish Government, 2021), and most residential properties are located around the centre of the town, bounded by the M9 to the south, with the refinery/petrochemical plant, the Port of Grangemouth and other commercial buildings predominating to the east, north and west. Grangemouth has a long history of industrial activity; approximately half of the Grangemouth area is dominated by the Port of Grangemouth and a petrochemical plant facility.

2.2.2 The Port of Grangemouth

The Port of Grangemouth is Scotland's largest container port and refrigerated container terminal. It handles 9 million tonnes of cargo each year through specialist container, liquid and general cargo terminals and it facilitates the flow of more than £6 billion worth of goods annually (Forth Ports Group, 2023). Multiple vessel movements in and out of the port are recorded daily; it is estimated that 1,000 vessel movements occur at the port annually. To support and supply the vessel movements, a significant number of vehicle movements occur within the port and the port has multiple vehicle entrances which have good connections with the national road and motorway network. The port also has a railway line linked to main east and west coast lines and there is a weekly rail link with the Port of Tilbury in London, enabling movement of goods between the two ports (Forth Ports Group, 2023).

The Port of Grangemouth operates 24 hours a day, 365 days a year and plays a significant role in importing and exporting goods in Scotland and to the Grangemouth petrochemical plant. The port is continuously lit, with vertical light columns spread throughout the site for security and to enable 24-hour working.

2.2.3 Petrochemical Plant

The town's economy is heavily reliant on the petrochemical industry, with almost 2000 people employed directly by the INEOS, INEOS FPS and Petroineos businesses. Grangemouth is home to Scotland's only crude oil refinery, which provides the country with most of its fuel needs and is of strategic importance to Scotland's energy supply. Forty percent of the UK's oil and gas from the North Sea oil fields is transported via the Forties pipeline, and is processed at the Grangemouth petrochemical plant, while substantial quantities of other petrochemical products are exported to industries across the UK and beyond (INEOS, 2023).

The Grangemouth petrochemical site generates approximately 4% of Scotland's Gross Domestic Product (GDP) and was the first place in the UK to import US shale gas-derived ethane. The site produces over 1.3 million tonnes of petrochemicals annually and around 9 million litres of fuel which is supplied to petrol stations and airports (including Scotland's major airports: Glasgow, Edinburgh, and Prestwick) (INEOS, 2023). Therefore, the ongoing functioning of the facilities at Grangemouth has economic relevance to other areas beyond the town and it is a site of national economic importance. Within the petrochemical site, there are multiple flares which are regularly used. The frequency and duration of flaring is highly dependent on the flow of oil and gas from the North Sea pipeline and the production at the site. The petrochemical plant operates 24 hours a day and 365 days a year. Periodically, parts of the site have 'shutdowns' for essential maintenance and upgrade work. The shutdowns are typically for a few weeks and take years of planning.

In September 2024, Petroineos 'announced its intention to cease refinery operations at Grangemouth and transition to a finished fuels import terminal and distribution hub during the second quarter of 2025, subject to consultation with employees' (INEOS, 2024). It was stated that the INEOS and INEOS FPS businesses will continue as normal. The Scottish and UK Governments have committed to investing in the Grangemouth site to secure a long-term industrial future and facilitate the transition to a green energy hub. Both governments have committed to review the Project Willow feasibility study, which has identified nine key investment areas which are viable low-carbon alternatives for the refinery site (Scottish Government, 2025).

2.3 Description of the Scheme

The Scheme comprises a series of flood protection measures along the three main watercourses (River Carron, River Avon, Grange Burn), targeted sections of their tributaries (Westquarter Burn, Polmont Burn and Millhall Burn), and the Firth of Forth estuary. The outline design includes a series of new flood walls and embankments which when combined have an approximate total length of 28km. Other measures comprise relining the flood relief channel, coastal revetments, a new flow control structure (on the Grange Burn) and modification/replacements to bridges. The Scheme will provide protection for more than 3,000 properties, the petrochemical plant, port area and nationally important infrastructure up to a 1 in 200-year standard of protection.

The Scheme has been divided into six Flood Cells, with each Flood Cell then sub-divided into distinct Working Areas (Figure 1). The Working Areas are based on form of construction, geographic divisions, source of flooding and sensible breaks within the Flood Cells. It is anticipated that the contractor will develop their own programme and sequence of construction based on the Flood Cells or Working Areas. More information on the construction activities associated with the Scheme, including details on construction methodology, phasing and advance works, can be found below in Section 2.4 and in Appendix C: Construction Methodology Report.

2.3.1 Scheme Layout

As noted previously, the outline Scheme design includes a combination of flood protection measures such as fluvial and coastal flood walls, earth embankments, a new flood control structure and relining of the existing flood relief channel. To accommodate these measures, the Scheme also includes flood gates, ramps, footpaths, ground raising, bridge raising, restoration of the river channel/banks, three replacement bridges, other bridge modifications, and landscaping. The existing A9 (Beancross) underpass will be blocked off and infilled. A new at-grade, traffic signal-controlled crossing is to be provided on the A9 west of this underpass.

The height above ground level of flood defences will vary along their length, averaging a height of 1.0 – 1.5m, with a maximum height of 3.9m. The specific flood defence heights at each section may be subject to refinement at the detailed design stage.

Appendix C: Construction Methodology Report provides more details on the design and construction for the whole Scheme and the outline Scheme design for each Flood Cell is detailed on Figures 2 to 7.

The following Working Areas fall within or are immediately adjacent to the Firth of Forth SPA and Ramsar site:

- all Working Areas in Flood Cell 3 (Working Areas 3-1 to 3-5);

- Working Area 4-9 in Flood Cell 4;
- Working Area 5-4 in Flood Cell 5; and
- all Working Areas in Flood Cell 6 (Working Areas 6-1 to 6-4).

Working Areas 2-1 and 2-2 in Flood Cell 2 are located on the other side of the River Carron from the Firth of Forth SPA and Ramsar site boundary.

Those areas in proximity to the SPA and Ramsar site include a combination of the following flood management measures:

- Coastal flood walls: concrete walls with sheet piles and rock armour coastal revetments (Flood Cells 3 and 6) to attenuate wave action. Flood walls will be constructed where space is restricted along the estuary and embankments are not possible.
- Earth embankments: granular filled embankments with an impermeable core (possibly clay, concrete or bentonite core). Embankments in Flood Cells 3 and 6 will also have coastal revetments to attenuate wave action.
- Flood gates: used to allow access through the flood defences (Working Areas 2-2, 5-4 and 6-2).
- Replacement lock gates to the entry lock to the Port of Grangemouth.
- Culverts: new and/or extensions to existing culvert will be required at Working Area 6-1.

Due to the very soft estuarine deposits, it will be necessary to carry out ground improvement or piling under the footprint of the proposed defence structures so that the ground is capable of supporting the structure.

Details of the measures proposed for Flood Cells 2, 3, 4 (Working Area 4-9 only), 5 (Working Area 5-4 only) and 6, divided by Working Area, are provided in Table 2.2.

Information on the construction process for flood walls, embankments and coastal revetments can be found in Appendix C: Construction Methodology Report and typical cross sections the defence types of are shown on Figure 8.

Table 2.2: Summary of the proposed flood protection measures in Flood Cells 2, 3, 4 (Working Area 4-9 only), 5 (Working Area 5-4 only) and 6.

Flood Cell No.	Working Area	Location	Length of Flood Defences (m)	Type of Flood Defences
2	2-1	Forth and Clyde Canal Lock	662	Earth embankment and bare sheet pile wall
	2-2	Jarvie Plant/Rossco Properties	840	Bare sheet pile wall
3	3-1	Mouth of the River Carron	922	Bare sheet pile wall and coastal revetments.
	3-2	West Coast of the Port	962	Bare sheet pile wall and coastal revetments.
	3-3	West Gate to the Port	1169	Bare sheet pile wall and coastal revetments.
	3-4	East Gate to the Port	992	Sheet pile wall, plain concrete wall and formed concrete wall. Coastal revetments will be installed along the defences south from the port's east gates.
	3-5	Mouth of the Grange Burn	682	Bare sheet pile wall
4	4-9	Mouth of Grange Burn	1142	Sheet pile wall, seepage only

Flood Cell No.	Working Area	Location	Length of Flood Defences (m)	Type of Flood Defences
5	5-4	Mouth of the River Avon	438	Sheet pile wall with coastal revetments: revetments will be installed along the northern boundary of INEOS FPS compound.
6	6-1 & 6-2	West of River Avon (Beach Road & Mouth of River Avon)	2166	Sheet Pile Wall, Bored Pile Wall with revetment
	6-3 & 6-4	East of River Avon (Chemical Works at River Avon & Chemical Works)	1420	Sheet Pile Wall & Embankment

2.4 Construction

2.4.1 Introduction

The likely construction methodology for the Scheme has been developed during outline design and has been used as the basis on which the construction impacts for the HRA have been assessed. The construction information within this section primarily focusses on the Working Areas in the vicinity of the Firth of Forth SPA and Ramsar site, however, the Construction Methodology Report in Appendix C provides details for all Working Areas across the Scheme. The extent of the likely construction Working Areas for Flood Cells 2, 3, 4 (Working Area 4-9 only), 5 (Working Area 5-4 only) and 6 are shown on Figures 3 to 7.

Construction methods will be developed further during detailed design, in liaison with stakeholders such as statutory consultees, landowners/operators, utilities companies and Falkirk Council. Whilst the final construction methods will be determined by the construction contractor, the design team have identified the worst-case feasible methods based on ground investigation information, design specifications, environmental constraints, terrain, and access requirements. Developments in technology between the completion of this assessment and construction of each phase of the Scheme may allow for quieter, more efficient methods to be implemented. The design and implementation of temporary works, which includes construction access, will be detailed in the contractor's method statements and submitted to Falkirk Council for acceptance. Any required consents for temporary works will be obtained by the contractor. Any potential impacts to the SPA due to changes to the detailed design at construction stage will be assessed and discussed with NatureScot as appropriate.

An Outline Construction Environmental Management Plan (CEMP) will be prepared and made available prior to confirmation of the Scheme. A more detailed CEMP will be developed by the appointed contractor(s) in accordance with relevant standards and guidance. The CEMP will include the findings of the HRA and its conclusions and will set out any necessary mitigation. An Environmental Clerk of Works will be appointed, as well as an Ecological Clerk of Works (ECoW), who together will oversee construction works.

2.4.2 Site Compounds

At the outline design stage, the number and locations of the proposed site compounds are still to be confirmed, however, it is estimated that 12 site compounds will be required across all Flood Cells to facilitate construction works. It should be noted that due to the phasing of construction, not all site compounds are expected to be active at the same time. There are two site compound locations that are currently adjacent to the estuary edge - compound 3-A and 3-B in Flood Cell 3 by the Port of Grangemouth lock gates. Figures 13 and 14 identify that the anticipated noise generated during the set up and operation of the compound sites will attenuate to acceptable levels before reaching the intertidal area (further information is provided in Section 4.5: Noise Assessment). Whilst the compound locations could move within the port, it is unlikely that they would be any

closer to the estuary due to the existing infrastructure and limited suitable space. No compounds would be situated within the petrochemical plant due to health and safety considerations.

The main site compounds would comprise offices, welfare facilities, parking and space for storage of materials and equipment. Additional smaller site compounds provide localised welfare facilities and storage to service the more remote work sections. Activity within the site compounds would take place within normal working hours, 08:00-18:00. Some additional lighting would be required, particularly during the winter months. This lighting would be directed into the compound area to reduce light spill into the surrounding areas.

It is anticipated that Flood Cells 2 and 6 would have one compound each and Flood Cell 3 would have two site compounds. Working Areas 4-9 and 5-4 would not have a site compound. In Flood Cell 2, the potential compound is in an industrial area at the south east end of the Port of Grangemouth and the potential site compounds in Flood Cell 3 are located adjacent to the direct defences within the port, with existing roads providing access to the Working Areas in both Flood Cells. In Flood Cell 6, the proposed site compound is located on an area of grassland south of the waste water treatment works. The potential locations identified for site compounds and main access routes to these are shown on Figures 2 to 7. As the availability of land for site compounds may change over the construction period, it is possible that their location may be revisited by the appointed contractor.

2.4.3 Enabling Works

In advance of the main works contract, enabling works (such as utility diversions, preparation of working areas, etc.) may be carried out to reduce the risk of delay to the main works, to provide greater certainty of cost, and to reallocate activities which are more suited to specialist contractors.

Grangemouth contains numerous buried and overhead utilities, and the construction of the flood defences may be hindered due to the works being too close to or conflicting with these. To minimise this risk, each utility provider would be consulted to determine which utilities can be diverted and which should be protected to enable the planning and implementation of the utility diversions to be completed in advance of the construction works.

Tree felling would be required to enable access to the banks of watercourses and facilitate construction of the flood defences. Trees would either be felled before main works commence or by making the main works contractor responsible for the felling. Falkirk Council are unlikely to determine their preferred approach to tree felling until the Scheme is confirmed and they commence the procurement of contractors.

The exact timing of enabling work is not set in the programme. Once the Scheme is confirmed, enabling works could take place any time after this, subject to funding and obtaining the necessary consents.

2.4.4 Main Construction Works

The main Scheme construction works would include works associated with establishing compound sites and working areas, piling, earthworks, concrete construction, demolishing existing structures and buildings, movement of materials, wall cladding, surfacing and landscaping.

There are many constraints associated with construction works near watercourses, namely the proximity of buildings, roads and other infrastructure on or adjacent to the watercourse banks. Therefore, construction of some lengths of flood defences would likely be required from the 'wet side' of the defence (i.e. from the side closest to the watercourse), and include in-water working where accessing works from the 'dry side' (i.e. from the side furthest from the watercourse) is not considered feasible, or where there are access or health and safety issues.

2.4.4.1 In-Water Works

There will be a need for in-water working in all Flood Cells. All in in-water Working Areas are shown on Figures 2 to 6 and the locations of relevance to this HRA are:

- Flood Cell 2: Working Area 2-2 (Jarvie Plant).
- Flood Cell 3: Working Areas 3-1 (mouth of the River Carron), 3-3 (west gate to port) and 3-4 (east gate to port).
- Flood Cell 4: Working Area 4-9 (mouth of Grange Burn).
- Flood Cell 5: Working Area 5-3 (Grangemouth Road).
- Flood Cell 6: Working Areas 6-1 (Beach Road) and 6-2 (Petroineos mouth of River Avon).

Where possible, works would be completed from the banks of watercourses and the estuary within the areas identified for in-water working. In some instances, this would mean plant and materials located adjacent to the water and only minimal in-water working for specific activities (such as an excavator bucket removing substrate at the toe of existing defences): it is anticipated that this will be feasible for some sections of Working Areas 2-2, 3-1, 3-3 and 4-9.

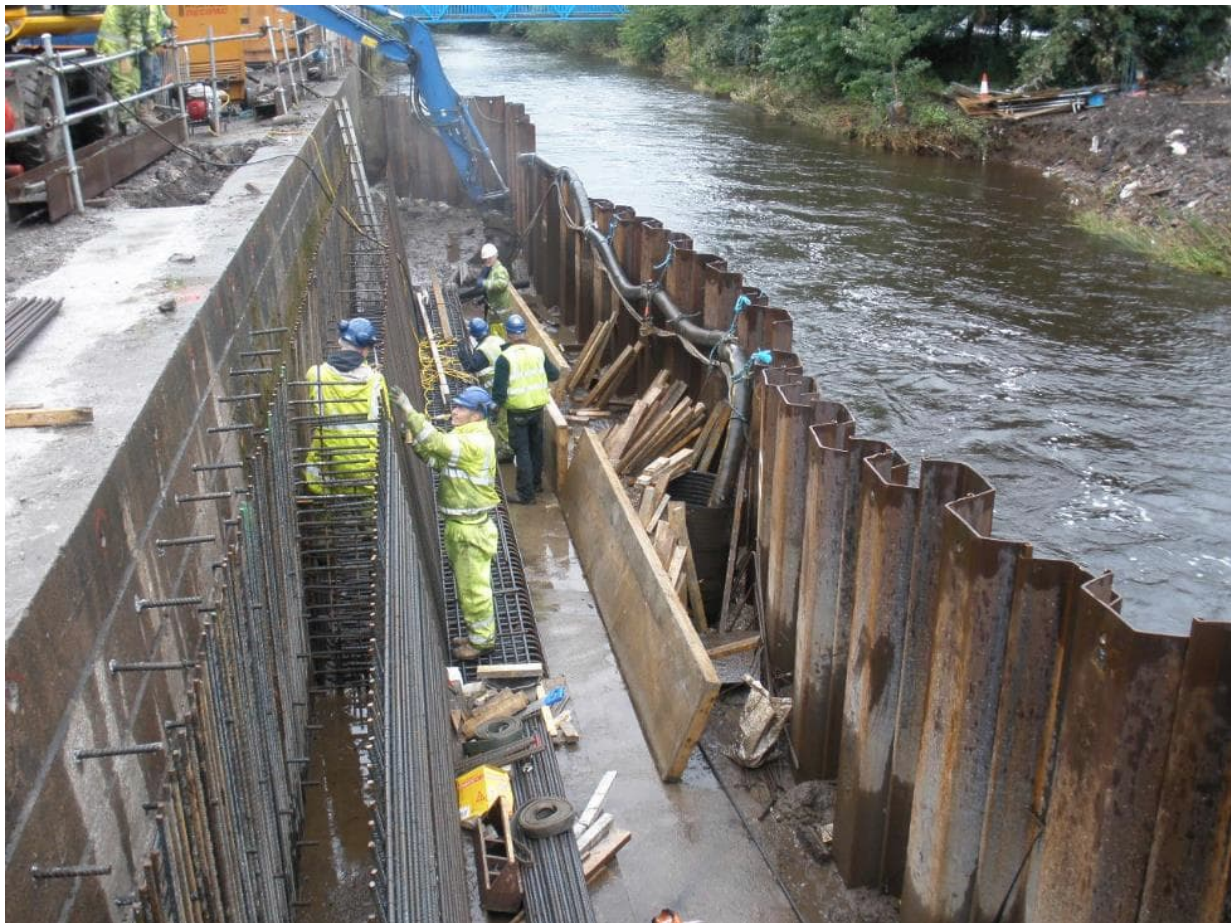
In-water working would also be facilitated by temporary features. In some locations, temporary raised working platforms would be constructed up to 9m wide to accommodate the required construction plant. It is likely that raised working platforms would be used for some works within the River Carron (Working Areas 2-2 and 3-1), Grange Burn (Working Area 4-9), and within the River Avon (Working Area 5-3).

The platforms would likely be created from clean crushed rock (approximately 75-150mm in size) placed on a separation geotextile and surrounded with sand/stone-filled bulk bags to hold the granular fill in place. This would create a dry working area for personnel and machinery to construct the flood protection measures, and for plant to move between work sections on the wet side of the defences. The platform would be high enough to ensure that work can progress without regular interruption from changing water levels, (e.g. above mean high water level) and the specific heights at each location will be confirmed during the detailed design stage. An example of a raised working platform is provided in Photograph 2.1.



Photograph 2.1: Example of a raised working platform at White Cart Water FPS, Glasgow

Other options to facilitate in-water working include the use of cofferdams, where a temporary dam would be constructed, typically using sheet piles, around the area of works to exclude water. An example of a cofferdam is provided in Photograph 2.. It is likely that a cofferdam would be used in Working Areas 3-3 to construct the flood wall across the western lock. A much smaller limpet cofferdam, which would attach to side of the existing port wall, is also likely to be used in Working Area 3-4 to install the new flood/lock gates. As piling is required, installation of a cofferdam is typically noisier than creating a working platform. However, due to the soft sediment along the estuary, it is anticipated that an air hammer would not be required to install the sheet piles, and therefore the noise generated when installing cofferdams would be in line with typical construction plant movement. Where the underlying ground is permeable, the differential water pressure across the cofferdam may cause groundwater to seep up through the bottom of the dry area, which would require the water to be pumped out to keep the working area in the cofferdam dry. It is likely that the other works in Working Areas 3-3 and 3-4 can be constructed from the bank or from a barge.



Photograph 2.2: Example of a cofferdam at White Cart Water FPS, Glasgow

Access to the in-water working areas in Flood Cells 1 to 5 is anticipated to be achieved via a combination of ramps (existing and new ones), existing bridges and temporary construction bridges. In Flood Cell 6, access will be determined by the contractor, however, this is likely to include a haul road constructed along the edge of the Firth of Forth Estuary, with the footprint of the haul road forming part of the foundation for the rock revetment. Further details of in-water working methods can be found in Appendix C (Construction Methodology Report).

2.4.4.2 Coastal Works

Due to the extremely soft ground along the estuary frontage, improvement works to the existing ground are required to increase the strength (bearing capacity) of the ground to facilitate construction of flood defences within Working Areas 6-1 and 6-2. The flood defences will consist of bored piles into the improved ground, with a concrete wall situated on top of the piles and rock armour revetment flush with the wall on the estuary side. The bored pile is likely to be concrete and extend no more than 4m below the existing ground level. The bored pile will have a concrete capping beam and a reinforced concrete wall stem or pre-cast concrete wall stem.

Ground improvement works will be undertaken before the installation of piles and rock revetment and the improved ground will form part of the temporary haul road along the estuary frontage. The ground improvement process will require an additive (such as lime, cement or pulverised fly ash (PFA)) to be mixed into the ground to a depth of up to 4m below existing ground level (this depth is determined by the required depth of the bored pile at each location). The additive will be mixed with water to create a thick paste which will be pumped to a rotavator head and mixed into the existing ground using an excavator. This will quickly bind within the existing substrate and harden – no leaching of the additive will occur into the surrounding area.

Works within this coastal area will be dictated by the tides. Soil mixing will only be conducted when the tide has receded past the working area and will halt in sufficient time before the area is submerged by the rising tide each day. Once the soil mixed ground has cured sufficiently, the excavator with the mixing head and pump will track over the soil improved ground and begin mixing the next area of ground. This process will continue along the estuary frontage until all the necessary ground has been mixed.

Geotechnical sampling and testing will be carried out to ensure the improved ground achieves the specified design parameters.

Further information on the soil mixing methods is provided in Appendix C (Construction Methodology Report).

2.4.4.3 'Dry Side' Construction

The remainder of the works would be constructed from the dry/protected side of the defences and would likely include earthworks and excavation works up to 3m in depth. It is anticipated that the works would result in some disturbance to local traffic, as temporary diversions and road closures may be required. The duration of closures would be dependent on the form of construction and constraints set by other stakeholders (e.g. owners, operators and Falkirk Council).

Several measures have been proposed to minimise the effects of construction traffic. Primarily, preferred routes have been identified to and from site compounds and individual construction sites. It has also been recommended that all construction traffic use the trunk road network or A-class roads and only deviate where necessary to reach individual sites. Several other traffic management measures have been proposed, including:

- provision of alternative routes for diverted traffic and appropriate signage;
- regulated site working hours in order to avoid heavy volumes of movement during peak hours in the morning and evening when general traffic levels will be higher than normal;
- installation of additional (temporary) warning and speed control signs;
- provision of a wheel wash facility and road sweeper to minimise any mud and debris on the surrounding public road network and prevent the introduction of non-native/invasive plant material to the site;
- formation of a construction liaison committee to ensure the smooth management of the project – public interface;
- introduction of temporary parking restrictions and alternative parking arrangements where on and off-street parking is restricted as a result of the Scheme;
- temporary closure of public rights of way and provision of suitable alternative routes; and
- stationing of a "Stop-Go" banksman to facilitate communication between drivers.

It is also anticipated that a Traffic Management Plan will be developed at the detailed design stage to further minimise the effects of construction traffic associated with the Scheme.

2.4.4.4 Temporary Flood and Erosion Protection

The sequence of construction may temporarily lower the standard of flood protection within the individual Flood Cells where flood defences have yet to be constructed. Temporary changes to the standard of flood protection is inevitable as all defences cannot be constructed simultaneously. During construction, the appointed contractor would be required to provide temporary flood protection measures within each Flood Cell until construction of the permanent defences is complete to maintain at least the current standard of protection across the Scheme. Temporary flood protection measures could be in the form of sandbags, bags filled with granular fill, temporary flood barriers or pumps to remove water.

Some temporary erosion protection of the riverbanks may be required, should the working areas increase the risk of scour. Such protection will take the form of geotextile and rip rap/armour stone and will only be implemented following a period of monitoring and discussion with the relevant stakeholders.

2.4.4.5 Reinstatement Works

As part of the construction phase of the Scheme, nearly all access tracks and Working Areas (including in-water) will be removed in their entirety and habitats will be reinstated. These reinstatement works will fall within the overall construction programme and are assessed as part of the construction phase. The area of soil improved ground to facilitate construction of defences within Working Areas 6-1 and 6-2 cannot be fully reinstated due to the additive mixed into the substrate and therefore this will be included within the permanent works habitat loss calculations.

A habitat management plan will be developed which will include measures to reduce damage and encourage recovery of the habitats affected by construction works, in particular the intertidal areas of the estuary.

2.4.5 Anticipated Construction Programme

The Contractor will be responsible for developing the programme and sequencing of construction works, subject to any constraints imposed by the project team and/or planning/licence conditions. The construction period for the Scheme is estimated to be up to 10 years, with discrete sections being completed in phases within that timeframe. Table 2.3 identifies the approximate duration to construct flood defences within the Flood Cell Working Areas of relevance to the HRA. Construction works are anticipated to be carried out from Monday to Friday, over a period of 50 working weeks each year.

Table 2.3: Approximate duration of construction works within the Flood Cell Working Areas of relevance to the HRA.

Cell No	Working Area	Approximate Duration (Months)
2	All Working Areas (2-1 and 2-2)	15
3	All Working Areas (3-1 to 3-5)	42
4	4-8 and 4-9	12
5	5-3 (downstream of Grangemouth Road) and 5-4	21
6	East extents (6-1 and 6-2)	21
	West extents (6-3 and 6-4)	18

The key dates for the anticipated construction programme are outlined below, assuming the hearing for the Scheme is concluded by 2026.

- Enabling works: 2028.
- Main construction phase: late 2028 – 2038 (Scheme operational by 2038).
- Defects correction period: minimum two years post construction works (landscape maintenance period is to be confirmed in due course).

The dates above are subject to change and will be periodically reviewed.

2.4.5.1 Sequencing of Construction Works

The Scheme is a complex project, involving construction, logistics, watercourse management, traffic management and public interface, and is spread over a large spatial area. Due to its scale and spatial extent, it is likely that construction works will be divided into at least four construction phases, with each phase potentially involving more than one construction contract. At this stage the construction phasing cannot be confirmed, but it is likely that construction work will take place in a range of Flood Cells within each construction phase as detailed in Table 2.4.

Table 2.4: Possible split of Flood Cells into construction phases

Phase Number	Flood Cell
1 (Mainly residential properties)	1, 2, 4 (part), and 5 (part)

Phase Number	Flood Cell
2 (Port lock gates)	3
3 (Port flood defences)	3
4 (Industrial areas)	4 (part), 5 (part) and 6

The sequencing and timing of these works is not definitively known, and construction contracts could overlap. The sequencing of construction works is likely to mean that only two construction phases can be undertaken at the same time. Construction works within Flood Cells 3 and 6 predominantly fall within or directly adjacent to the Firth of Forth SPA and Ramsar site. Therefore, it will be stipulated that any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with a gap of at least one winter (October to March) in between, to reduce disturbance to the qualifying species of the Firth of Forth SPA and Ramsar site. The lock gates are located within the busy Port of Grangemouth. This area is outwith the Firth of Forth SPA and bird numbers recorded during surveys were low. Therefore, works at the lock gates within Flood Cell 3 may overlap with other works in Flood Cell 3 or 6. The following diagram provides an indicative illustration of how the phasing of contracts may occur, with each colour indicating a separate construction contract (Diagram 2.1).

				Year 1				Year 2				Year 3				Year 4				Year 5				Year 6				Year 7				Year 8				Year 9				Year 10				Year 11			
Flood Cell No.	Area	Working Area	Location	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct								
1 and 4	Residential	1-1, 1-2, 1-3, 1-4, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6 and 4-7 (part)	Enabling Works for flood defences in the residential areas on the River Carron and Grange Burn catchments																																												
1 and 4	Residential	1-1, 1-2, 1-3, 1-4, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6 and 4-7 (part)	Includes flood defences covering the residential areas on the River Carron and Grange Burn catchments																																												
2, 4 (part) and 5	Industrial areas and Ineos Companies	2-1, 2-2, 4-7 (part), 4-8, 4-9, 5-1, 5-2, 5-3 and 5-4	Includes flood defences covering the industrial areas on the lower sections of the River Carron, Grange Burn and on the banks of the River Avon																																												
6	Ineos Companies	6-1, 6-2, 6-3 and 6-4	Includes flood defences along the estuary frontage																																												
3	Port (excluding Lock Gates)	3-1, 3-2, 3-3 (part), 3-4 (part) and 3-5	Includes flood defences on the banks of the River Carron and Grange Burn around the Port of Grangemouth																																												
3	Port (Lock Gates)	Part 3-3 and 3-4	Includes flood defences at the locks																																												
N/A	Compensation sites	N/A	Bothkennar and Kinnell																																												

Diagram 2.1: Indicative phasing of construction contracts.

While it will be for the contractor to establish a construction programme, some contract constraints on the sequencing of works shall be incorporated to manage environmental impacts during the construction period. These will include:

- restrictions to minimise disturbance to sensitive protected species or designated nature conservation sites;
- restrictions on the total length of haul roads in place at any one time;
- restriction on the length of the Working Area which can be closed to the public at any one time;
- restrictions on in-channel works, especially those that would prevent fish passage; and
- restriction on work which disturbs the riverbed during salmon spawning season (depending on the limitations enforced in the CAR licence).

2.4.6 Likely Plant, Materials and Waste

At this outline design stage, there is limited detail on the machinery and materials required and waste likely to be generated by the Scheme. However, Table 2.5 and 2.6 set out an indicative list of the likely equipment and materials required for the whole Scheme during construction.

Table 2.5: Indicative list of likely plant to construct the Scheme

Indicative List of Construction Plant			
360 degree tracked/wheeled excavators	Dumpers/tipper lorries	Mobile cranes	Tracked/Non-tracked piling equipment
Vibrating roller compactors	Vibrating plate compactors	Concrete cutting equipment	Concrete pumps and skips and vibrating pokers
Burning and steel cutting and welding equipment	Drilling and coring equipment	Mobile pumps	Mobile settlement tanks
Mobile generators	Mobile compressors	Mobile heaters	Tarmac planers and pavers

Table 2.6: Indicative list of likely material to construct the Scheme

Indicative List of Materials			
Cohesive, low permeability fill for embankments	Granular fill (sands, gravels, rock)	Additives (cement, lime or pulverized fly ash (PVA))	Rock armour stone
Topsoil	Steel sheet piles	Precast concrete piles	Mass and reinforced concrete
Seeds, trees and plants	Geotextiles	Timber fencing	Metal fencing
Bitumen macadam	Plastic pipework and ductwork	Metal pipework	Concrete pipework
Mechanical/electrical pumps	Stonework, brickwork, and reconstituted stone products	Precast concrete products	Glass products
Metal and plastic fixings and fixtures	Hydrocarbon-based cellular products	Organic-based coatings and sealants	Hydrocarbon-based paints, coatings, and sealants
Lighting, wiring and fixtures	Fuel oils	Steel flood gates and lock gates	

The estimated quantities of materials required for the construction of selected structures included within the Scheme design are listed in Table 2.7.

Table 2.7: Indicative quantities of materials to construct the Scheme (materials for fluvial walls and re-lining of a flood relief channel are not included)

Asset	Material	Quantity	Units
Embankments	Primary aggregate	155,600	m ³
	Steel	1,230	m ³
Tidal walls	Concrete	1,765	m ³
	Steel	247	t
	Steel	570	m ³
Bank protection	Erosion matting	68,520	m ²
Rock armour	Primary aggregate	227,870	t
	Damp-proof coarse membrane	58,430	m ²
Headwalls	Concrete	100	m ³
	Steel	14	t
Drainage pipe	Plastics	975	m ³
	Concrete	2,525	m ³
	Iron	3	m ³
Lock Gates	Steel	80	t
Flood Gates	Steel	15	t
Landscaping (soil and grass seed)	Soil/Clay	24,000	m ³
Path	Asphalt	1,870	m ²
Permanent access points	Primary aggregate	20	m ³
Soil mixed ground	Additives (cement, lime or PFA)	49,000	m ³

The number of staff likely to be directly associated with construction of the cells adjacent to the Firth of Forth estuary is unknown, but it would comprise operatives, managers, administration staff, supervisors and an environmental clerk of works, and is estimated to be a minimum of 27 and maximum of 110 personnel during peak periods of construction.

At this stage of design, limited information is known about the waste that could be generated by the project. The detailed design will consider resource efficiency and waste minimisation in order to identify the materials that can be reduced, reused or recycled. However, it is anticipated that main waste is likely to comprise inert materials, potentially contaminated soils and made ground.

All such waste would require disposal in accordance with the Waste Regulations, with waste that meets the landfill Waste Acceptance Criteria taken into a local material recycling facility/landfill site. Any special waste designated under the Special Waste Regulations 1996 must be disposed in accordance with the relevant SEPA guidance. The volume of special waste would depend on the extent of ground contamination, which would only be fully known at the time of construction.

The contractor would be required to prepare management plans and method statements for carrying out the construction works. For example, the contractor would be required to prepare a Site Waste Management Plan, which would contain details of how different waste materials would be handled, in accordance with the waste hierarchy and regulatory requirements. Also, as part of their method statements, the contractor would be required to propose appropriate methods for works at or near watercourses for managing sedimentation risk.

2.5 Operation and Maintenance

Operation effects of the Scheme will be negligible due the fixed nature of the flood defences.

The Scheme has been designed to have minimal operation and maintenance requirements during the life of the project (anticipated to be over 100 years). Once constructed, the Scheme will only require intervention to operate and maintain the flood protection measures by Falkirk Council and others. These will be set out in an operation and maintenance manual, which will be developed at a later stage, but it is anticipated that annual inspections of the flood defences and coastal revetments will be required. Topping up of coastal revetments

may be required approximately every 15-20 years post-construction. Although the duration and periodicity of these topping up events are unknown due to their very nature, due consideration and restrictions to ensure the conservation objectives of the SPA will not be compromised will be undertaken during these maintenance events. Due to the improved ground stability achieved by soil mixing in Working Areas 6-1 and 6-2, it is expected that these areas will require less maintenance works in the future, than would otherwise have been required.

The key operation and maintenance tasks for flood defences adjacent to the Firth of Forth estuary will be:

- closure of the flood gates during periods of predicted flood risk, and re-opening afterwards;
- erection of demountable flood defences in the port along the lock;
- regular maintenance checks, such as the walls/embankments for structural defects, operation of flap-valves and identifying any damage from vandalism. Flood gates and seals will be checked on an annual basis and after a significant flood to check for damage or wear and tear;
- closure of port lock gates and railway flood gates;
- maintenance works as required, such as carrying out any pointing, cladding repairs, cleaning, replacing seals, vegetation clearance, removal of debris from bridges; and
- landscape maintenance of the embankments and landscaped areas, as defined during detailed design.

The plant, materials and personnel required for the operation and maintenance works will be minor in comparison with that required for the construction phase. Falkirk Council will be responsible for operating and maintaining the flood defences. At this stage it is estimated that two to five personnel will be directly involved in the operation and maintenance of the flood defences, however this may significantly increase during a flood event. Access to all flood defences for maintenance has been considered during the design process. Within the Port of Grangemouth, access will primarily be taken from existing roads. Within Flood Cell 6 along the estuary, a permanent access track will be constructed directly behind the flood defences and outwith the petrochemical plant fenceline.

Where possible, maintenance works should be timed to occur in the summer months when most qualifying species of the Firth of Forth SPA and Ramsar site are either absent or present in lower numbers. However, it is acknowledged that occasionally emergency maintenance works may be required during winter months, for example as a result of storm damage. Compensation habitat will be created for the Scheme (Section 8: Compensation), which will be maintained throughout the lifespan of the Scheme and provide alternative habitat for qualifying bird species of the Firth of Forth SPA and Ramsar site during any maintenance works. Therefore, the integrity of the European site network will be maintained.

Defences along the estuary between Grange Burn and the River Avon (Working Areas 6-1 and 6-2) have been designed and constructed to account for climate change. The new lock gates within the Port of Grangemouth have also been constructed to account for climate change. The remaining defences have been designed to allow for future flexibility, in that the flood wall/embankment foundations have been designed so that the defences may in future be increased in height. This measure would mitigate the future impacts of climate change, where flood events are predicted to become more frequent and severe. Any alterations to flood defences to account for climate change, which could affect the Firth of Forth SPA and Ramsar site, will be taken forward as a new Scheme and will be assessed in a separate HRA.

2.6 Decommissioning

It is highly unlikely that the Scheme will be demolished within the foreseeable future, as the Scheme is anticipated to be maintained for over 100 years. Should demolition be required, it is anticipated that any future local authority will ensure that the relevant consents are attained, and environmental procedures are followed in accordance with relevant guidance and environmental protective measures.

3. Stage 1 (Screening)

3.1 Introduction

This section details the Stage 1 Screening of the HRA process, which comprises the following:

- determining whether the project or plan is directly connected with or necessary to the management of a European/Ramsar site;
- identifying the potential for effects on European/Ramsar sites individually or in combination with other plans and projects; and
- assessing the likely significance of any potential effects on European/Ramsar sites.

As stated in Section 1.1 (Project Background), the Scheme is not directly connected with, or essential for, the management of any European or Ramsar site.

3.2 European Sites with Potential Effects from the Scheme

Guidance dictates that all European/Ramsar sites, and their qualifying features, which have the potential to be affected by a plan or project should be considered as part of the HRA process. For the assessment of the Scheme, relevant European and Ramsar sites were identified by looking for potential source-receptor pathways. In addition, NatureScot provided guidance on designated sites to be included within this HRA in their response to the Scoping Report for the Scheme (Jacobs, 2018). The following sites were identified to be considered within the screening process (Figure 9), namely:

- Firth of Forth SPA (NatureScot, 2023c);
- Firth of Forth Ramsar (JNCC, 2008a; NatureScot, 2023d);
- River Teith SAC (NatureScot, 2023e);
- Forth Islands SPA (NatureScot, 2023f);
- Imperial Dock Lock, Leith SPA (NatureScot, 2023g);
- Isle of May SAC (NatureScot, 2023h);
- Outer Firth of Forth and St Andrews Bay Complex SPA (SPA) (NatureScot 2022, NatureScot 2023i);
- Slamannan Plateau SPA (NatureScot, 2023j);
- Loch Leven SPA (NatureScot, 2023k); and
- Loch Leven Ramsar (JNCC, 2008b; NatureScot, 2023l).

Qualifying species, conservation objectives and pressures on feature condition (Scotland's Environment, 2019) are presented in Table 3.1 below, and in Appendix A (European and Ramsar Site Details).

Table 3.1: European and Ramsar sites to be included in Stage 1 Screening for LSEs

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
UK9004411 / 8499 Firth of Forth SPA (NatureScot, 2023c)				
6,317.93	The site qualifies under Article 4.1 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following Annex 1 species: - bar-tailed godwit (<i>Limosa lapponica</i>)*, non-breeding - golden plover (<i>Pluvialis apricaria</i>)*, non-breeding - red-throated diver (<i>Gavia stellata</i>)*, non-breeding - Sandwich tern (<i>Thalasseus sandvicensis</i>)¹, passage - Slavonian grebe (<i>Podiceps auritus</i>)*, non-breeding The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following migratory species (all non-breeding): - knot (<i>Calidris canutus</i>)* - pink-footed goose (<i>Anser brachyrhynchus</i>)* - redshank (<i>Tringa totanus</i>)* - shelduck (<i>Tadorna tadorna</i>)* - turnstone (<i>Arenaria interpres</i>)* The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting a waterfowl assemblage of national importance. Assemblage qualifying species (all non-breeding): - bar-tailed godwit - common scoter (<i>Melanitta nigra</i>) - cormorant (<i>Phalacrocorax carbo</i>) - curlew (<i>Numenius arquata</i>) - dunlin (<i>Calidris alpina alpina</i>) - eider (<i>Somateria mollissima</i>) - goldeneye (<i>Bucephala clangula</i>)	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species	The Firth of Forth SPA is a mosaic of estuarine and coastal habitats spanning the length of the Forth Estuary. The intertidal mudflats, saltmarsh, rocky shores and bays that provide important food sources and shelter for the qualifying, wintering, birds and passage migrants are included within the extensive 6,317.93ha designated site boundary. The Firth of Forth SPA is designated for 27 species; comprising five Annex I species, five individually-cited species (due to the presence of internationally important populations) and an assemblage of 17 waterbird species.	- Game/fisheries management - Recreation/disturbance - Water quality - Climate change - Natural event

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	- golden plover - great crested grebe (<i>Podiceps cristatus</i>) - grey plover (<i>Pluvialis squatarola</i>) - knot - lapwing (<i>Vanellus vanellus</i>) - long-tailed duck (<i>Clangula hyemalis</i>) - mallard (<i>Anas platyrhynchos</i>) - oystercatcher (<i>Haematopus ostralegus</i>) - pink-footed goose - red-breasted merganser (<i>Mergus serrator</i>) - red-throated diver - redshank - ringed plover (<i>Charadrius hiaticula</i>) - scaup (<i>Aythya marila</i>) - Slavonian grebe - velvet scoter (<i>Melanitta fusca</i>) - wigeon (<i>Mareca penelope</i>)² - turnstone			
UK13017 / 8424 Firth of Forth Ramsar (NatureScot, 2023d)				
6,317.93	The site qualifies under Ramsar criterion 2 by supporting (1993/4 to 1997/98 winter peak means): - red throated Diver (90 individuals, 2% of the GB population) - golden plover (2949 individual, 1% of the GB population) The site qualifies under Ramsar criterion 4 by supporting the following waterbird species at a critical stage in their life cycles: - common scoter - cormorant	The Ramsar Convention's mission is '<i>the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world</i>'.	The Ramsar site comprises a complex of estuaries, mudflats, rocky shorelines, beaches and saltmarshes. The site provides habitat for large numbers of wintering waders and wildfowl, many in nationally and internationally important numbers (NatureScot, 2023d). It is estimated that 90% of the world's population of pink-footed geese spend winter on wetland and farmland habitats in the UK (Scottish Wildlife Trust, 2019).	- Game/fisheries management - Recreation/disturbance - Climate change - Water quality

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	• curlew • dunlin • eider • great crested grebe • grey plover • long-tailed duck • oystercatcher • red-breasted merganser • ringed plover • scaup • velvet scoter The site qualifies under Ramsar criterion 5 by regularly supporting waterbirds in numbers of 20,000 individuals or more. In the five-year period 1992/93 to 1996/97, a winter peak mean of 95,000 individual waterbirds was recorded, comprising 45,000 wildfowl and 50,000 waders. The site qualifies under Ramsar criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbird: Qualifying species/populations with peak counts in spring/autumn: • pink-footed goose • redshank • shelduck • turnstone Qualifying species/populations with peak counts in winter: • bar-tailed godwit • goldeneye • knot • Slavonian grebe Qualifying passage species:			

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	Sandwich tern¹			
UK0030263 / 8367 River Teith SAC (NatureScot, 2023e)				
1,289.33	The site is designated for the following qualifying species: - Atlantic salmon (<i>Salmo salar</i>) - brook lamprey (<i>Lampetra planeri</i>) - river lamprey (<i>Lampetra fluviatilis</i>) - sea lamprey (<i>Petromyzon marinus</i>)	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species, including range of genetic types for salmon, as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species	The River Teith is the most significant tributary of the River Forth, flowing eastward through Central Scotland and discharging into the Firth of Forth west of Stirling.	- Forestry operation - Invasive species - Water quality - Water management
UK9004171 / 8500 Forth Islands SPA (NatureScot, 2023f)				
9,797.01	The site qualifies under Article 4.1 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following Annex 1 species (all breeding): - Arctic tern (<i>Sterna paradisaea</i>)* - common tern (<i>Sterna hirundo</i>)* - roseate tern (<i>Sterna dougallii</i>)* - Sandwich tern* The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting populations of	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species	The Forth Islands SPA includes a number of islands in the Firth of Forth (Figure 8) and is classified on the basis of supporting populations of European importance of eight seabird species as well as an assemblage of over 20,000 seabirds. The nearest island of the SPA (Long Craig island) is located approximately 16km from the Scheme. Roseate, common and Sandwich terns are the only qualifying species of the Forth Islands SPA known to regularly nest on Long Craig island and are present in large numbers (equivalent to 1% or more of the SPA population at classification) (Jacobs Arup, 2009).	- Inter-specific competition - Climate change - Game/fisheries management - Proactive on-site management - Invasive species - Recreation/disturbance

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	European importance of the following migratory species (all breeding): • gannet (<i>Morus bassanus</i>)* • lesser black-backed gull (<i>Larus fuscus</i>)* • puffin (<i>Fratercula arctica</i>)* • shag (<i>Phalacrocorax aristotelis</i>)* The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting a seabird assemblage of national importance. Assemblage qualifying species (all breeding): • Arctic tern • cormorant • gannet • guillemot (<i>Uria aalge</i>) • herring gull (<i>Larus argentatus</i>) • kittiwake (<i>Rissa tridactyla</i>) • lesser black-backed gull • puffin • razorbill (<i>Alca torda</i>) • roseate tern • Sandwich tern • shag	• structure, function and supporting processes of habitats supporting the species • no significant disturbance of the species		
UK9004451 / 8668 Imperial Dock Lock, Leith SPA (NatureScot, 2023g)				
0.11	The site qualifies under Article 4.1 of the Directive (79/409/EEC) by regularly supporting breeding populations of European importance of the following Annex I species: • common tern, breeding	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • population of the species as a viable component of the site • distribution of the species within site	The Imperial Dock Lock, Leith SPA is a man-made structure at the mouth of the Imperial Dock in the Port of Leith. The SPA supports the largest colony of common tern in the Forth (an average of 558 pairs, 1997-2001).	• Other

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
		• distribution and extent of habitats supporting the species • structure, function and supporting processes of habitats supporting the species • no significant disturbance of the species		
UK0030172 / 8278 Isle of May SAC (NatureScot, 2023h)				
356.64	Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site: • reefs Annex II species that are a primary reason for selection of this site: • grey seal (<i>Halichoerus grypus</i>)	To avoid deterioration of the qualifying habitat thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitat that the following are maintained in the long term: • extent of the habitat on site • distribution of the habitat within site • structure and function of the habitat • processes supporting the habitat • distribution of typical species of the habitat • viability of typical species as components of the habitat • no significant disturbance of typical species of the habitat To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term:	The Isle of May is located at the entrance to the Firth of Forth and supports a breeding colony of grey seals. The site is the largest breeding colony of grey seals on the east coast of Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of annual UK pup production (JNCC, 2019).	• Invasive species • Water management

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
		• population of the species as a viable component of the site • distribution of the species within site • distribution and extent of habitats supporting the species • structure, function and supporting processes of habitats supporting the species • no significant disturbance of the species		
UK9020316 / 10478 Outer Firth of Forth and St Andrews Bay Complex SPA (NatureScot, 2022 and 2023i)				
272,068.10	The site meets the qualifying requirements under Article 4.1 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following Annex I species: • Arctic tern, breeding • common tern, breeding • little gull (<i>Hydrocoloeus minutus</i>), non-breeding • red-throated diver, non-breeding • Slavonian grebe, non-breeding The site meets the qualifying requirements under Article 4.2 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following migratory species: • black-headed gull (<i>Chroicocephalus ridibundus</i>), non-breeding • common gull, non-breeding • common scoter, non-breeding • eider, non-breeding • gannet, breeding • goldeneye, non-breeding • guillemot, breeding and non-breeding • herring gull, breeding and non-breeding	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long-term and it continues to make an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species. This contribution will be achieved through delivering the following objectives for each of the site's qualifying features: a) Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term; b) To maintain the habitats and food resources of the qualifying features in favourable condition.	The Outer Firth of Forth and St Andrew's Bay Complex comprises an area of 272,068.10ha which stretches from Arbroath to St. Abb's Head and comprises the Firth of Forth, the outer Firth of Tay and St Andrew's Bay. The site extends beyond the 12NM (Nautical Mile) boundary of territorial and offshore waters to encompass feeding, moulting and roosting grounds of 21 qualifying species of breeding and/or wintering seabirds and waterfowl.	n/a ³

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	- kittiwake, breeding and non-breeding - long-tailed duck, non-breeding - Manx shearwater (<i>Puffinus puffinus</i>), breeding - puffin, breeding - razorbill, non-breeding - red-breasted merganser, non-breeding - shag, breeding and non-breeding - velvet scoter, non-breeding			
UK9004441 / 9184 Slamannan Plateau SPA (NatureScot, 2023j)				
590.91	The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting nationally important numbers of the following migratory species: Taiga bean geese (<i>Anser fabalis fabalis</i>)	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species	Slamannan Plateau lies east of Cumbernauld, in the headwaters of the River Avon. It consists of two small lochs and their surrounding peatlands and associated areas of rough and improved grassland. The site supports roosting and feeding taiga bean geese during winter. This flock is the only regular wintering flock of bean geese in Scotland and one of only two in the UK, with over 50% of the total UK population in recent years (NatureScot, 2023h).	n/a ³
UK9004111 / 8530 Loch Leven SPA (NatureScot, 2023k)				
1,611.29	The site qualifies under Article 4.1 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following Annex I species: whooper swan (<i>Cygnus cygnus</i>), non-breeding The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting populations of European importance of the following migratory species:	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term:	Loch Leven in central Scotland is the largest natural eutrophic lake in Britain. It is a relatively shallow loch, surrounded by farmland, with a diverse aquatic flora and shoreline vegetation (NatureScot, 2020a).	n/a ³

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	- pink-footed goose, non-breeding - shoveler The site qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting a waterfowl assemblage of national importance. Assemblage qualifying species (all non-breeding): - cormorant - gadwall (<i>Anas Strepera</i>) - goldeneye - pochard (<i>Aythya farina</i>) - shoveler (<i>Anas clypeata</i>) - teal (<i>Anas crecca</i>) - tufted duck (<i>Aythya fuligula</i>)	- population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species		
UK13033 / 8436 Loch Leven Ramsar (NatureScot, 2023l)				
1,611.29	The site qualifies under Ramsar criterion 1 by containing a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region: - largest naturally eutrophic loch in Britain The site qualifies under Ramsar criterion 2 by supporting vulnerable, endangered, or critically endangered species or threatened ecological communities (1993/4 to 1997/8 winter peak mean): - whooper swan (97 individuals, 2% of the GB population) The site qualifies under Ramsar criterion 5 by regularly supporting 20,000 or more waterbirds (1993/94-1997/98 winter peak mean): 34,280 waterfowl The site also qualifies under Ramsar Criterion 4 by supporting the following waterbird species at a critical stage in their life cycles: - cormorant (391 individuals, 3% of the GB population)	The Ramsar Convention's mission is '<i>the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world</i>'.	The Ramsar site is a particularly good example of a naturally eutrophic loch. It is the largest loch of its kind in Britain, being both large and shallow with only rare stratification. It supports characteristic flora and fauna, including the nationally rare invertebrates <i>Macroplea appendiculata</i>, <i>Thanatophilus dispar</i> and <i>Saldula fucicola</i> (JNCC, 2008a).	n/a ³

Area (ha)	Qualifying Interest	Conservation Objectives	Site Description	Identified Feature Pressures
	- gadwall (245 individuals, 3% of the GB population) - goldeneye (339 individuals, 2% of the GB population) - teal (2,771 individuals, 2% of the GB population) - pochard (1,095 individuals, 2% of the GB population) - tufted duck (3,636 individuals, 6% of the GB population), and The site further qualifies under Ramsar Criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbirds (1993/1994 to 1997/1998): - pink-footed goose (winter peak mean of 17,163 individuals, 8% the Eastern Greenland/Iceland/UK biogeographic population), and - shoveler (winter peak mean of 509 individuals, 1% of North Western & Central Europe biogeographic population)			

*species also an assemblage qualifier

¹Formerly *Sterna sandvicensis*

²Formerly *Anas penelope*

³Site is not included in Scotland's Environment Pressures webpage

3.3 Screening

The construction and operational phases of the Scheme could result in a variety of LSEs which could directly or indirectly affect European/Ramsar sites, namely:

- habitat loss (temporary and permanent);
- disturbance (e.g. noise, vibration, movement and lighting);
- changes in water quality (e.g. accidental spillage and sediment delivery); and
- changes in coastal geomorphology (e.g. tidal flows).

During a site visit in June 2019, two additional potential impacts as a result of the operational flood walls were suggested by NatureScot: an increase in predation of qualifying species by raptors; and shading effects along the flood defences.

Once operational, the flood defences could provide increased opportunities for raptors to predate qualifying species of the SPA, by enabling hunting raptors to use the flood defence structures as a visual barrier allowing close approach to prey species. This effect is, however, considered to be negligible given the low numbers of birds of the raptor species with potential to make use of the flood defence wall in the area. No raptors were recorded during the 2015/16 and 2016/17 bird surveys. During the 2022/23 surveys, raptors were observed infrequently (15 records between August and March) and these records were primarily of raptors flying over grassland areas where there is suitable habitat for small mammals. Sparrowhawk and merlin are the only raptor species likely to be present in the vicinity of the Forth Estuary that regularly make use of linear features whilst hunting to obscure their presence from prey in ambush attacks. Linear features adjacent to the Forth Estuary are already present: there is considerable infrastructure, pipework, fenceline and bunds associated with the petrochemical plant and Port of Grangemouth. Bands of trees, scrub and tall vegetation also line large sections of the estuary edge. Therefore, it is considered extremely unlikely that the new flood walls would result in a reduction in the numbers of prey species via this effect.

Artificial shading could indirectly affect birds by impacting their feeding resource by reducing species richness and abundance of benthic assemblages. However, the flood defences are to be constructed at the edge of the estuary mostly on verge habitat and any shading would be localised to areas where birds do not forage; the majority of species present in the estuary forage in the lower reaches of the shore and mudflats. Therefore, no potential impact is anticipated as a result of shading.

Potential changes in water quality from pollution events (e.g. accidental spillage and sediment delivery) during construction have the potential to have an indirect effect on qualifying species of the SPA and Ramsar through deterioration of mudflat habitats, and thus the feeding resource for waders and waterfowl. However, best practice measures which are intrinsic to the project, including production of a Pollution Prevention Plan, will mitigate any potential changes in water quality. The Pollution Prevention Plan will include, but will not be limited to, the setting back of stockpiles, concrete mixing and washing areas, and the storage of chemicals, fuels and oil more than 10m from the estuary. The plan will be based on those produced for previous projects, including previous flood protection schemes and projects adjacent to designated sites, and will be reviewed by suitably experienced individuals to provide confidence in its effectiveness. The plan will form part of the CEMP and will be a specification in the contract for the Scheme. The plan will also be submitted to SEPA for approval prior to construction. In addition, best practice construction methods will be used, including the use of appropriate pollution controls (i.e. Guidance for Pollution Prevention (GPPs)). It will be a contract requirement to protect the water environment during construction and operational changes in water quality are not considered to differ significantly from the existing conditions. Therefore, no implications to qualifying species are predicted and changes in water quality have not been considered further within this HRA.

Construction areas and flood defences would encroach on the Firth of Forth estuary. As a result, there is potential for changes in coastal geomorphology. Chapter 10 (Water Environment), and in particular Appendix C10.2 (Estuarine Geomorphology), of the EIA Report (Jacobs, 2024) assessed the potential impacts of the Scheme on the water environment. The assessments from these documents have been summarised in

Appendix D (Estuarine Geomorphology) of this HRA. During construction, there could be temporary and localised changes of the following: speed and direction of tidal flows, morphology due to disturbance of intertidal areas, and subtidal morphology. During construction, there could be temporary morphological changes and changes in flow speeds and directions, localised to the works, considered to be of minor and negligible magnitude. During operation, there would be a small loss of intertidal habitat under the footprint of the defences and negligible localised changes of estuarine morphology. No potential construction or operational impacts were identified as significant in the EIA Report assessment (the methods and criteria for the assessment are included within Appendix D). In the context of this HRA, no potential for LSE is identified during construction or operation with regards to changes in coastal geomorphology. Therefore, changes in coastal geomorphology have not been considered further within this HRA.

The potential impacts were used to identify LSEs on the European/Ramsar sites in terms of the sites' conservation objectives from the construction and operation activities of the Scheme, presented in Section 2 (The Scheme). Table 3.2 provides the screening of European/Ramsar sites with potential for LSEs from the construction and/or operation of the Scheme.

Potential in combination effects with other projects or plans are considered in Section 3.4. In-Combination Effects.

As no LSEs have been identified due to changes in water quality or coastal geomorphology, the following conservation objective will be maintained and is not considered further in the assessment:

- To ensure for the qualifying species that the following are maintained in the long term: structure, function and supporting processes of habitats supporting the species.

All other conservation objectives (presented in Table 3.2) have been considered in the assessment.

Table 3.2: Screening of European/Ramsar sites with potential for LSEs from the construction and/or operation of the Scheme

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
UK9004411 / 8499 Firth of Forth SPA				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • population of the species as a viable component of the site • distribution of the species within site • distribution and extent of habitats supporting the species • structure, function and supporting processes of habitats supporting the species • no significant disturbance of the species	The Scheme is partly within the Firth of Forth SPA.	• bar-tailed godwit*, non-breeding • golden plover*, non-breeding • knot*, non-breeding • pink-footed goose*, non-breeding • red-throated diver*, non-breeding • redshank*, non-breeding • Sandwich tern, passage • shelduck*, non-breeding • Slavonian grebe*, non-breeding • turnstone, non-breeding Waterfowl assemblage (non-breeding): • common scoter • cormorant • curlew • dunlin • eider • goldeneye • great crested grebe • grey plover • lapwing	<u>Habitat Loss</u> The Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the SPA. The Scheme could result in the permanent alteration of up to 1.15ha within the SPA, of which 0.59ha is mudflat habitat. This may result in localised fragmentation/loss of habitat for qualifying species of the SPA, especially those which rely on intertidal areas at the estuary edge as their primary habitat type over winter.	LSEs identified during construction and operation. Requirement to progress to AA (HRA Stage 2).
			<u>Disturbance (Noise, Vibration and Visual)</u> There is potential for disturbance to qualifying species of the SPA which are found within the inner Forth, during the construction and maintenance of the Scheme from temporary lighting, piling works, and human and vehicle movements. With the exception of maintenance works, disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	LSEs identified during construction and maintenance. Requirement to progress to AA (HRA Stage 2).

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
		• long-tailed duck • mallard • oystercatcher • red-breasted merganser • ringed plover • scaup • velvet scoter • wigeon		
UK13017 / 8424 Firth of Forth Ramsar				
The Ramsar Convention's mission is <i>'the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world'</i> .	The Scheme is partly within the Firth of Forth Ramsar.	• bar-tailed godwit*, non-breeding • goldeneye*, non-breeding • golden plover*, non-breeding • knot*, non-breeding • pink-footed goose*, non-breeding • red-throated diver*, non-breeding • redshank*, non-breeding • Sandwich tern, passage • shelduck*, non-breeding • Slavonian grebe*, non-breeding • turnstone*, non-breeding Waterfowl assemblage (non-breeding): • common scoter • cormorant	<u>Habitat Loss</u> The Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the SPA. The Scheme could result in the permanent alteration of up to 1.15ha within the Ramsar site, of which 0.59ha is mudflat habitat. This may result in localised fragmentation/loss of habitat for qualifying species of the SPA, especially those which rely on intertidal areas at the estuary edge as their primary habitat type over winter.	LSEs identified during construction and operation. Requirement to progress to AA (HRA Stage 2).
			<u>Disturbance (Noise, Vibration and Visual)</u> There is potential for disturbance to qualifying species of the Ramsar which are found within the inner Forth, during the construction and maintenance of the Scheme from temporary lighting, piling works, and human and vehicle movements. With the exception of maintenance works, disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	LSEs identified during construction and maintenance. Requirement to progress to AA (HRA Stage 2).

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
		• curlew • dunlin • eider • great crested grebe • grey plover • lapwing • long-tailed duck • mallard • oystercatcher • red-breasted merganser • ringed plover • scaup • velvet scoter • wigeon		
UK0030263 / 8367 River Teith SAC				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: • population of the species, including range of genetic types for salmon, as a viable component of the site • distribution of the species within site	The SAC is located approximately 18km in a straight line, and 31km following the hydrological connection, upstream of the Scheme. Qualifying species of the SAC will migrate through the Firth of Forth.	• Atlantic salmon • brook lamprey • river lamprey • sea lamprey	<u>Habitat Loss</u> No land-take from the SAC is required for the Scheme. Furthermore, there will be no loss or severance of supporting habitat for lamprey species or Atlantic salmon as all the works are localised to the estuary edge around The Port of Grangemouth and petrochemical plant. No potential for LSE during construction or operation with regards to habitat loss is identified. <u>Disturbance (Noise, Vibration and Visual)</u> The Scheme is located approximately 18km in a straight line, and 31km following the hydrological connection, downstream of the SAC, however lamprey species and Atlantic salmon will migrate through the Firth of Forth. The Firth of Forth is a wide estuary and the Scheme is localised to the estuary edge around the Port of Grangemouth and petrochemical plant; during construction a sufficient migratory corridor would be maintained. Disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area. No potential for LSE during construction or operation with regards to disturbance is identified.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required. No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
- distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species				
UK9004171 / 8500 Forth Islands SPA				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species	The SPA is located approximately 16km in a straight line, and 17km following the hydrological connection, downstream of the Scheme. Qualifying bird species of the SPA, mainly those that nest on Long Craig Island, may use the Firth of Forth in the vicinity of the Scheme for foraging.	- Arctic tern, breeding - common tern, breeding - cormorant, breeding - gannet, breeding - guillemot*, breeding and non-breeding - herring gull*, breeding and non-breeding - kittiwake*, breeding and non-breeding - lesser black-backed gull, breeding - roseate tern, breeding - Sandwich tern, breeding - shag*, breeding and non-breeding Waterfowl assemblage, breeding: - puffin, breeding - razorbill, breeding	<u>Habitat Loss</u> Forth Islands SPA consists of a series of islands supporting important numbers of breeding seabirds in the Firth of Forth. No permanent land-take from the SPA is required for the Scheme. The Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the Forth estuary. The Scheme could result in the permanent alteration of up to 1.15ha within the Forth estuary, of which 0.59ha is mudflat habitat. The loss of this supporting habitat which could be used for foraging, may result in localised fragmentation/loss of habitat for qualifying species of the Forth Islands SPA. The key species for this potential impact are common and roseate terns which nest on Long Craig Island. Due to the small areas of habitat loss and wide availability of alternative foraging habitats in the Forth estuary for those species that could be affected by the loss of foraging habitat, no potential for LSE during construction or operation with regards to habitat loss is identified. <u>Disturbance (Noise, Vibration and Visual)</u> The SPA is designated for supporting important numbers of breeding seabirds. The nearest island of the SPA (Long Craig Island) is located approximately 16km from the Scheme which supports nesting common and roseate terns. None of the qualifying species will be disturbed as a result of the Scheme whilst breeding on the islands. Individuals from the tern breeding colony on Long Craig Island may be disturbed should they forage in the open waters near the Scheme. However, due to the wide availability of alternative foraging habitats in the Forth estuary no potential for LSE during construction with regards to disturbance is identified.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required. No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
			Disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	
UK9004451 / 8668 Imperial Dock Lock, Leith SPA				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: • population of the species as a viable component of the site • distribution of the species within site • distribution and extent of habitats supporting the species • structure, function and supporting processes of habitats supporting the species • no significant disturbance of the species	The SPA is located approximately 30km downstream of the Scheme. Common tern may use the Firth of Forth in the vicinity of the Scheme for foraging. Hydrologically connected to the Scheme.	• common tern, breeding	<u>Habitat Loss</u> Imperial Dock Lock, Leith SPA supports the largest common tern colony in the Firth of Forth. No permanent land-take from the SPA is required for the Scheme. The Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the Forth estuary. The Scheme could result in the permanent alteration of up to 1.15ha within the Forth estuary, of which 0.59ha is mudflat habitat. The loss of this supporting habitat which could be used for foraging, may result in localised fragmentation/loss of habitat for qualifying species of Imperial Dock Lock, Leith SPA. Due to the small areas of habitat loss and wide availability of alternative foraging habitats in the Forth Estuary for common tern, no potential for LSE during construction or operation with regards to habitat loss is identified.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.
			<u>Disturbance (Noise, Vibration and Visual)</u> The SPA is designated for supporting important numbers of common tern. The SPA is located approximately 30km from the Scheme. No qualifying species will be disturbed as a result of the Scheme whilst breeding at Leith Dock. Individuals from the breeding colony at Leith Dock may be disturbed should they forage near the Scheme. However, due to the wide availability of alternative foraging habitats in the Forth Estuary and the location of the works in relation to the SPA, no potential for LSE during construction with regards to disturbance is identified. Disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.
UK0030172 / 8278 Isle of May SAC				

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying species that the following are maintained in the long term: • population of the species as a viable component of the site • distribution of the species within site • distribution and extent of habitats supporting the species • structure, function and supporting processes of habitats supporting the species • no significant disturbance of the species To avoid deterioration of the qualifying habitat thus ensuring that the integrity of the site is maintained, and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and To ensure for the qualifying habitat that the following are maintained in the long term: • extent of the habitat on site • distribution of the habitat within site	The SAC is located approximately 70km downstream of the Scheme. Hydrologically connected to the Scheme.	• grey seal • reefs	<u>Habitat Loss</u> The Isle of May is located in the north of the outer Firth of Forth and supports a breeding colony of grey seal and the Annex I habitat, reefs. No land-take from the SAC is required for the Scheme. Furthermore, there will be no loss or severance of supporting habitat for grey seal as all the works are localised to the estuary edge around the Port of Grangemouth and petrochemical plant. No potential for LSE during construction or operation with regards to habitat loss is identified.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.
			<u>Disturbance (Noise, Vibration and Visual)</u> The SAC is designated for breeding grey seal and is located approximately 70km from the Scheme. Grey seal will not be disturbed as a result of the Scheme whilst breeding in or near the SAC. Grey seal could only be disturbed if they forage or travel near to the Scheme. However, grey seals favour more exposed coasts and islands closest to the open sea (NatureScot, 2020), and no designated haul out sites are located in the Scheme area (Marine Scotland, 2020). Therefore, grey seal will not be disturbed by works taking place in the inner Forth. No potential for LSE during construction with regards to disturbance is identified. Disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
• structure and function of the habitat • processes supporting the habitat • distribution of typical species of the habitat • viability of typical species as components of the habitat • no significant disturbance of typical species of the habitat				
UK9020316 / 10478 Outer Firth of Forth and St Andrews Bay Complex SPA				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long-term and it continues to make an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species. This contribution will be achieved through delivering the following objectives for each of the site's qualifying features: a) Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term; b) To maintain the habitats and food resources of the qualifying features in favourable condition.	The SPA is located approximately 18km downstream of the Scheme. Hydrologically connected to the Scheme.	• Arctic tern, breeding • black-headed gull*, non-breeding • common gull*, non-breeding • common tern, breeding • eider, non-breeding • gannet, breeding • goldeneye, non-breeding • guillemot*, breeding and non-breeding • herring gull*, breeding and non-breeding • kittiwake*, breeding and non-breeding • little gull, non-breeding • long-tailed duck, non-breeding • razorbill*, breeding and non-breeding • red-breasted merganser, non-breeding	<u>Habitat Loss</u> The site is located to the east of the Forth Bridges and is intended to protect marine foraging areas. No land-take from the SPA is required for the Scheme. Furthermore, there will be no loss or severance of supporting habitat for qualifying species as all the works are localised to the estuary edge around the Port of Grangemouth and petrochemical plant. No potential for LSE during construction or operation with regards to habitat loss is identified based on the SPA's position and function.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.
			<u>Disturbance (Noise, Vibration and Visual)</u> The marine area included in the SPA is located approximately 18km east from the Scheme and encompasses the marine environment into the outer estuary. Qualifying species could be disturbed if utilising marine foraging areas adjacent to the Scheme. However, as the works are localised to the estuary edge, disturbance to marine foraging areas will be limited and therefore disturbance to foraging birds using the marine environments is unlikely. Disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
		- red-throated diver, non-breeding - shag*, breeding and non-breeding - Slavonian grebe, non-breeding - velvet scoter, non-breeding Waterfowl assemblage, breeding: - puffin, breeding Waterfowl assemblage, non-breeding: - common scoter, non-breeding - Manx shearwater, non-breeding	No potential for LSE during construction or operation with regards to disturbance is identified.	
UK9004441 / 9184 Slamannan Plateau SPA				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species	The SPA is located approximately 5km southwest from the Scheme. Hydrologically connected to the Scheme (River Avon).	Taiga bean geese, non-breeding	<u>Habitat Loss</u> No land-take from the SPA is required for the Scheme. Furthermore, there will be no loss or severance of supporting habitat for qualifying species as all the works are localised to the estuary edge around the Port of Grangemouth and petrochemical plant; habitat not used by bean goose. No potential for LSE during construction or operation with regards to habitat loss is identified. <u>Disturbance (Noise, Vibration and Visual)</u> The SPA is located 5km southwest of the Scheme. Qualifying species could be disturbed if utilising the estuary adjacent to the Scheme. Taiga bean geese were not recorded during the surveys. The dispersal of individuals from the Slamannan Plateau <i>'is unknown and considered unlikely'</i> (Hearn, 2004) and there is very little fluctuation in wintering bird counts at the site until spring migration commences. Taiga bean geese have displayed high fidelity to wintering sites elsewhere in Europe (Nilsson and Persson, 1991).	No potential for LSE during construction or operation. AA (HRA Stage 2) is not required. No potential for LSE during construction or operation. AA (HRA Stage 2) is not required.

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
- structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species			No potential for LSE during construction or operation with regards to disturbance is identified.	
UK9004111 / 8530 Loch Leven SPA				
To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and To ensure for the qualifying species that the following are maintained in the long term: - population of the species as a viable component of the site - distribution of the species within site - distribution and extent of habitats supporting the species - structure, function and supporting processes of habitats supporting the species - no significant disturbance of the species	The SPA is located approximately 24km northeast from the Scheme. Cormorant from Loch Leven are known to travel to the Firth of Forth (Wright, 2003). The River Leven flows from Loch Leven to the Firth of Forth, downstream of the Scheme, at Leven.	- pink-footed goose, non-breeding - whooper swan, non-breeding Waterfowl assemblage, non-breeding: - cormorant - gadwall - goldeneye - pochard - shoveler - teal - tufted duck	<u>Habitat Loss</u> No land-take from the SPA is required for the Scheme. However, the Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the Forth estuary. The Scheme could result in the permanent alteration of up to 1.15ha within the Forth estuary, of which 0.59ha is mudflat habitat. The loss of this supporting habitat may result in localised fragmentation/loss of habitat for qualifying species of the SPA should they utilise the Firth of Forth. Cormorant is known travel between Loch Leven and other sites, including the Firth of Forth (Wright, 2003). No other individuals of the qualifying species of Loch Leven SPA are known to travel between Loch Leven and the Firth of Forth. <u>Disturbance (Noise, Vibration and Visual)</u> The SPA is designated for supporting important numbers of wintering birds. None of the qualifying species will be disturbed as a result of the Scheme whilst wintering on Loch Leven. However, individuals may be disturbed during construction and maintenance works if visiting the Firth of Forth from Loch Leven. With the exception of maintenance works, disturbance during the operation of the Scheme is not considered to differ from that currently experienced on the Firth of Forth.	LSEs identified during construction and operation. Requirement to progress to AA (HRA Stage 2).
UK13033 / 8436 Loch Leven Ramsar				
The Ramsar Convention's mission is 'the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world'.	The SPA is located approximately 24km northeast from the Scheme. The River Leven flows from Loch Leven to the Firth of Forth, downstream of the Scheme, at Leven.	- eutrophic loch - pink-footed goose, non-breeding - shoveler, non-breeding - whooper swan, non-breeding	<u>Habitat Loss</u> No land-take from the Ramsar is required for the Scheme. However, the Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the Forth estuary. The Scheme could result in the permanent alteration of up to 1.15ha within the Forth estuary, of which 0.59ha is mudflat habitat. The loss of this supporting habitat may result in localised fragmentation/loss of habitat for qualifying species of the Ramsar site should they utilise the Firth of Forth. Cormorant is known travel between Loch Leven and other sites,	LSEs identified during construction and operation. Requirement to progress to AA (HRA Stage 2).

Conservation Objectives	Distance/Connectivity to Scheme	Qualifying Interests	Potential Effects and Commentary	Screening Conclusion
		Waterfowl assemblage (non-breeding): - cormorant - gadwall - goldeneye - pochard - teal - tufted duck	including the Firth of Forth (Wright, 2003). No other individuals of the qualifying species of Loch Leven Ramsar site are known to travel between Loch Leven and the Firth of Forth. <u>Disturbance (Noise, Vibration and Visual)</u> The Ramsar is designated for supporting important numbers of wintering birds. None of the qualifying species will be disturbed as a result of the Scheme whilst wintering on Loch Leven. However, individuals may be disturbed if visiting the Firth of Forth from Loch Leven. Disturbance during the operation of the Scheme is not considered to differ from that currently experienced within the area.	LSEs identified during construction and maintenance. Requirement to progress to AA (HRA Stage 2).

*species also an assemblage qualifier.

As stated in Section 1.2.3, an AA is required where any plan or project is likely to have a significant effect either individually or in combination with other plans or projects. This assessment is required prior to AA (i.e. at identification of LSEs) to determine whether effects which may not be likely or significant may become so in combination. The assessment also checks for adverse and or/residual effects of other plans or projects. Thus, the assessment considers both the potential effects of other plans published for consultation and projects seeking consent and any ongoing negative effects of completed plans or projects.

A full list of projects and plans assessed can be found in Appendix E (In-Combination Assessment). NatureScot noted that the Musselburgh Flood Protection Scheme (Musselburgh FPS) should be considered within the in-combination assessment, due to the scale of the project and its proximity to the Firth of Forth SPA. Information on the Musselburgh Flood Protection is provided below.

3.3.1 Musselburgh Flood Protection Scheme

This proposed scheme will consist of a combination of direct defences (walls and embankments), pumping stations and bridge removal/replacement in Musselburgh town centre along with flood alleviation measures in the upper catchment. Defences for the proposed Musselburgh FPS are to be constructed along the River Esk, which flows through the town, and along the coastal boundary of the Firth of Forth SPA.

An options appraisal process has been undertaken and the preferred scheme was approved by the East Lothian Council's cabinet on 21 January 2020. The Outline Design for the scheme was presented to East Lothian Council on 23rd January 2024 and the scheme documents (including EIA Report) were published on 21st March 2024 (East Lothian Council and Jacobs, 2024). The HRA for the scheme is in development and there is currently no information available on this specific assessment as all data and drafts are proprietary to East Lothian Council until the documentation is finalised and made available to other parties. However, based on the information provided within the Musselburgh FPS EIA Report, it is understood that the scheme could result in a small area of habitat loss from the Firth of Forth SPA and could cause disturbance to qualifying species during construction.

In relation to habitat loss, the Musselburgh FPS EIA Report identified that there could be up to 2.14ha of temporary habitat loss from the Firth of Forth SPA during construction and up to 4.3ha of permanent habitat loss as a result of the scheme, which would be a small percentage of habitat available to qualifying species in the Firth of Forth estuary. Habitats lost consist of intertidal sand, boulders and rocks, some of the existing seawall, and small areas of grassland and dune habitats. No loss of mudflat or saltmarsh habitat from the Musselburgh FPS has been identified and therefore there will be no loss of foraging habitat for the qualifying species of the Firth of Forth SPA. With the implementation of mitigation identified in the Musselburgh FPS EIA Report, no significant residual effects were predicted on the Firth of Forth SPA for temporary or permanent habitat loss. Habitat loss at Musselburgh FPS is not predicted to have any in-combination effects with the Scheme.

In relation to roosting birds, construction works within the vicinity of the Firth of Forth SPA could feasibly take place for both flood protection schemes at the same time. The Musselburgh FPS EIA Report states '*construction would not proceed along the entire length of the scheme adjacent to the SPA at any one time; therefore, temporary disturbance would be limited to discrete working areas according to the phasing of the project*'. It notes that standard best practise construction mitigation measures will be implemented to reduce disturbance, including soft starts of machinery and noise/visual barriers. Additionally, mitigation item E8 states '*works on the sea wall will be restricted to a maximum length of 500m at any one time unless otherwise agreed with NatureScot. Construction along the sea wall would only be carried out during summer months (approximately April to Sept) in any one year unless otherwise agreed with NatureScot.*' With the implementation of mitigation identified in the Musselburgh FPS EIA Report, no significant residual effects were predicted on the Firth of Forth SPA for disturbance during construction.

In relation to the potential for in-combination effects due to interchange of birds *between* schemes, the Musselburgh FPS is located approximately 39km from the Scheme. Information available on the wintering foraging behaviours of qualifying species of the Firth of Forth SPA indicates that, except for cormorant, birds are unlikely to regularly travel this distance. For example, the core range for non-breeding pink-footed goose is 15km to 20km (SNH, 2016a). Additionally, NatureScot (2023m) guidance for offshore windfarms recommends that

impact pathways be considered within a 15km buffer '*for all inshore wintering waterfowl qualifying features of marine SPAs*'. Given that this 15km buffer has been applied to a range of species and covers all potential pathways, including disturbance, it is reasonable to also apply this buffer to disturbance pathways for the Scheme. The distance between the GFPS and MFPS (approximately 39km) comfortably exceeds the distances that qualifying species of the Firth of Forth SPA are known to typically travel whilst at their non-breeding grounds. It is therefore reasonable to assume that there will be very limited interchange of birds between the two schemes – birds potentially affected (e.g. disturbed whilst roosting) by construction at one scheme are very unlikely to also experience effects from the other scheme. No in-combination effects via interchange of birds between schemes are identified.

Cormorants are known to travel further distances between sites than other species during the non-breeding season, up to 45km in a day depending on food availability (Forrester et al., 2007). Cormorants (from either the Firth of Forth SPA or the Loch Leven SPA populations) roosting or foraging around either scheme could therefore potentially relocate to the other scheme and be similarly disturbed. Cormorant has a low sensitivity to human disturbance – foraging and/or roosting/loafing cormorants, if disturbed at either or both schemes, have abundant nearby alternative available suitable habitat. No in-combination effects on cormorant are identified.

In relation to in-combination effects due to disturbance at *either* scheme, birds affected by disturbance at Grangemouth FPS are duly addressed via the proposed mitigation measures and compensatory measures as described within this document. Birds which might experience disturbance effects at Musselburgh FPS are likely to be similarly dealt with at the location of the Musselburgh site. Therefore, no in-combination effects on the SPA are identified.

3.4 Screening Conclusion

As identified in the screening in Table 3.2, the Scheme has the potential for LSEs due to habitat loss and disturbance/displacement on the Firth of Forth SPA and Ramsar site, and Loch Leven SPA and Ramsar site. Therefore, an Appropriate Assessment (HRA Stage 2) is required. No LSEs on these sites have been identified due to changes in water quality or changes in coastal geomorphology.

No LSEs were identified on the River Teith SAC, Forth Islands SPA, Imperial Dock Lock, Leith SPA, Isle of May SAC, Outer Firth of Forth and St Andrews Bay Complex SPA, or Slamannan Plateau SPA. Therefore, there is no requirement for further consideration for these European sites either alone or in combination with other plans and projects within the HRA process.

No in-combination effects are predicted with any other plans or projects. No additional LSEs are identified via in-combination effects to those presented in Table 3.2.

4. Stage 2 (Appropriate Assessment)

4.1 Introduction

This section forms the Stage 2 (Appropriate Assessment (AA)) step of the HRA process which was identified as required in Stage 1 (Screening). The AA considers the effect of the project or plan, either alone or in combination with other projects or plans, on the integrity of the European/Ramsar site, with respect to the site's structure and function, and its conservation objectives. Specific conservation objectives are not available for Ramsar sites. However, Scottish Government policy states that '*Where Ramsar interests coincide with Natura qualifying interests protected under an SPA or an SAC, as the case may be, the interests are thereby given the same level of (legal) protection as Natura sites*' (Scottish Government, 2019) and therefore the same objectives for SPAs are applicable (SNH, 2018a). As both the Firth of Forth SPA and Ramsar site occupy the same area and have the same species listed as qualifying species, the assessment of effects will be against the Firth of Forth SPA's conservation objectives. The assessment of effects on Loch Leven SPA and Ramsar site will also be against Loch Leven's SPA conservation objectives as the two sites occupy the same area and have the same species listed as qualifying species.

The approach adopted for this AA is to focus on the avoidance of effects on European/Ramsar site integrity in the first instance. Where avoidance is not possible, appropriate mitigation measures are proposed to reduce effects in order to avoid adverse effects on site integrity (AESI). Where, after an AA, an AESI may remain, measures to offset the impact may be required (compensation) where the Competent Authority deems that the Scheme must be delivered for Imperative Reasons of Overriding Interest (IROPI) and there are no alternative solutions.

4.2 Aims

The following sections summarise the information used to inform the AA. Information on the distribution, abundance and behaviour of bird species and habitats within the Firth of Forth was gathered through a combination of desk study, bird surveys, and biotope surveys. Information on the baseline noise levels of the site and noise levels during ground investigation (GI) works was also collected along the estuary edge, in tandem with bird monitoring to assess bird reactions to noise stimuli. The aim of the Stage 2 HRA is to assess the potential for effects on the Firth of Forth SPA/Ramsar site, and Loch Leven SPA/Ramsar site from the Scheme and to identify appropriate mitigation to reduce these impacts and avoid AESI. To achieve this, the following will be undertaken:

- assessment of the usage of the Firth of Forth area by bird species in relation to the Scheme, thus determining the ecological importance to the qualifying bird species of the areas potentially affected;
- analysis of bird data to determine the implication from the LSEs resulting from habitat loss and disturbance as a result of the Scheme;
- determination of the severity of the identified effects predicted on the qualifying species;
- assessment and analysis of the potential for AESI of the Firth of Forth SPA/Ramsar site, and Loch Leven SPA/Ramsar site;
- specification of suitable mitigation measures to avoid AESI; and
- identification of any remaining implications for the Firth of Forth SPA /Ramsar site and Loch Leven SPA/Ramsar site.

4.3 Ornithological Assessment Approach

This section sets out the ornithology data gathered and describes how it has been used to inform the AA. The data used in the assessment focusses on bird survey Sectors 4 – 11, which are adjacent to the Scheme (Figure 10). Surveys conducted in 2015/16 and 2016/17 covered a larger area (Sectors 1 – 16) as the Scheme design had not yet been refined. Further details on the ornithology information can be found in Appendix B (Ornithological Information), which details the bird survey methodologies and presents data on the abundance and distribution

of bird species within the study area. The data were used to identify qualifying species that occur within the study area and could be affected by the Scheme.

Assessment of the bird data in relation to effects pathways for the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar site is presented within Section 4.7 and Section 4.8 respectively.

4.3.1 Habitat Loss

Habitat loss as a result of the Scheme has been identified as having potential effects (i.e. loss of roosting and/or foraging habitat) on qualifying species of the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar site (Section 3.3 Screening). The Zone of Influence (Zol) for temporary and permanent habitat loss encompasses the area directly under the Scheme footprint during construction and operation – these areas have been identified by the design team using AutoCAD and GIS software. Temporary habitat loss during construction was calculated by subtracting the Permanent Works Footprint shapefile from the Site Boundary (Land Affected) shapefile, which includes all working areas, haul roads and indicative compound sites. All habitat under the Permanent Works Footprint has been identified as habitat permanently altered at the operational stage of the Scheme. The entire Site Boundary of the Scheme is unlikely to be unavailable at the same time as construction will be phased over a number of years (Section 2.4.5). This loss of habitat could result in the loss, or localised fragmentation, of foraging and/or roosting habitat due to installation of the flood defences and could impact birds which rely on intertidal areas at the estuary edge, including their displacement.

4.3.2 Disturbance

Noise and visual impacts from the Scheme have been identified as having potential effects (disturbance potentially leading to displacement) to qualifying species of the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar site (Section 3.3 Screening).

The Zol (for noise and visual disturbances) demarcates the area within which birds could be disturbed/displaced. The bird data shows the numbers of birds within this Zol which could be disturbed or displaced, the locations at which aggregations of birds occur, during which period of the year and at what tidal state. In order to establish a Zol around visual and noise disturbances and potential impacts to qualifying species an understanding of potential disturbance distances for each affected species is required.

The Waterbird Disturbance Mitigation Toolkit (Cutts et al., 2013) suggests a 300m Zol for noise and visual disturbances for wintering waterbirds. As part of the ornithological investigation for this HRA, the suitability of this 300m Zol distance has been tested for each of the qualifying species individually by investigating available literature. In general, 300m is a suitable Zol for many of the key species in this assessment, however on consideration of the NatureScot commissioned Research Report 1283 – Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species (Goodship and Furness, 2022), a more precautionary distance of 650m has been adopted for visual disturbance of select, more sensitive species. A summary of the review conducted for this HRA, and the disturbance distance thresholds for each qualifying species based on a range of academic literature and research studies, can be found in Table 4.1.

Table 4.1: Disturbance distance / response threshold for qualifying species of the Firth of Forth SPA/ Ramsar site, including cormorant, a qualifying species of the Loch Leven SPA/Ramsar with connectivity to the Firth of Forth.

Species	Discussion	Zone of Influence (ZoI) Validity
300m ZoI for noise and visual disturbance		
Bar-tailed godwit (300m ZoI)	Bar-tailed godwit do not breed in the UK, and therefore only have the potential to be disturbed on foraging and roosting grounds during the non-breeding season. A maximum Flight Initiation Distance (FID)¹ value recorded for bar-tailed godwit is 450m when approached by a pedestrian (Laursen et al., 2005), however the majority of FID values are less than a mean of 200m when approached by a pedestrian. Other records showed a mean FID of 85m and a minimum/maximum of 32m – 225m to surveyors walking along the shoreline in the UK (Collop et al., 2016), with other references showing mean FIDs for bar-tailed godwit as 39m to surveyors walking in an estuary (Brett, 2012). Bar-tailed godwit at Musselburgh Lagoons are more likely than other waders to be disturbed by people and aircraft (Furness, 1973), and it has been noted that bar-tailed godwit are more prone to natural causes of disturbance (e.g., predators) than human disturbance. Birds that react to human disturbance are often flushed by tractors and/or trucks (Versluis, 2011).	Bar-tailed godwit has been assessed by Goodship and Furness (2022) as having a medium sensitivity to disturbance and suggested a buffer zone of 200m-300m for this species. Therefore, a 300m ZoI for disturbance is considered suitable.
Cormorant (300m ZoI)	Cormorant have been shown to have a mean FID range of 74m – 77.9m to pedestrians and 7.7m to 23.5m to a car at a disturbed site for seaweed harvesting during the non-breeding season. Cormorant have also been shown to have escape distances¹ with a mean of 193m with an unobstructed view to the cause of disturbance (Bregnballe et al., 2009). Other literature shows that cormorant tolerate high levels of activity and the presence of artificial structures, so are less vulnerable to noise and visual disturbance.	Cormorant was not assessed in the Goodship and Furness (2022) paper, however from other literature they are deemed to have low sensitivity. FIDs have been recorded from 7m – 200m to human activity for cormorant, and as such a 300m ZoI for disturbance is considered suitable.
Dunlin (300m ZoI)	During the non-breeding season, minimum and maximum FIDs for dunlin have been recorded from 5m to 450m in response to pedestrians (Collop et al., 2016; Laursen et al., 2005). A mean FID of 52m has been recorded to motorized watercraft, with a minimum and maximum FID of 9m and 175m respectively (Scarton, 2018).	Goodship and Furness (2022) have assessed dunlin as having a medium sensitivity to disturbance, with a suggested disturbance buffer of 150m-300m during the non-breeding season. Due to the range of FIDs recorded in literature and from personal observations (Andy Douse) noted in Goodship and Furness (2022), a 300m ZoI for disturbance is considered suitable.
Goldeneye (300m ZoI)	During the non-breeding season, FIDs for goldeneye to pedestrians have been shown to be a minimum and maximum of 75m to 150m respectively (Liley et al., 2010), with other records showing a maximum of up to 200m (Hume, 1976). Maximum FIDs to motorized watercraft (jet-ski) have been recorded for goldeneye up to 830m (Laursen et al., 2017), with smaller FIDs to non-motorised watercraft ranging from 300m-400m (Laursen et al., 2017).	Goldeneye have been assessed as having a high sensitivity to disturbance in Goodship and Furness (2022). A buffer zone of 150m-800m is suggested for the non-breeding season. The larger FIDs for goldeneye are based on watercraft, with pedestrian-based disturbance unlikely at a distance over 150m. Therefore, a 300m ZoI is considered suitable for disturbance.
Great crested grebe (300m ZoI)	During the non-breeding season, great-crested grebe FIDs range from 70m for a large land-based vehicle (McLeod et al., 2013) to 340m to non-motorised watercraft (Laursen et al., 2017). In response to pedestrians along the shoreline in England, great crested grebe have shown minimum and maximum FID's of 20m-100m (Liley et al., 2010).	Great crested grebe has been assessed as having medium sensitivity to disturbance in Goodship and Furness (2022), however a non-breeding season buffer is not provided. A 300m ZoI for disturbance is considered suitable for great crested grebe as FIDs range up to 340m.
Grey plover (300m ZoI)	During the non-breeding season, FIDs vary for grey plover, however the maximum recorded is 400m (Laursen et al., 2005). The minimum FID has been recorded as 32m (Mikula et al., 2018) with the majority of FID values in the literature averaging around 150m.	Grey plover has been assessed as having medium sensitivity to disturbance in Goodship and Furness (2022). A 150m-350m buffer zone is suggested during the non-breeding season. A 300m ZoI is considered suitable for grey plover as mean FIDs are under 200m.

Species	Discussion	Zone of Influence (Zol) Validity
Knot (300m Zol)	The Waterbird Disturbance Mitigation Toolkit (WDMT) (Cutts et al., 2013) states that knot has high sensitivity to noise disturbance but is tolerant of visual disturbance. It also states that knot will forage within 50m of plant and within 75m of workers. FIDs have been recorded for knot in the non-breeding season at a range of distances, from 21.3m to surveyors walking in Australia (Weston et al., 2012), and a maximum of 240m to surveyors walking a shoreline in England (Collop et al., 2016).	Knot have been assessed as having a medium sensitivity to disturbance in Goodship and Furness (2022). There are a lack of studies regarding FID during the non-breeding season, and so no buffer is suggested. With FIDs recorded up to 240m, a 300m Zol for knot is deemed suitable for disturbance.
Lapwing (300m Zol)	Laursen et al. (2005) has shown lapwing as having an escape distance of a minimum of 45m and maximum of 450m. The WDMT (Cutts et al., 2013) states that lapwing show no response to visual disturbance at 300m-400m.	Lapwing has not been assessed in Goodship and Furness (2022). The WDMT has classed lapwing as medium sensitivity to disturbance. The 300m Zol is deemed suitable for lapwing due to the escape distances recorded and lack of response to visual disturbance at over 300m.
Mallard (300m Zol)	FIDs for mallard during the non-breeding season have been recorded ranging between 2.8m and 400m to surveyors walking in various habitats (Weston et al., 2012; Laursen et al., 2005).	Mallard has been assessed as having a low to medium level of sensitivity to disturbance in Goodship and Furness (2022). A buffer of $\geq 100\text{m}$ is suggested during the non-breeding season. Due to the suggested buffer and FIDs recorded, a 300m Zol for disturbance is considered suitable.
Oystercatcher (300m Zol)	During the non-breeding season, a range of FIDs for oystercatcher has been recorded, with a maximum FID of 200m recorded for pedestrian activities (Liley et al., 2010) and a mean FID of 137m to surveyors walking over mudflats in Scotland (Dwyer, 2010).	Oystercatcher has been assessed as having a medium sensitivity to disturbance in Goodship and Furness (2022). A buffer of 150m – 300m is suggested during the non-breeding season. Due to FID ranges recorded, the 300m Zol for disturbance is deemed suitable for oystercatcher.
Red-breasted merganser (300m Zol)	FID distances for marine traffic show that 90% of red-breasted merganser are flushed at a distance of 250m (Gittings and O'Donoghue, 2016). For pedestrian disturbance, there is evidence that red-breasted mergansers are tolerant between 30m-150m (Goodship and Furness, 2019).	Red-breasted merganser have not been assessed in Goodship and Furness (2022). However, through other literature these have been assessed as a medium sensitivity to disturbance. There is no suggested buffer zone, however FID has been discussed in the previous column. As red-breasted merganser have been shown to be tolerant to land based activities from 30m-150m, a 300m Zol for disturbance is considered suitable to minimize any FID events.
Redshank (300m Zol)	During the breeding season, mean FIDs for redshank have been recorded between 19m and 41m, with a maximum FID recorded of 57m (Diaz et al., 2021). During the non-breeding season, multiple FIDs have been recorded in response to surveyors walking along the shoreline and mudflats, ranging from 40m to 450m with the mean FID averaging around 150m (Laursen et al., 2005).	Redshank has been assessed as a medium sensitivity to disturbance in Goodship and Furness (2022). A buffer of 200m-300m has been suggested for the non-breeding season. The 300m Zol is deemed sufficient for disturbance for redshank due to FIDs recorded.
Ringed plover (300m Zol)	During the non-breeding season, FIDs for ringed plover have been recorded up to 162m (Smit and Visser, 1993) in response to pedestrians on tidal flats, however FIDs of mixed winter roosts containing ringed plover have been recorded up to 270m (Scarton, 2018).	Ringed plover has been assessed as having a medium sensitivity to disturbance in Goodship and Furness (2022). A buffer of 100m-300m has been suggested for the non-breeding season. The 300m Zol for disturbance is considered suitable for ringed plover due to FIDs recorded.
Sandwich tern (300m Zol)	There is a lack of research available however, Goodship and Furness (2022) note that away from breeding grounds, sensitivity is considered to be low.	Goodship and Furness (2022) has assessed Sandwich tern as having a high sensitivity to human disturbance. A 50m buffer has been suggested for the non-breeding season. Therefore, a 300m Zol for disturbance is considered suitable.
Turnstone (300m Zol)	Turnstone are an extremely tolerant species to all forms of disturbance, with an FID of 30m-50m. One example of turnstone being flushed at 100m was caused by moving trucks (Cutts et al., 2009; Cutts et al., 2013).	Turnstone have not been assessed by Goodship and Furness (2022), however they have been assessed as having low sensitivity to disturbance.

Species	Discussion	Zone of Influence (ZoI) Validity
		As turnstone are known to be a highly tolerant species, a ZoI of 300m is considered suitable.
650m ZoI for visual disturbance		
Common scoter (650m visual ZoI)	During the non-breeding season when common scoter are in flocks on water, they have been observed to have median FID of 804m and a maximum FID of 3200m from large commercial ships in Germany (Schwemmer et al., 2011), and a maximum FID of 100m to a high-speed ferry service in Denmark. A buffer zone for forestry operations in the UK ranges from 300m – 800m during the breeding season, and personal observations (by Griffin, L.) referenced in Goodship and Furness (2022) show that common scoter keep a minimum distance of 300m from boats and pedestrians.	Common scoter have been assessed to have a high sensitivity to human disturbance, with Goodship and Furness (2022) suggesting a buffer zone of 300m-500m. During the non-breeding surveys undertaken for the Scheme, common scoter were not recorded within the ZoI, and there are only 7 individual records of common scoter within the wider study area recorded during these surveys. This species are likely to be absent from the ZoI during construction of the Scheme. Therefore, a 650m visual ZoI for disturbance is appropriate for common scoter.
Curlew (650m visual ZoI)	During the non-breeding season, surveyors walking over mudflats in Scotland caused a mean FID of 235.16m (Dwyer, 2010) for curlew, with other mean FIDs recorded as 88m (Brett, 2012) to surveyors walking in an estuary, and a mean minimum/maximum of 88m to 570m (Collop et al., 2016) to surveyors walking a shoreline in England. An FID has been recorded up to 650m for curlew from surveyors walking along mudflats, with the mean FID from this range 298m (Laursen et al., 2005). Agricultural activities and motorised vehicles caused a mean FID of 129m and 188m respectively (Smit and Visser, 1993), as well as a 200m Minimal Approach Distance (MAD)¹ to pedestrians running along footpaths close to intertidal areas in England (Burton et al., 2002)	Curlew have been assessed to have a high sensitivity to human disturbance, with Goodship and Furness (2022) suggesting a non-breeding season buffer of 200m-650m. Mean FID for curlew ranges between less than 200m and up to 650m. Therefore, a 650m visual ZoI for disturbance for this species is considered suitable.
Eider (650m visual ZoI)	There is limited research available for eider, however the available literature identifies that during the non-breeding season FIDs range from 0m to 3200m in response to large commercial fishing ships, with a median FID of 208m (Schwemmer et al., 2011). Maximum alert distances to surveyors in a motorboat approaching moulting eiders were recorded at 600m, and for smaller motorized watercraft, FIDs range from 30m-400m (Dehnhard et al., 2020).	Eider have been assessed as having a medium/high sensitivity to disturbance in Goodship and Furness (2022), with a suggested buffer of 200m-500m during the non-breeding season. Some FIDs range up to 400m. A maximum FID of 3200m was recorded to a large commercial fishing vessel. Large vessels regularly travel to and from the Port of Grangemouth, therefore any eider present is likely to be habituated to the presence of large boats. A peak count of only five eider has been recorded during surveys for the Scheme, with eider recorded on four occasions in total (two counts of two birds, one count of three birds, and one count of five birds). As they are likely to be absent from the area during works, a 650m visual ZoI for disturbance is considered suitable for eider for this Scheme.
Golden plover (650m visual ZoI)	During the non-breeding season, FIDs for golden plover have been recorded as a minimum of 45m and maximum of 450m (Laursen et al., 2005), with mean FIDs recorded as 143m in response to surveyors walking in mudflats in Denmark (Laursen et al., 2005) and 280m to surveyors walking over mudflats in Scotland (Dwyer, 2010).	Golden plover is assessed to have a medium sensitivity to human disturbance in Goodship and Furness (2022). A 200m-500m buffer zone is suggested. A 650m visual ZoI is considered suitable for disturbance to golden plover. Mean FIDs range from 140m to 280m, with a maximum of 450m. Therefore, a 650m ZoI is considered suitable.
Pink-footed goose (650m visual ZoI)	There is limited research on pink-footed goose FID during the non-breeding season. During the migratory season, a range of mean FID decreased from 500m to 350m after the closure of the hunting season.	Pink footed goose is assessed as having a high sensitivity to human disturbance in Goodship and Furness (2022). A buffer zone of 500m – 1000m is suggested for the non-breeding season.

Species	Discussion	Zone of Influence (Zol) Validity
	During the non-breeding season, a minimum and maximum FID has been recorded as 350m and 500m respectively (Fox and Madsen, 1997).	However, there is evidence of pink-footed goose being tolerant of disturbance at shorter distances, with disturbance distances in the closed hunting season being as low as 350m. Most pink-footed goose records from the 2022/23 surveys for the Scheme are in the vicinity of Bothkennar Pools and along the shoreline immediately north-east of these pools. Similarly, the 2015/16 and 2016/17 surveys recorded pink-footed goose in this area and in close proximity to Kincardine Bridge. This area around Bothkennar Pools is largely screened from the construction areas due to the surrounding embankments. Therefore, it is considered that most individuals present in the wider area will not be disturbed, and the 650m Zol is considered suitable to minimize any FID events.
Red-throated diver (650m visual Zol)	During the non-breeding season, mean FIDs for red-throated diver have been recorded as 1200m to motorized watercraft, and 1400m to non-motorised watercraft (Laursen et al., 2017).	Red-throated diver has been assessed as having a high sensitivity to disturbance. A buffer of ≤ 1000 m during the non-breeding season is recommended (Goodship and Furness 2022). This recommendation is related to disturbance by shipping vessels and watercraft. Red-throated diver have been shown to be more tolerant of some boats (Jarrett et al., 2018). Construction activities will occur at the estuary edge and red-throated diver are unlikely to be present here as they primarily forage in deeper water further offshore and roost only on water. Based on this and published FIDs, a 650m Zol for disturbance is considered suitable to minimize any FID events.
Scaup (650m visual Zol)	There are limited studies on FID for scaup, with FIDs only available for non-breeding season. Pochard and tufted duck have been used as proxies for scaup, with FIDs recorded as 10m to 30m for these species (Diaz et al., 2021). During the non-breeding season, the mean MAD has been recorded as 146m (Trulio and White, 2017) in response to pedestrians, and 450m to watercraft (Havera et al., 1992).	Goodship and Furness (2022) has assessed scaup as having a high sensitivity to human disturbance. A buffer zone of 150m-450m has been suggested for the non-breeding season. A 650m visual Zol is considered suitable for disturbance to scaup due to FID's recorded.
Shelduck (650m visual Zol)	FID for shelduck during the non-breeding season have been recorded as a mean of 178.4m in response to surveyors walking over mudflats in Scotland (Dwyer, 2010) and 36m to surveyors walking in Europe (Møller and Erritzøe, 2010), with a max of 700m recorded to surveyors walking over mudflats in Denmark in Laursen et al. (2005).	Shelduck has been assessed as having a high sensitivity to disturbance in Goodship and Furness (2022). A buffer zone of 100m-400m has been suggested for the non-breeding season. As the suggested buffer from the literature is 150m-400m for shelduck, a 650m visual Zol for disturbance is therefore considered suitable.
Wigeon (650m visual Zol)	FIDs for wigeon during the non-breeding season in response to pedestrians range from 20m to 1000m (Liley et al., 2010), with a majority of records showing FIDs at 200m to 300m (Goodship and Furness, 2022). FIDs are larger in response to watercraft and may be up to 500m (Laursen et al., 2017).	Wigeon has been assessed as having a high sensitivity to human disturbance in Goodship and Furness (2022). A buffer zone of 200m-500m has been suggested for the non-breeding season. Due to the FIDs recorded for wigeon, a 650m Zol for disturbance is considered sufficient.

¹ Terms used within the table are sourced from the literature referenced. These terms have been kept as per the original source of the research. Terms may change per species, however for the purposes of this document these terms are interchangeable: Flight Initiation Distance (FID), Minimum Approach Distance (MAD), Alert Distance and Escape Distance

The information provided in Table 4.1 identifies that the strategic level approach of a 300m noise and visual Zol suggested by Cutts et al. (2013) is suitable for most qualifying species of the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar site for the purposes of this HRA. The available literature indicates that nine species (common scoter, curlew, eider, golden plover, pink-footed goose, red-throated diver, scaup, shelduck, and wigeon) have visual disturbance/response thresholds at distances greater than 300m from the source of disturbance. To

avoid implementing several Zol, for the purposes of this assessment, the recommended visual disturbance buffer of the most sensitive species (650m for curlew) has been applied to all species with a visual disturbance threshold of more than 300m. Therefore, the 650m Zol is very precautionary for some of the nine species (e.g. eider and scaup) based on a review of the literature.

The 300m Zol and 650m visual Zol for selected species from the edge of the construction Site Boundary is shown on Figure 10.

4.3.3 Consultation

Consultation was undertaken with a number of statutory and non-governmental organisations to gain advice on the surveys required to inform the AA and to investigate historical records of the numbers and distribution of qualifying species in the Firth of Forth to provide context to the gathered survey data. Consultees included:

- NatureScot;
- the Royal Society for the Protection of Birds (RSPB); and
- the British Trust for Ornithology (BTO) (requests for Wetland Bird Survey (WeBS) data).

4.3.4 Desk Study

A desk study was undertaken to gather relevant baseline information on the qualifying interests of the Firth of Forth SPA/Ramsar site, including cormorant, who are known to travel to the Firth of Forth from Loch Leven SPA/Ramsar site. All relevant data was collated from various up to date, recognised sources and published material relating to the qualifying species and reviewed in relation to the Scheme. Sources included:

- information on the qualifying species including details on ecology, distribution, population size, trends, pressures and threats, ranging from an international overview down to a national, Scottish and site-specific scale (Appendix B Ornithological Information);
- the international, national (UK and Scottish) conservation status of qualifying species, based on the most recent site condition monitoring reports from NatureScot;
- recent population estimates of qualifying species within the SPA based on WeBS data; and
- published information on the migration of waterbirds through the Firth of Forth.

The most recently available BTO WeBS data were obtained for the latest five-year period (2016/17, 2017/18, 2018/19, 2019/20 and 2020/21). Data received covered the non-breeding period (from September to March inclusive). WeBS data from the 'Forth Grangemouth to Kincardine Bridge' and 'Grangepans to Grangemouth' BTO WeBS count sectors (Figure 10) were compared with the project's survey data for Sectors 4, 6, 7, 8, 9, 10 and 11 in order to ascertain if the two years' worth of data collected for the Scheme was representative of the longer term (five years) WeBS dataset. Project survey Sector 5 is not covered by either WeBS count sector (Figure 10) and was therefore not included in the comparison.

Methods of data collection differed between the WeBS surveys and the bird surveys carried out for the Scheme, therefore the two datasets are not directly comparable in terms of estimating population sizes. Data were compared to inspect for similarities or anomalies with respect to species diversity, patterns of rises and falls in bird numbers by month, and approximate locations of aggregations of birds. The WeBS data received are presented in Appendix B (Ornithological Information).

4.3.5 Bird Surveys

Ornithological surveys were undertaken over the winters of 2015/2016, 2016/2017 and 2022/2023 to assess the usage of the Firth of Forth area by non-breeding birds, including those species listed as qualifying species of the Firth of Forth SPA/Ramsar site. Cormorant are considered to be the only qualifying species of the Loch Leven SPA/Ramsar site affected by the Scheme as they are known to travel to the Firth of Forth. As cormorant are also a qualifying species of the Firth of Forth SPA, and it is their presence in the Firth of Forth that could be impacted,

the analysis of the survey data will be against the Firth of Forth SPA population. The survey method was agreed with NatureScot prior to commencement and is detailed in the Grangemouth Flood Alleviation Scheme: Ornithology Survey Desk Study and Proposed Scope (CH2M Hill, 2015). The aim of the surveys was to establish the ornithological baseline (abundance and distribution of bird species through the tidal cycle in the study area, during the study period) to allow an assessment of potential effects of the Scheme on ornithological features, particularly the SPA qualifying species. The surveys in 2015/16 and 2016/17 covered a distance of approximately 26km along the southern shore of the Firth of Forth, which was divided up into 16 Sectors. Surveys were conducted in 2022/2023 over an 11km distance of the shore within Sectors 4-11 due to a refinement of the Scheme design and followed the same method as the previous surveys. Data collected and survey methodology used is summarised in Appendix B (Ornithological Information).

4.3.6 Analysis of the Scheme's Survey Data

Survey data from the bird surveys conducted for the Scheme were used to inform the assessments of the potential effects of habitat loss and bird disturbance. A subset of the data was used, namely data from within count Sectors 4-11, which coincide with the locations of the proposed works, to present information on abundance and distribution of birds within the study area. For each qualifying species recorded within each survey sector in the study area, the peak count of each tidal state during each survey was used to determine distribution and abundance of birds within each sector. From this dataset, a further subset of data, i.e. records from within the Zol was then used to inform the assessment. The methods of analysis highlight particular locations within the study area and Zol which host important numbers of qualifying species within the context of the SPA, for example the presence of high tide roosts. Heat density maps (see Section 4.3.9) of data within Sectors 4-11 were used to inform the Zol assessments and also provide context of bird numbers within the wider survey areas.

Peak counts for each species at rising/high tide were calculated as percentages to help highlight species which occur in large numbers relative to the population size noted in the SPA citation and of the Forth estuary 5-year average (2017/18 to 2021/22) (Frost et al., 2023), and are presented below in Table 4.2 and Table 4.3 for the study area, and for the Zol respectively.

4.3.7 Bird Survey Results

4.3.7.1 Species within the Study Area

A total of 24 qualifying species (out of a total of 27 species) were recorded within the study area (Sectors 4-11) during the surveys. Common scoter was recorded in the study area, but not within the Zol. The three species that were not recorded within the study area are: Slavonian grebe, long-tailed duck and velvet scoter. Slavonian grebe was recorded in Sectors 13-15, which is outwith the study area (Sectors 4 – 11). Long-tailed duck and velvet scoter were absent from all survey sectors (Sectors 1-16).

Table 4.2 details the peak species count recorded within the study area. These numbers are also provided as percentages of the cited SPA population to help highlight species present in larger proportions of the SPA population as recorded at classification. The 5-year average population of the estuary from the 2017/18 to 2021/22 winters (Frost et al., 2023) is also provided.

Table 4.2 Peak species counts at rising/high tide within the study area as percentages of the Firth of Forth SPA population at classification and of the five-year average population of the estuary from the 2017/18 to 2021/22 winters. Species are ordered by percentage of cited SPA population.

Species	Peak Study Area Count	Cited SPA Population ¹	% of Cited SPA Population	Forth Estuary 5-year Average ²	% of 5-year Average
Dunlin	11000	9514	115.6%	5833	188.6%
Shelduck	4700	4509	104.2%	3952	118.9%
Knot	7300	9258	78.9%	3510	208.0%
Ringed plover	210	328	64.0%	419	50.1%

Species	Peak Study Area Count	Cited SPA Population ¹	% of Cited SPA Population	Forth Estuary 5-year Average ²	% of 5-year Average
Redshank	1470	4341	33.9%	4704	31.3%
Bar-tailed godwit	630	1974	31.9%	996	63.3%
Wigeon	660	2139	30.9%	2648	24.9%
Curlew	490	1928	25.4%	3040	16.1%
Red-breasted merganser	130	670	19.4%	297	43.8%
Lapwing	750	4148	18.1%	2757	27.2%
Cormorant	110	682	16.1%	575	19.1%
Golden plover	436	2949	14.8%	1174	37.1%
Pink-footed goose	1370	10852	12.6%	18635	7.4%
Oystercatcher	590	7846	7.5%	6929	8.5%
Grey plover	52	724	7.2%	178	29.2%
Mallard	180	2564	7.0%	1094	16.5%
Scaup	28	437	6.4%	24	116.7%
Great crested grebe	30	720	4.2%	96	31.3%
Red-throated diver	2	90	2.2%	56	3.6%
Turnstone	12	860	1.4%	721	1.7%
Sandwich tern	17	1617	1.1%	1973	0.9%
Goldeneye	23	3004	0.8%	1237	1.9%
Eider	22	9400	0.2%	4620	0.5%
Common scoter	1	2880	0.03%	2781	0.04%

¹Population estimates are taken from JNCC (2001) and are for the years 1993/94–1997/98 for species that qualify under Article 4.1 and 1992/93–1996/97 for those species that qualify under Article 4.2

²Five year average population for the Forth estuary is taken from the 2017/18–2021/22 winters as detailed in Waterbirds in the UK 2021/22: The Wetland Bird survey and Goose & Swan Monitoring Programme (Frost et al., 2023)

Cormorant is also a qualifying species of Loch Leven SPA, which has a cited Loch Leven SPA population of 391 individuals and a Forth Estuary 5-year average of 575. Following the same approach as above, the peak study area count (110) for cormorant accounts for 28.1% of the cited Loch Leven SPA population.

4.3.8 Species within the Zol for Noise and Visual Disturbances

Twenty-three species recorded within the study area were also recorded in the Zol for noise and visual disturbances, and one species was absent from the Zol entirely (common scoter) (Table 4.3).

Table 4.3: Peak species counts within the Zol for disturbance as percentages of the Firth of Forth SPA population at classification and of the five-year average population of the estuary from the 2017/18–2021/22 winters. Species are ordered by percentage of cited SPA population.

Species	Peak Zol Count	Cited SPA Population ¹	% of Cited SPA Population	Forth Estuary 5-year Average ²	% of 5-year Average
Dunlin	11000	9514	115.6%	5833	188.6%
Knot	7300	9258	78.9%	3510	208.0%
Ringed plover	210	328	64.0%	419	50.1%
Redshank	1470	4341	33.9%	4704	31.3%
Bar-tailed godwit	630	1974	31.9%	996	63.3%

Species	Peak Zol Count	Cited SPA Population ¹	% of Cited SPA Population	Forth Estuary 5-year Average ²	% of 5-year Average
Shelduck (650m Zol)	1440	4509	31.9%	3952	36.4%
Wigeon (650m Zol)	660	2139	30.9%	2648	24.9%
Curlew (650m Zol)	430	1928	22.3%	3040	14.1%
Golden plover (650m Zol)	436	2949	14.8%	1174	37.1%
Lapwing	548	4148	13.2%	2757	19.9%
Pink-footed goose (650m Zol)	1370	10852	12.6%	18635	7.3%
Cormorant	60	682	8.8%	575	10.4%
Oystercatcher	588	7846	7.5%	6929	8.5%
Mallard	180	2564	7.0%	1094	16.5%
Red-breasted merganser	28	670	4.2%	297	9.4%
Scaup (650m Zol)	17	437	3.8%	24	70.8%
Red-throated diver (650m Zol)	2	90	2.2%	56	3.6%
Great crested grebe	11	720	1.5%	96	11.5%
Grey plover	7	724	1.0%	178	3.9%
Goldeneye	23	3004	0.8%	1237	1.9%
Sandwich tern	11	1617	0.7%	1973	0.6%
Turnstone	4	860	0.5%	721	0.6%
Eider (650m Zol)	5	9400	0.02%	4620	0.02%

¹Population estimates are taken from JNCC (2001) and are for the years 1993/94-1997/98 for species that qualify under Article 4.1 and 1992/93-1996/97 for those species that qualify under Article 4.2

² Five year average population for the Forth estuary is taken from the 2017/18-2021/22 winters as detailed in Waterbirds in the UK 2021/22: The Wetland Bird survey and Goose & Swan Monitoring Programme (Frost et al., 2023)

Cormorant is also a qualifying species of Loch Leven SPA, which has a cited Loch Leven SPA population of 391 individuals and a Forth Estuary 5-year average of 575. Following the same approach as above, the peak Zol area count (60) for cormorant accounts for 15.3% of the cited Loch Leven SPA population.

Although the peak shelduck count for high and rising tides within the Zol is 1440 birds, a large flock (4,700 birds) was recorded at low tide within the Zol, north of the River Avon. A moulting flock of shelduck is known to be present in the Firth of Forth close to this location (Bryant, 1978; Green et al., 2019). During the moulting period, shelduck are completely flightless and so are more vulnerable to disturbance and predation (Salomonsen, 1968). Extensive mudflat areas offer good protection from predation and human disturbance, whilst providing abundant food resources. Given the size of this flock and the likelihood that they occupy a larger area than the point data suggests, on a precautionary basis, moulting shelduck has been considered in the assessment.

4.3.9 Heat Density Mapping

Heat density maps have been produced for the qualifying species whose peak counts recorded within the Zol resulted in the 12 highest percentages of the cited SPA population. For context, all data within Sectors 4-11 has been included, not data just within the Zol. These maps show the location of hotspots for foraging at low tide, roosting at high tide and within which months aggregations occur. User instructions and further information about the heat density maps can be found in Appendix B (Ornithological Information). All other species recorded either infrequently or in low aggregations are shown in Figures 22-32.

4.3.10 Key Points from Bird Survey Results

24 of 27 qualifying species were recorded within the survey study area, twenty-three of which were recorded within the Zol. Common scoter is the only qualifying species that was recorded within the study area, but not within the Zol. Long-tailed duck, Slavonian grebe and velvet scoter were absent from the study area. Details of species recorded during surveys can be found in Appendix B (Ornithological Information). The bird surveys recorded the largest numbers of roosting waders between December and March, with particularly high numbers in January 2017 in survey Sectors 9 and 10.

The recorded distribution of birds was relatively consistent throughout the survey period. Particularly large aggregations were recorded roosting at the below locations, which are identified on Figure 10:

- the sheltered bay adjacent to petrochemical plant in Sector 9, more than 50m from the Scheme at its nearest point;
- the breakwater adjacent to the Port of Grangemouth in Sector 6, more than 50m from the Scheme at its nearest point;
- mudflats and creeks at the mouth of the River Avon in Sector 10, adjacent to Scheme; and
- Bothkennar Pools, north of the River Carron in Sector 5, more than 300m from the Scheme at its nearest point.

Sector 9 supported some of the largest peak counts of bar-tailed godwit, curlew, golden plover, dunlin, knot, ringed plover and shelduck. This sector provides important feeding habitat and roosting habitat for a number of species within the SPA. The surveys undertaken in 2016/17 and 2022/23 showed that Sector 9 is particularly important as a roosting area for waders and bar-tailed godwit, curlew, golden plover, knot, lapwing, redshank, shelduck and dunlin roosted in the sheltered bay area in the western part of the sector. This area was found to be largely undisturbed by humans during field surveys, mainly because public access is restricted by the presence of the petrochemical plant.

The breakwater was found to support large numbers of roosting and feeding birds, in particular redshank, dunlin, lapwing, curlew and oystercatcher. Peak counts of these species often occur just before high tide, as large high tides limit the amount of roosting habitat available within the estuary.

From the comparison of WeBS and the Scheme's datasets, the survey data collected for the Scheme was seen to correlate well with the WeBS data collected over a longer period of time, indicating the survey data is representative of ongoing bird use of the habitats in the study area. However, several species counts in the survey data were notably higher than their corresponding WeBS count for that month (e.g. redshank and dunlin). This indicates that bird use of the estuary can vary within a given month, and possibly within the space of a few days, depending on the dates the WeBS count and surveys for the Scheme were undertaken.

4.4 Bird Monitoring During Ground Investigation Works

4.4.1 Introduction

To inform the design and construction of the Scheme, numerous phases of Ground Investigation (GI) works have been conducted. Phase 5 was conducted around the perimeter of the Port of Grangemouth and works were undertaken at 35 locations comprising trial pits (TP), boreholes (BH) and cone penetration testing (CPT) (Figure 11). Bird monitoring surveys were undertaken during these GI works to gather data on the birds' reaction to works.

4.4.2 Methods

Monitoring during GI works was undertaken by two competent ecologists between August 2019 and January 2020 to account for differing use of the site by birds through the period and during all tidal states (high, mid and low). Monitoring was undertaken during a range of ground investigation types: cable percussive drilling at boreholes; rotary drilling at boreholes, and cone penetration tests, and at locations both adjacent to and more distant from

the SPA boundary. Bird monitoring took place at ten GI locations; eight boreholes and two CPT locations (Table 4.4).

Survey duration varied depending on GI activity, but each survey typically lasted three hours. Where possible, ecologists began the monitoring period prior to the commencement of the GI works and continued to monitor for a period after GI activity ceased. Ecologists observed birds for the duration of the survey period using binoculars and a telescope. Weather conditions during each monitoring period are detailed in Appendix B (Ornithological Information). At the beginning of the survey and again each hour, birds within a 300m Zol from the GI position (see Section 4.3.2) were plotted onto a basemap using standard BTO species codes to provide an hourly snapshot of bird distribution. Birds were assigned a behaviour code of either feeding, loafing or roosting.

In addition to mapping birds each hour, Potential Disturbance Events (PDE) were captured on a recording form. The type/category of potential disturbance was categorised as follows, and a description was recorded in the field:

- Anthropogenic (GI-related) (e.g. noise from drilling rig, visual disturbance from contractors).
- Anthropogenic (non GI-related) (e.g. industrial activity, aircraft, boat).
- Predator/threat species (e.g. raptor, fox).
- Non predator/threat species (e.g. cormorant).
- Unknown (i.e. the source of the disturbance was unknown and therefore not recordable by observers).

Reaction types were categorised as follows, and a description was recorded in the field:

- Fly up (birds fly up and either return to same location or leave the area).
- Attack (birds fly towards disturbance and mob it).
- On-ground agitation (birds become alert / unsettled but do not fly).
- No observable reaction.

Reactions to PDEs at any distance were recorded, not just within the 300m Zol, if observed by the ecologists.

4.4.3 Results

Five of the ten locations were predicted to have LSE as identified in the HRA for GI works (Jacobs, 2019). GI related anthropogenic PDEs were observed on 88 occasions; birds reacted to only five of these events (Table 4.4). No LSE were identified for BHFP11, which was visually screened from the SPA, however redshank reacted twice during the nine GI-related disturbance events. Ten redshank appeared to be agitated on the ground during low tide, but did not disperse as a result of the disturbance on one occasion, and seven redshank flew approximately 30m along the breakwater, away from the disturbance, on the second occasion.

Table 4.4: Disturbance events recorded during bird monitoring of GI works.

GI Location	LSE identified in GI HRA	Date and Time	Tide	PDE Types	Qualifying Species within 300m (Peak Count)*	Reactions
BHFP04	New location. No LSE predicted as borehole was 135m from SPA and naturally screened.	24 September 2019, 08:10-09:40	Mid	4 x Anthropogenic (GI related)	Cormorant (1) and mallard (4) at mouth of River Carron.	None
BHFP07	LSE identified in GI HRA. Borehole was 8m from SPA, on the road verge immediately	11 December 2019, 10:10-12:00	Mid	2 x Anthropogenic (GI related)	Wigeon (2), curlew (2), cormorant (2) and shelduck (4) feeding and loafing mainly on or behind breakwater.	None

GI Location	LSE identified in GI HRA	Date and Time	Tide	PDE Types	Qualifying Species within 300m (Peak Count)*	Reactions
	adjacent to the sites with no natural screening.				Approximately 100 redshank and 20 dunlin roosting in western channel in centre of port (not in estuary).	
BHFP08	LSE identified in GI HRA. Borehole was 6m from SPA, on the road verge immediately adjacent to the sites with no natural screening.	22 October 2019, 08:15-12:25	High	7 x Anthropogenic (GI related)	Curlew (13), redshank (228), dunlin (111), grey plover (1) and shelduck (11) foraging behind breakwater. Redshank (323), dunlin (34) and cormorant (2) loafing and roosting on/in front of breakwater. Redshank (237) roosting at estuary edge.	One fly up: Redshank and dunlin (60 individuals) on the south side of the breakwater flew approximately 25m to the north side of the breakwater.
				1 x Anthropogenic (Non-GI related)		None
				1 x Predator / threat		Fly up: Carrion crows flushed 240 redshank (not entire flock) which flew out of sight.
				1 x Unknown		All waders (except curlew) (450 individuals) flew approximately 500m downstream and roosted on the breakwater.
		31 October 2019, 09:15-11:40	Low	3 x Anthropogenic (GI related)	Curlew (5), lapwing (130), redshank (47) and shelduck (25) foraging and loafing behind breakwater. Redshank (165), bar-tailed godwit (4) and lapwing (61) roosting on breakwater.	None
BHFP09	No LSE identified in GI HRA. Borehole was 17m from SPA, immediately adjacent to the port infrastructure and naturally screened from the sites.	23 September 2019, 09:45-13:15	High	7 x Anthropogenic (GI related)	Shelduck (17), lapwing (1), oystercatcher (1) and curlew (5) foraging and loafing behind breakwater. Redshank (266), dunlin (7), shelduck (3) ringed plover (1), curlew (1) and oystercatcher (2) roosting, foraging and loafing on River Carron mudflats on southern side of breakwater.	None
				1 x Anthropogenic (Non-GI related)		One fly up: Redshank (30 individuals) flew out of sight.
BHFP10	LSE identified in GI HRA. Borehole was 4m from SPA, on the road verge immediately adjacent to the sites with no natural screening.	11 October 2019, 09:00-10:45	Low	5 x Anthropogenic (GI related)	Shelduck (3) and curlew (1) foraging behind breakwater. Mallard (4) loafing in River Carron. Curlew (1) roosting on breakwater. Curlew (1) foraging at estuary edge.	None
				1 x Anthropogenic (Non-GI related)		Fly up: Wildfowling approximately 2km to the northeast. Pink-footed goose (50 individuals) flew over survey location from that direction, heading southwest.

GI Location	LSE identified in GI HRA	Date and Time	Tide	PDE Types	Qualifying Species within 300m (Peak Count)*	Reactions
		15 October 2019, 09:15-11:15	Low	7 x Anthropogenic (GI related)	Shelduck (9), curlew (7) and redshank (211) foraging behind breakwater. Curlew (1) loafing on breakwater. Curlew (3), mallard (17), cormorant (1), oystercatcher (1) and redshank (101) loafing and foraging in mudflats in front of breakwater.	None
BHFP11	No LSE identified in GI HRA. Borehole was 14m from SPA, immediately adjacent to the port infrastructure and naturally screened from the sites.	11 September 2019, 08:15-10:00	Low	3 x Anthropogenic (GI related)	Shelduck (15), curlew (9), oystercatcher (1), foraging and roosting behind and near breakwater. Redshank (44) foraging and loafing on mudflats in front of breakwater and on edge of River Carron. Curlew (1) foraging at estuary edge.	One on ground agitation: In response to the noise of machinery starting, redshank (10 individuals) became alert and slightly agitated but did not fly.
		19 September 2019, 08:30-10:00	Mid	6 x Anthropogenic (GI related)	Shelduck (19), curlew (10), oystercatcher (8) and redshank (74) foraging behind breakwater. Curlew (1) and redshank (1) foraging on mudflats in front of breakwater. Curlew (1) and redshank (2) foraging at estuary edge.	One fly up: In response to a loud noise caused by the borehole casing being dropped, redshank (7 individuals) flew approximately 30m away from disturbance along the breakwater,
BHFP12	No LSE identified in GI HRA. Borehole was 16m from SPA, immediately adjacent to the port infrastructure and naturally screened from the sites.	22 August 2019, 08:10-12:14	High	8 x Anthropogenic (GI related)	Shelduck (291) and curlew (3) foraging and loafing behind breakwater.	None
				1 x Anthropogenic (Non-GI related)	Cormorant (15), shelduck (18) and redshank (39) loafing in front of breakwater. Shelduck (16), dunlin (3) and redshank (140) roosting on and in front of breakwater. Curlew (1) foraging at estuary edge.	Fly up: Redshank (39 individuals) flew approximately 50m away from disturbance and along the breakwater.
		05 September 2019, 08:30-13:00	High-Low	5 x Anthropogenic (GI related)	Curlew (23), oystercatcher (5), knot (2), redshank (5) and shelduck (15) foraging behind breakwater.	None
				1 x Anthropogenic (Non-GI related)	Cormorant (14), curlew (3) and oystercatcher (1) roosting and loafing along breakwater.	None

GI Location	LSE identified in GI HRA	Date and Time	Tide	PDE Types	Qualifying Species within 300m (Peak Count)*	Reactions
					Redshank (35) and curlew (1) foraging along breakwater. Curlew (1) and redshank (3) foraging at estuary edge.	
BHFP15	LSE identified in GI HRA. Borehole was 11m from SPA at the Port Locks with no natural screening.	05 August 2019, 10:50-12:50 and 14:00-16:05	Low	11 x Anthropogenic (GI related)	Shelduck (310), curlew (8) and redshank (125) foraging in mudflats. Shelduck (940) loafing in mudflats. Shelduck (4) roosting along pier.	One on ground agitation: Shelduck (30 individuals) walked approximately 20m further away from disturbance but did not fly, possibly due to moulting. This was the first day of GI works and the first location to be drilled. The birds did not react after this initial reaction.
		08 August 2019, 08:45-12:15	High	8 x Anthropogenic (GI related)	Redshank (1) roosting at estuary edge. Sandwich tern (5) flying over. Cormorant (5) loafing and roosting along pier.	One fly up: Redshank (8 individuals) flew approximately 30m further away from disturbance
				1 x Non-predator / threat	Shelduck (930) roosting and loafing in mudflats. Redshank (87), curlew (2) and shelduck (12) foraging in mudflats.	None
		14 August 2019, 08:00-10:00	Low	1 x Anthropogenic (GI related)	Shelduck (72) loafing in mudflats. Curlew (3), shelduck (3) and oystercatcher (1) foraging in mudflats.	None
				2 x Anthropogenic (Non-GI related)		None
		23 August 2019, 08:00-10:05	High	6 x Anthropogenic (GI related)	Cormorant (18) loafing along pier.	None
CPTFP05	No LSE identified in GI HRA. CPT was 20m from SPA, immediately adjacent to the port infrastructure and naturally screened from the sites.	01 October 2019, 08:45-11:15	Low	3 x Anthropogenic (Non-GI related)	Shelduck (23), redshank (108) and curlew (11) foraging behind breakwater. Redshank (145) and dunlin (1) foraging in front of breakwater. Redshank (90) foraging in mudflats at estuary edge. Redshank (130) roosting at estuary edge.	None – GI location is on the landward side of the road and surrounded by vegetation.
CPTFP11	LSE identified in GI HRA. CPT was 14m from SPA adjacent to Grange Burn with no natural screening.	08 January 2020, 08:30-11:30	Low	5 x Anthropogenic (GI related)	Redshank (284) and dunlin (4) foraging in mudflats along Grange Burn.	None
				4 x Anthropogenic (Non-GI related)	Mallard (2) roosting in derelict ground within the port.	None

*peak count for each behaviour over the monitoring period

4.4.4 Discussion

GI-related PDE were observed on 88 occasions during 17 periods of monitoring. No visual/noise barriers were deployed during GI works. On only five occasions was an observable reaction recorded. On three occasions, birds (redshank on all occasions and dunlin on one occasion) flew a maximum of 30m away from the disturbance. Redshank showed on-ground agitation once during GI works, as did shelduck, but there is a possibility that this was a moulting flock of shelduck that were unable to fly. Although the GI works are not directly comparable to the main works for the Scheme, for example in scale and duration, these reactions provide some evidence to suggest that if disturbed by unscreened works (additional noise and increased visual disturbance from site personnel and plant/vehicles), qualifying species may disperse perhaps only a short distance, within the Firth of Forth SPA and Ramsar site, if at all.

4.5 Noise Assessment

4.5.1 Introduction

Grangemouth is a busy industrial area; the Port of Grangemouth is Scotland's largest container port, handling nine million tonnes of cargo through the dock every year (Forth Ports Group, 2023). The port operates 24 hours a day. There are periodic alarm tests carried out at both the port and the petrochemical plant as part of their health and safety and incident response training. Forth Ports have confirmed that they have no noise measurements from within the port.

Immediately to the southeast of the port is the petrochemical site. Within the petrochemical site, there are multiple flares which are regularly used. The frequency and duration of flaring is highly dependent on the flow of oil and gas from the North Sea pipeline and the production at the site.

During a site meeting with NatureScot representatives on 06 June 2019, it was agreed that baseline noise measurements along the estuary edge impacted by works would be beneficial to help contextualise the construction noise in the environment. Noise monitoring was undertaken to determine the baseline noise experienced by birds and record their reactions to the noise emitted from the various tasks and activities undertaken around the port and petrochemical plant.

4.5.2 Methods

4.5.2.1 Site Monitoring

Baseline noise measurements were taken at four locations between 29 and 31 October 2019 (Figure 12). These four locations were selected to provide measurements from across the sites and are located at the edge of the estuary at areas used frequently by birds (MacArthur Green, 2017). Monitoring was undertaken during daylight hours and lasted for approximately two hours at each location. It is important to note that any baseline noise monitoring is a snapshot of the acoustic environment.

Measurements were undertaken using a Castle Mirus Sound Level Meter Set (Serial Number 35769) with a Svantek SV18 Pre-amplifier (Serial Number 41663) and a Svantek 7052E ½" Microphone (Serial Number 58860), calibrated using a Castle GA607 Calibrator (Serial Number 035748).

The equipment complies with the Specification for sound level meters (British Standards Institution, 1994) and capable of operating as a Type 1 integrating sound level meter, complying with the British Standard, Integrating-averaging sound level meters (British Standards Institution, 2001). The meter and calibrator were also calibrated in a National Physical Laboratory (NPL) accredited laboratory. Details of the equipment and calibration are in Table 4.5.

Table 4.5: Measurement Equipment & Calibration Record

Equipment	Serial Number	NPL Calibration Certificate No.	NPL Calibration Certificate Reference	Date
Castle Mirus Sound Level Meter	35769	035748/75944	CDK1806682	30 August 2019
Svantek SV18 Pre-amplifier	41663			
Svantek 7052E ½" Microphone	58860			
Castle GA607 Acoustic Calibrator	035748			

The Sound Level Meter was calibrated before and after the measurements; no significant drift in calibration level was found to have occurred and measurements were considered to be accurate.

Seven measurement parameters were utilised: L_{A10} , L_{A50} , L_{A90} , L_{Amax} , L_{Amin} , L_{Aeq} and L_{Apeak} . Variable background noise levels are measured as the noise level which is exceeded for a proportion of the time over a given measurement period. Therefore, L_{A10} , L_{A50} and L_{A90} are the sound levels exceeded for 10%, 50% and 90% respectively of a specified time period. In each case, the suffix 'LA' implies that the sound pressure level (L) has been A-weighted. The A-weighting system is used for measurement of environmental noise and is the manner in which the measured level is corrected to more accurately reflect the sensitivity of human hearing. Birds are considered to have a similar hearing range to that of humans and A-weighted measurements are generally used in bird studies (Drewitt et al., 2018).

L_{Amax} and L_{Amin} are an approximation of the maximum and minimum noise level recorded during a given period of assessment; they represent an average level recorded over the monitoring period.

L_{Aeq} is different to the measurements above as it is a measure of the actual sound energy rather than a statistical measure. L_{Aeq} describes a sound level with the same energy content as the fluctuating acoustic signal over a fixed time period, which equates to the mean noise level. L_{Aeq} is the equivalent level of steady, continuous noise which produces the same amount of sound energy as a fluctuating noise over the same period. This measurement can be used to describe 'ambient' noise level, although it provides no information on the number and maximum amplitude of peaks in noise emissions.

L_{Apeak} is the peak sound pressure measurement and important to assess the potential startle effect of impulse noise on birds (Drewitt et al., 2018).

The measurements were undertaken by a Principal Noise Consultant with over 20 years' experience in the measurement and assessment of noise and vibration, with a specific specialism in construction noise. An Ecologist was also present during the measurements, who monitored bird behaviour during the measurement period.

4.5.2.2 Noise Monitoring during Ground Investigation Works

Noise monitoring at one location was undertaken while GI works were being carried out at the Port of Grangemouth. On 30 October 2019, during high tide, a measurement was taken within the vicinity of an active borehole on North Shore Road (Figure 11) to gain an understanding of the noise levels experienced by the birds during GI works. Measurements were taken for 15 minutes following the methods described in Section 4.5.2.1.

4.5.2.3 Potential Construction Noise Levels

The typical noise attenuation during different phases of construction work was assessed to help determine the likely effects these noise levels would have on qualifying features of the SPA. Table 4.6 details the possible plant and equipment used for the noise calculations that could be used for each phase of construction, the estimated daily duration the plant may be in use, and the sound power level at source of each item of plant (L_w dB).

Calculations were informed by the proposed construction methods and the construction methodology contained in Annex F of the Code of practice for noise and vibration control on construction and open sites (British Standards Institution, 2014), specifically the method using 'Sound Power Levels'.

Table 4.6: Possible plant and equipment details and sound level.

Phase	Activity	Plant Description	No.	% On-time	Shift Duration (h)	Duration of Activity (h)	% Activity Time	Total Lw dB
Site Compound - Excavation Hardstanding & Offices Installation	Earthworks	Dozer 20t	1	20%	10	8	80%	109
	Trenching	Tracked excavator 21t	1	25%	10	8	80%	99
	Material Distribution	Dumper 6t	1	20%	10	8	80%	107
	Rolling & Compaction	Vibratory roller 12t	1	20%	10	8	80%	108
	Lifting	Lorry with lifting boom 6t	1	30%	10	8	80%	105
	Power for Site Cabins	Diesel generator	1	50%	10	8	80%	88
Site Compound - Operation	Power for Site Cabins	Diesel generator	1	50%	10	8	80%	88
	Vehicles	General 4x4	2	20%	10	8	80%	111
	Material Distribution	Lorry (4-axle wagon)	1	10%	10	8	80%	108
Embankment Construction	Earthworks	Tracked excavator 25t	1	30%	10	8	80%	105
	Vibro piling	Vibratory piling rig 52t	1	35%	10	8	80%	116
	Material Distribution	Lorry (4-axle wagon)	1	20%	10	8	80%	108
	Rolling & Compaction	Roller (rolling fill) 18t	1	20%	10	8	80%	107
	Material Distribution	Wheeled backhoe 9t	1	15%	10	8	80%	95
	Material Distribution	Dumper 9t	1	15%	10	8	80%	104
Sheet Pile Walls	Earthworks	Tracked excavator 25t	1	25%	10	8	80%	105
	Vibro piling	Vibratory piling rig 52t	1	30%	10	8	80%	116
	Cutting steel	Gas cutter	1	10%	10	8	80%	96
	Mixing Concrete	Concrete mixer truck	1	15%	10	8	80%	108
	Concrete Other	Poker vibrator	1	10%	10	8	80%	106
	Power for Lighting	Diesel generator	1	15%	10	8	80%	93
	Material Distribution	Dumper 9t	1	20%	10	8	80%	104
Flood Walls (Formwork Reinforcement & Concrete)	Breaking Stud Partition	Lump Hammer	1	5%	10	8	80%	97
	Cutting concrete	Circular saw	1	10%	10	8	80%	107
	Mixing Concrete	Concrete mixer truck	1	25%	10	8	80%	108
	Concrete Other	Poker vibrator	1	15%	10	8	80%	106
	Power for Lighting	Diesel generator	1	20%	10	8	80%	93
	Material Distribution	Dumper 9t	1	15%	10	8	80%	104
	Earthworks	Tracked excavator 25t	1	30%	10	8	80%	105

Phase	Activity	Plant Description	No.	% On-time	Shift Duration (h)	Duration of Activity (h)	% Activity Time	Total Lw dB
Coastal Revetment	Material Distribution	Lorry (4-axle wagon)	2	25%	10	8	80%	111
	Earthworks	Tracked excavator 40t	1	40%	10	12	120%	107

Calculations have not been undertaken for distances in excess of 300m. Cutts et al. (2013) derived Diagram 3.1 based on their observed responses of waterbirds to various noise stimuli to show standard distance decay rates for noise. Acceptable levels (up to 70dB(A)) are shaded green with dark green unlikely to have any effect and light green occasionally resulting in a low-level behavioural response, for example heads-up. Diagram 3.1 shows that at 170.67m, only plant emitting 120dB(A) levels will be at an unacceptable level. It is not anticipated that plant emitting 120dB(A) at source will be used (Table 4.6) and therefore acceptable noise levels during construction of the Scheme should be experienced from approximately 170m from works. A Zol of 300m is therefore precautionary in the context of noise disturbance.

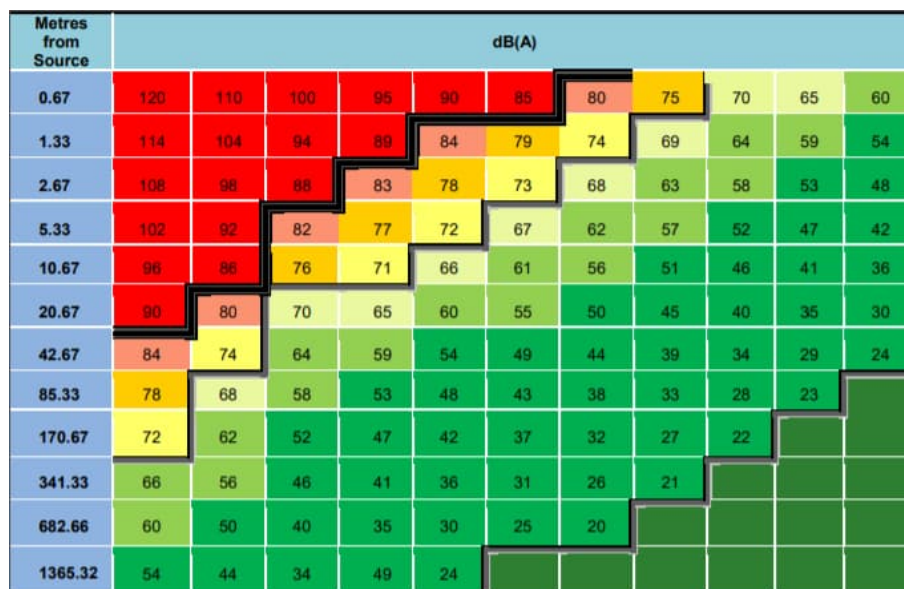


Diagram 3.1: Standard distance decay rates for noise from source (Cutts et al., 2013).

The measured baseline levels collected were used alongside the calculated potential construction noise levels to determine potential impacts on qualifying species of the Firth of Forth SPA/Ramsar site, and cormorant which are known to travel to the Firth of Forth from Loch Leven SPA/Ramsar site.

4.5.3 Results

4.5.3.1 Site Monitoring

Noise Measurements

The baseline noise levels recorded are detailed in Table 4.7. Levels recorded in the vicinity of measurement Locations A-C around the Port of Grangemouth were typical of industrial areas, with considerable impact from HGVs and other industrial activities. There were occasional high noise events, for example a ship warning horn recorded at Location B.

Location D close to the petrochemical plant was acoustically different to those around the port, with lower noise levels experienced and peaks in activity experienced as a result of train shunting activities in a nearby railway yard.

Table 4.7: Date, time and duration of each measurement and a summary of the results at each location

Location	Date and Time	Duration	Measured Noise Levels, dB						
			LAPeak	LAMax	LAMin	LAeq	LA10	LA50	LA90
A – North Shore Road	29 October 2019, 14:12	2 hours	96.5	84.4	44.7	63.2	63.3	55.9	52.7
B – North Shore Road	31 October 2019, 12:44	2 hours	103.3	84.0	45.6	54.5	53.9	50.3	48.6
C – South Shore Road	31 October 2019, 09:22	2h 2m	94.2	76.6	41.9	50.1	49.9	45.7	44.2
D – petrochemical plant	30 October 2019, 11:19	1h 56m	97.0	73.8	38.5	48.3	48.5	45.6	43.6

Bird Monitoring

Observations from bird monitoring during the measurement period are presented in Table 4.8. Weather conditions during each measurement are detailed in Appendix B (Ornithological Information).

Table 4.8: Behavioural observations from bird monitoring during noise monitoring.

Location	Tidal Cycle	Observations
A	High	From the commencement of monitoring, there was noise from forklift trucks operating at a fish pellet plant and a crane being repaired on the opposite side of South Shore Road from the monitoring location. General road traffic noise and noise from trucks was also experienced. Monitoring took place during a spring tidal cycle (very high tide). Very few birds were present in the area which was likely due to high tide. Between 14:30 – 14:40 all waders flew upstream as the tide covered all of the breakwater except for the top of the stone towers and posts. Gulls and shelduck were recorded in the far distance beyond Skinflats. The closest qualifying species to the noise monitoring position were redshank and dunlin roosting on the stone towers/posts of the breakwater (approximately 125m from surveyor), and the occasional feeding cormorant in the River Carron channel. There was no observable reaction from the species present to any noise experienced during the monitoring period.
B	Mid	At the beginning of the monitoring period, a high frequency noise from pressure washing was recorded. Other noises recorded during the monitoring period included a ship's horn, traffic, metallic bangs and passing aircraft. The closest aggregation of qualifying species was approximately 100m from the noise monitoring position on the mudflats either side of the River Carron. Wader flocks (from 2 – 200 birds, mostly redshank) moved away from the breakwater as the tide rose to the near side of the River Carron and flew away upstream. Redshank were unsettled for the duration of the monitoring period, flying from foraging on the mudflats on the east bank of the river, to feeding on the far side of the breakwater. The redshank may have been exhibiting predator avoidance behaviour because of the presence of four herons. There was no observable reaction from the species present to any noise experienced during the monitoring period.
C	Low	At 10:00 there was a controlled explosion at Longannet Power Station which is approximately 2km from the monitoring location on the other side of the estuary. Other noise experienced during the monitoring period included car horns and industrial noise from within the chemical plant. The monitoring took place at low tide and only small numbers of qualifying species (redshank and curlew) were present, the closest being approximately 100m from the noise monitoring position on the mudflats. There was no observable reaction from the species present to any noise recorded during the monitoring period.
D	Mid	Most of the noise experienced was from shunting operations in the rail depot within the petrochemical plant. The nearest qualifying species were approximately 200m away on the mudflats. As the tide rose, curlew, black-tailed godwit and shelduck flew closer to the noise monitoring position to roost in the upper shore area. There was no observable reaction from the species present to noise produced from shunting or other noises recorded.

4.5.3.2 Noise Monitoring during GI

Measurements were taken for 15 minutes within the vicinity of borehole BHFP08 on North Shore Road (Table 4.9). The measurement location was on the verge on the opposite side of the road from the port. The road was subject to traffic control during the GI works and passing port traffic also influenced the measurement.

Table 4.9: Results of noise monitoring undertaken adjacent to an active GI location (borehole)

Location	Date and Time	Duration	Measured Noise Levels, dB						
			LAPeak	LAMax	LAMin	LAeq	LA10	LA50	LA90
BHFP08 – North Shore Road	30 October 2019, 15:00	15 minutes	120.6	97.8	66.0	76.4	74.4	70.8	69.3

During the short period of noise monitoring at an active borehole GI location, noise experienced was from running engines, noises from metal casings being installed and a road sweeping vehicle passing. Qualifying interests were present on the breakwater approximately 150m from the noise monitoring location. Flocks of dunlin and redshank

flew between the towers of the breakwater which were the only parts of the breakwater above high tide. There was no observable reaction from the species present to any noise experienced during the monitoring period.

4.5.3.3 Potential Construction Noise Levels

The distance from the construction site boundary at which construction noise levels would be 60dB, 70dB and 80dB, without mitigation, for each phase of construction are detailed in Table 4.10 and shown on Figures 13-18. It should be noted that the calculated distances indicate a worst-case scenario. In this instance this is defined as all plant and equipment for each phase of construction operating as a cohesive unit, at the stated 'On-times' for the full working day, and that all plant is operating at the closest assumed point for those operations. Therefore, these distances will be the maximum distance at which the particular noise level will be experienced, and if the noise levels do reach this distance, it would be for a short period of time.

Table 4.10: Distances for given activities to certain noise levels

Phase	Distance to Stated Noise Level (m)			Figure Reference
	80dB	70dB	60dB	
Site Compound - Excavation Hardstanding & Office Installation	8	25.5	70	13
Site Compound - Operation	6.5	20	57	14
Embankment Construction	15	45	125	15
Sheet Pile Walls	14	41	113	16
Flood Walls (Formwork Reinforcement & Concrete)	6.5	20	57	17
Coastal Revetment	10	30	85	18

4.5.4 Discussion

Cutts et al. (2013) states that for auditory disturbance to qualify as a high noise level effect it must constitute a prolonged noise level of over 72dB, moderate noise level effects would be regular noise of 60-72dB and low noise level effects would be <55dB (all at the bird, not the source of the noise). The baseline noise monitoring recorded L_{Aeq} noise levels across the site ranging between 48.3dB and 63.2dB at the edge of the estuary, demonstrating that the birds present in the Firth of Forth currently experience, and have habituated to, lower than moderate noise levels.

High noise level effects can also be experienced when there are sudden noise events of over 60dB (at bird, not at source) (Cutts et al., 2013). The L_{Apeak} noise levels recorded at the edge of the estuary ranged between 94.2dB and 103.3dB. No observable reaction from the birds was recorded during monitoring, suggesting that the qualifying species have habituated to high noise levels emitted from the Port of Grangemouth and petrochemical plant.

Figures 13-18 show where acceptable noise levels (≤ 70 dB) will be experienced for six phases of construction. Embankment construction would be the 'noisiest' phase of construction, with noise levels up to 70dB being experienced the furthest (up to 45m from works). As detailed in Section 4.3.10, large aggregations of birds were recorded at four locations; the breakwater adjacent to the port (more than 50m from the Scheme), the sheltered bay adjacent to the petrochemical plant (more than 50m from the Scheme), Bothkennar Pools (more than 300m from Scheme), and the mudflats and creeks at the mouth of the River Avon. Construction noise levels are predicted to attenuate to 70dB at 45m for embankment construction, 41m for sheet pile walls, and at 30m for coastal revetment works (Figures 15, 16 and 18) – the noisiest activities adjacent to the estuary. These calculations further demonstrate that a Zol of 300m from works is precautionary in the context of noise disturbance.

Table 4.9 identifies that the noise monitoring during GI works recorded L_{Aeq} noise levels of 76.4dB, which is above the acceptable noise levels of ≤ 70 dB identified by Cutts et al. (2013). As the noise measurements at the borehole location were only recorded for 15 minutes; a true representation of the L_{Aeq} levels (ambient noise levels) experienced during GI works was unlikely to be obtained in this time. The measurement was taken from the edge

of the estuary, i.e. the closest a bird could experience the noise, and in this area, birds favour the breakwater which is 50m-150m from the Scheme. As shown in Table 4.10, embankment construction, the loudest construction activity, will reach acceptable levels at 45m from source (Figure 15). Therefore, noise levels experienced at the breakwater during GI works would likely be at acceptable levels of ≤ 70 dB.

4.6 Biotope Mapping

4.6.1 Introduction

In their response to the Scoping Report (Jacobs, 2018), NatureScot advised that biotope mapping of areas affected by the Scheme should be undertaken in order to fully assess the importance of these areas to the qualifying species of the SPA/Ramsar. A biotope is a classification based on a combination of the physical environment and the associated biological community. The Marine Habitat Classification for Britain and Ireland (Connor et al., 2004) is a hierarchical classification system and is compatible with the European nature information system (EUNIS) habitat classification system. Biotope mapping is used as a tool for the assessment, management and conservation of marine habitats and in this case has been undertaken to identify the most important areas for the qualifying species of the SPA/Ramsar site that may be affected by the Scheme.

4.6.2 Methods

Core samples were collected from the intertidal mudflats at five sites; two on Skinflats and three in front of the petrochemical plant (Figure 19). Mapping was restricted to the mudflats and did not consider the extreme upper shore which, in the area in front of the petrochemical plant, predominantly consisted of a thin band (around 10m wide) of artificial erosion protection and coarse sediments (Photograph 4.1). Samples were taken using a 0.01m² core, preserved using formalin and sent to the laboratory for infaunal analysis. Three replicate cores were taken at each of the five sites. A sediment sample was also taken from each of the five sites and sent to National Laboratory Services (UKAS accreditation no. 0754) for particle size analysis. The species and abundance data were then combined with the results of the particle size analysis to assign a biotope to each of the five sites, in accordance with Connor et al. (2004).



Photograph 4.1. View of the upper shore in front of the petrochemical plant.

Intertidal core sampling for biotope mapping was undertaken on 09 and 10 April 2019 to coincide with midday low tides. The date of collection and location for each site is detailed in Table 4.11.

Table 4.11: Date and location core samples were taken

Site	Date	Location	
		X	Y
Site 1	09/04/2019	293113	682923
Site 2	09/04/2019	293158	682952
Site 3	10/04/2019	295429	682466
Site 4	10/04/2019	295547	682066
Site 5	10/04/2019	295921	681553

4.6.3 Results

The results of the taxonomic analyses are shown in Table 4.12. The sediment at all five sites was classified as slightly gravelly sandy mud. Taxa common to all sites were Nematoda, polychaete worms of the Eteoninae sub-family, *Hediste diversicolor* and *Streblospio* species, the small mud snail *Peringia ulvae* and the bivalve *Limecola* (previously *Macoma*) *balthica*. Ostracods of the order Podocopida, and the oligochaete, *Tubificoides benedii*, were recorded only from the two sites at Skinflats, not from the sites in front of the petrochemical plant. Cirratulid worms (including *Tharyx* species) were recorded only from the sites in front of the petrochemical plant, not from the sites on Skinflats. Taxon richness (the number of taxa recorded) was relatively low at each site (between 13 and 18 taxa) and the evenness score (which ranges from 0 – no evenness to 1 – complete evenness) show that the sites have a few dominant taxa. Taxon diversity (Simpson's Index, which takes into account taxon richness and evenness and ranges from 0 – infinite diversity to 1 – no diversity) was relatively high at all sites, 0.191 – 0.373.

The results of the sediment and infaunal analyses indicate that the intertidal benthic community at each of the five sites fit most closely with the *Hediste diversicolor* and *Limecola balthica* in littoral sandy mud biotope (LS.LMu.MEst.HedMac).

Table 4.12: Infaunal analyses of intertidal core samples (abundances are for combined replicates (i.e. 0.03m²)).

Taxon	Site 1	Site 2	Site 3	Site 4	Site 5
NEMERTEA	-	7	2	2	10
NEMATODA	155	102	10	269	125
<i>Pholoe</i> sp.	-	-	-	-	1
Eteoninae	24	26	33	22	73
<i>Eteone longa</i> agg.	-	-	-	-	1
Nereididae juv.	-	-	-	1	11
<i>Hediste diversicolor</i>	5	18	3	3	12
<i>Polydora</i> sp.	-	-	-	1	-
<i>Spio</i> sp.	-	-	-	1	-
<i>Streblospio</i> sp.	44	46	55	12	37
Cirratulidae	-	-	-	1	11
<i>Tharyx</i> sp.	-	-	10	1	76
<i>Tharyx killariensis</i>	-	-	-	-	11
<i>Heteromastus filiformis</i>	3	1	1	-	24
Naididae	1	-	2	-	-
<i>Paranais litoralis</i>	5	-	-	2	-
<i>Tubificoides</i> sp.	-	1	-	-	-
<i>Tubificoides benedii</i>	17	8	-	-	-
Enchytraeidae	-	-	1	14	-
Podocopida	4	17	-	-	-
<i>Corophium volutator</i>	55	-	1	8	1
Cephalaspidea	-	-	-	-	1
<i>Peringia ulvae</i>	331	268	113	139	253
<i>Limapontia</i> sp.	4	15	2	1	-
<i>Limapontia</i> juv.	7	18	1	3	1
Bivalvia sp.	-	-	-	-	4
<i>Limecola balthica</i>	23	73	14	18	57
Animalia eggs	Present	Present	Present	-	Present
Total	678	600	248	498	709
Taxon Richness	14	13	14	17	18
Evenness	0.609	0.696	0.622	0.488	0.698
Taxon Diversity (Simpson's Index)	0.304	0.253	0.278	0.373	0.191

4.6.4 Discussion

The mudflats around Kincardine are historically well studied and evidence of effects of pollution on the benthic community have been observed, however, improvements in effluents have corresponded with increased species diversity at Grangemouth between 1976 and 1999. Davis (2001) reported that in 1999 only the inner corner of the Grangemouth mudflat, adjacent to the refinery outfall, showed any impacts from the effluent with a lower number and diversity of species compared to the rest of the mudflat. Site 3 from the present study, which was located in the inner corner, did exhibit lower total abundance than all other sites. However, while taxon richness

was slightly lower than Sites 4 and 5 on the Grangemouth mudflat, it was similar to that recorded at Sites 1 and 2 on Skinflats. Davis (2001) also demonstrated that the benthic community of the upper shore around Grangemouth and Kinneil was less diverse and had lower abundances than the lower shore, suggesting that the abundances and diversity recorded in this study may be a conservative indication for the mudflat as a whole.

In context of the wider Forth Estuary, it is reported that 74% (4672.12ha) of the Firth of Forth Ramsar site is mudflat habitat (NatureScot, 2023b), with Skinflats, Grangemouth and Kinneil Kerse accounting for approximately 1,051ha of this. Indicative mudflat locations in the wider estuary (Bennet and McLeod, 1998; Marine Scotland, 2020; McLusky et al., 1993; Zoutenbier et al., 2016) are shown in Figure 19. Historic studies describe the shores of the upper estuary above Kincardine Bridge as narrow and organically enriched with high abundances of oligochaetes, while the middle estuary shores between the Kincardine and Forth bridges are the most productive, and the lower estuary has the greater species diversity but lower biomass (review by Bennet and McLeod, 1998). A comparison of the benthic community composition at Grangemouth and Kinneil against other mudflats, both within the Forth Estuary and around the UK found that Grangemouth and Kinneil were similar to other sites in the Forth and Montrose Basin, which was also classified as having Bad water quality (based on Environment Agency classifications) at the time (Davis, 2001). The community composition at Grangemouth and Kinneil differed from those estuaries with Good water quality classifications (such as the Loughour and Eden), with higher abundances of *Manayunkia aestuarina* at Grangemouth one of the main contributors. This opportunistic polychaete increased in abundance following a change in outfall locations at Grangemouth in the 1970s but was absent from the samples in this study. This may be an indication of further improvements in water quality around Grangemouth, but with a limited data set that cannot be said with confidence.

Biotope classifications for the intertidal areas of the Forth Estuary are not widely available for comparison. Studies conducted to inform the Environmental Statement for the Forth Replacement Crossing (Transport Scotland, 2009) identified extensive areas of sedimentary biotopes on both the northern and southern shores of the estuary, which were classified as the species-rich mixed sediment shores (LS.LMx.Mx) biotope and were dominated by the polychaetes *Pygospio elegans* and *Mediomastus fragilis* and the cockle *Cerastoderma* sp. An SNH survey in 2001 classified the intertidal mudflat areas between Cramond and the Forth Rail Bridge as *Hediste diversicolor* and *Limecola balthica* in littoral sandy mud (LS.LMu.MEst.HedMac) (Marine Scotland, 2020), the same biotope as identified at Skinflats and Grangemouth. Windylaw Bay, on the western side of Rosyth Dockyard was identified as a mosaic of intertidal habitats, with large areas of littoral sediment biotopes including polychaete/bivalve dominated mid estuarine mud shores (LS.LMu.MEst) (Jacobs, 2011). The biotope recorded by at Grangemouth and Skinflats is a sub-biotope of this overarching classification.

All of the taxa recorded in the present study are typical of intertidal estuarine mudflats and none are of particular note or conservation interest. The LS.LMu.MEst.HedMac biotope, is assessed as having high resilience to most pressures, meaning that full recovery will normally occur within two years after removal of the pressure (Tillin and Rayment, 2016). The characterising species of this biotope, *H. diversicolor* and *L. balthica*, have a reproductive lifecycle of one to two years and recovery of a habitat can occur through recovery of damaged individuals, adult migration from adjacent habitats or recolonisation of larvae. Lewis et al. (2002) found complete defaunation at one month following pipeline construction on intertidal mudflats in Clonakilty Bay, Ireland. However, six months after construction there was no significant difference between the construction site and the control sites, with *H. diversicolor* the first species to recolonise the area. Following managed realignment at Kennet Pans in 2007, benthic invertebrates (*Limecola*, *Corophium*, *Hediste* and *Hydrobia*) were found to have colonised the newly created habitat by the second winter post-construction (Dwyer, 2010). This suggests that areas of mudflat disturbed during the construction phase of the Scheme will be expected to recover quickly post-construction.

Of the dominant species recorded in this study, the molluscs *P. ulvae* and *L. balthica*, were indicated by Medonca et al. (2007) as potential preferred food sources for shorebirds in the Culbin Sands lagoon in the Moray Firth. It is therefore plausible that these species are also among the preferred prey items for several shorebirds in the Firth of Forth including bar-tailed godwit, knot, redshank and shelduck. These mollusc species have been recorded at similar abundances to Grangemouth in other areas of the Firth of Forth such as Torry Bay, Skinflats and Kincardine (Davis, 2001; McLusky et al., 1993).

4.7 Effects Pathways: Firth of Forth SPA and Ramsar Site

LSEs identified at Stage 1 (Screening) that might compromise the conservation objectives of the Firth of Forth SPA/ Ramsar site are:

- direct habitat loss; and
- disturbance and displacement (noise, vibration and visual) leading to indirect habitat loss.

4.7.1 Habitat Loss

Construction of the Scheme could result in the loss or localised fragmentation of foraging and roosting habitat. This could have a negative impact on birds that require the habitat and associated fauna for foraging, or rely on intertidal areas at the estuary edge as roosting habitat.

The Site Boundary for construction of the Scheme overlaps the SPA/Ramsar site for a total of 1.58ha. Of this, 0.43ha will be temporarily lost and 1.15ha will be permanently altered. Throughout the iterative design process, efforts have been made to reduce land take from the SPA. This includes altering the design of coastal revetment defences around the estuary edge from a 1:3 slope to a 1:1.5 slope and minimising the construction area available to only what is required to feasibly facilitate plant movement and construction.

4.7.1.1 Temporary Habitat Loss

Construction of the Scheme will result in the temporary loss of 0.43ha of SPA habitat. This area will be restored, and the upper shore habitat allowed to recolonise post construction. Of the 0.43ha, the UK Habitat Classification survey conducted for the Scheme identified that 0.27ha is marine inlets and transitional waters comprising mudflats (0.25ha), saltmarsh (0.02ha) and beach (<0.01ha) (collectively shown as UK Habitat type t in Diagram 4.1 below). The remaining 0.16ha of SPA habitat lost under the temporary footprint of the Scheme is made up of urban areas, wetland, grassland and river habitat (Diagram 4.1).

Mudflat habitats are an important foraging resource for many qualifying species of the SPA. The mudflat habitat that will be lost is widespread throughout the estuary. The biotope survey (Section 4.6) found that the intertidal mudflat areas in proximity to the Scheme fit most closely with the *Hediste diversicolor* and *Limecola balthica* in littoral sandy mud biotope and is not of conservation interest or of particular note with regards to previously reported communities in the Forth Estuary. This aligns with the findings of Davis (2001) and Bennet and McLeod (1998) who demonstrated that the benthic community of the upper shore around Grangemouth and Kinneil was less diverse and lower in abundances than the lower shore. This biotope is assessed as having high resilience to most pressures and therefore, where temporary impacts are predicted, full recovery can be expected within two years after removal of the pressure. Due to the resiliency of the mudflat habitats, minimal usage by roosting or foraging birds compared to other much more heavily used areas, and widespread availability of this habitat within the estuary, temporary loss of 0.25ha will not adversely impact qualifying species.

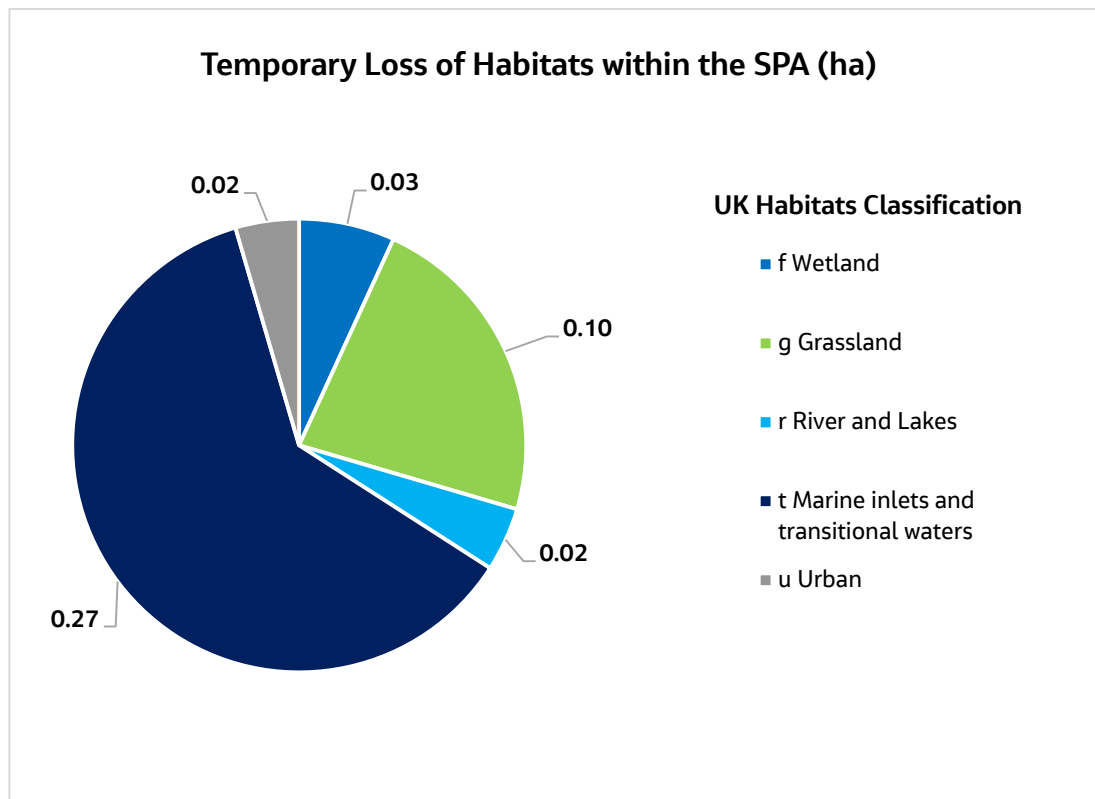


Diagram 4.1: Habitats within the SPA temporarily lost during construction of the Scheme.

4.7.1.2 Permanent Habitat Alteration

Permanent habitat alteration from the SPA has been identified as all land under the permanent footprint of the Scheme which overlaps with the Firth of Forth SPA and Ramsar boundary. The current design would result in the permanent alteration of 1.15ha of SPA and Ramsar habitat: the areas permanently altered are shown on Figure 21 and are broken down by Flood Cell in Table 4.13.

In Flood Cell 6, this includes areas of SPA habitat that will be permanently altered as a result of ground improvement works (see Section 2.4.4.2). In locations where access is restricted in Flood Cell 6, permanent habitat loss also includes the provision of a 3m wide permanent access track to be constructed on the dry side of the defence. The exact location of the access track is currently unknown but will be constructed between the flood wall and the pipelines.

Table 4.13: Permanent habitat loss/alteration within the SPA by Flood Cell.

Flood Cell	Location	Area (ha)
3	Very small areas adjacent to North Shore Road and adjacent to the lock gate, within the Port of Grangemouth.	0.10
5	Adjacent to the petrochemical plant fenceline in Working Area 5-1 (Mouth of the River Avon).	<0.01
6	Adjacent to the petrochemical plant fenceline in Working Areas 6-1 (Beech Road) and 6-2 (Petroineos Mouth of River Avon).	1.04
Total		1.15

Of the 1.15ha, 0.89ha is marine inlets and transitional waters comprising mudflats (0.59ha), saltmarsh (0.25ha) and beach (0.05ha) as detailed in the UK Habitat Classification survey data collected for the Scheme (collectively

shown as Habitat type t in Diagram 4.2 below). The remaining 0.26ha of SPA habitat lost under the permanent footprint of the Scheme is made up of urban areas, wetland, grassland and river habitat (Diagram 4.2).

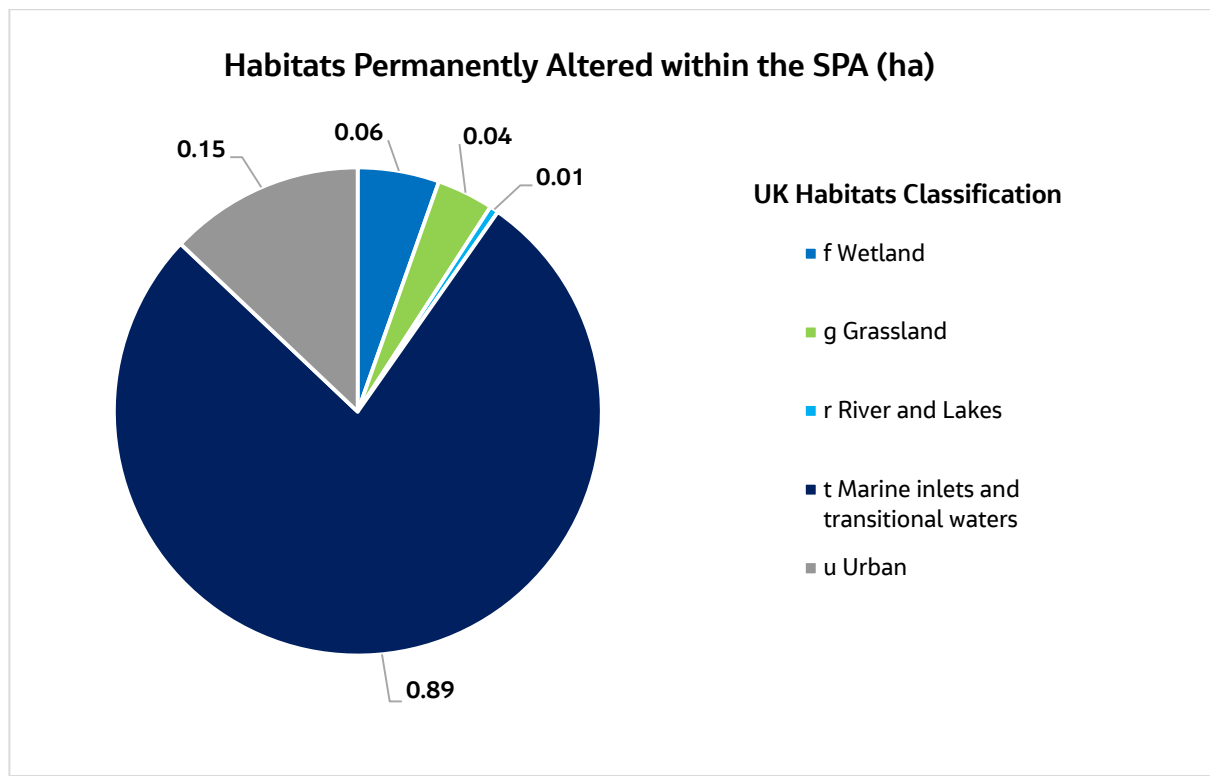


Diagram 4.2: Habitat types within the SPA permanently altered under the footprint of the Scheme.

4.7.1.3 Habitat Utilised by Qualifying Species

To assist in determining whether the temporary and permanent habitat alterations would impact the qualifying species, the bird survey data has been utilised to identify which qualifying species have been recorded within the SPA areas that fall within the temporary Site Boundary (Table 4.14) and permanent footprint of the Scheme (Table 4.15). The majority of records were along the shore to the east of the petrochemical plant.

Figure 20 identifies the location of peak counts for each species within the area where the Site Boundary temporarily encroaches upon the SPA during construction. Figure 21 identifies the location of peak counts within the SPA habitat that will be permanently altered. The number of birds recorded in these peak counts is also provided on each figure – the information on Figures 20 and 21, aligns with the peak counts for each species in Table 4.14 and Table 4.15 respectively.

Within the habitat unavailable during construction, eight qualifying species were recorded roosting and foraging: cormorant, dunlin, knot, lapwing, mallard, redshank, shelduck and wigeon (Figure 20). Knot was only recorded during the 2015/16 and 2016/17 surveys, whilst wigeon was only recorded during the 2022/23 surveys. The remaining six species were recorded in both surveys.

Within the habitat permanently altered habitat, the same eight qualifying species were recorded. Cormorant, knot and lapwing were only recorded during the 2015/16 and 2016/17 surveys, whilst mallard and wigeon were only recorded during the 2022/23 surveys (Figure 21).

The data identifies that birds of certain species do make some use of the areas that will be temporarily unavailable or permanently altered. Numbers are generally low and relate mainly to high tide records, indicating roosting behaviour. The data also show that relatively large numbers of dunlin can occasionally turn up to roost in these locations. However, as the records are 'point' records, the size of the area occupied by the large dunlin flock (and some other flocks) most likely spreads out into areas of unaffected habitat – the peak counts in some instances

show higher numbers of birds than actually make use of the affected areas. The proportion of estuary edge habitat directly affected is very small compared to the extent of suitable available alternative habitat nearby, and the revetment wall will itself offer roosting opportunities for birds.

Rock armour revetment defences will be implemented in areas north and east of the petrochemical plant (see Figure 7 for design information), which will provide roosting opportunities for the majority of qualifying species.

Table 4.14: Peak counts of qualifying species recorded within SPA habitat that the Scheme will temporarily encroach upon during construction. Peak counts of 2015/16 and 2016/17 survey data shown in white rows and peak counts for 2022/23 survey data are shown in green rows.

Species	Peak Count	% of Cited SPA Population	Month	Year	Sector	Tide
Cormorant	6	0.88	March	2017	10	Rising
Cormorant	11	1.61	August	2022	6	Rising
Dunlin	8000	84.09	December	2016	10	High
Dunlin	1	0.01	January	2023	10	High
Knot	40	0.43	December	2015	10	High
Knot	0	N/A	N/A	N/A	N/A	N/A
Lapwing	75	1.81	January	2017	10	High
Lapwing	35	0.84	August	2022	6	Rising
Mallard	20	0.78	January	2016	10	Rising
Mallard	4	0.16	March	2023	9	High
Redshank	266	6.13	February	2017	10	High
Redshank	165	3.80	February	2023	10	High
Shelduck	168	3.73	September	2016	9	Low
Shelduck	2	0.04	March	2023	9	High
Wigeon	0	N/A	N/A	N/A	N/A	N/A
Wigeon	12	0.56	January	2023	12	Rising

Table 4.15: Peak counts of qualifying species recorded within SPA habitat that will be permanently altered. Peak counts of 2015/16 and 2016/17 survey data shown in white rows and peak counts for 2022/23 survey data are shown in green rows.

Species	Peak Count	% of Cited SPA Population	Month	Year	Sector	Tide
Cormorant	6	0.88	March	2017	10	Rising
Cormorant	0	N/A	N/A	N/A	N/A	N/A
Dunlin	8000	84.09	December	2016	10	High
Dunlin	1	0.01	January	2023	10	High
Knot	40	0.43	December	2015	10	High
Knot	0	N/A	N/A	N/A	N/A	N/A
Lapwing	75	1.81	January	2017	10	High
Lapwing	0	N/A	N/A	N/A	N/A	N/A
Mallard	0	N/A	N/A	N/A	N/A	N/A
Mallard	2	0.08	March	2023	9	High
Redshank	266	6.13	February	2017	10	High
Redshank	165	3.80	February	2023	10	High
Shelduck	168	3.73	September	2016	9	Low
Shelduck	2	0.04	March	2023	9	High
Wigeon	0	N/A	N/A	N/A	N/A	N/A
Wigeon	12	0.56	January	2023	12	Rising

4.7.2 Disturbance

Unlike the direct impacts associated with habitat removal or deterioration, disturbance does not directly affect the physical conditions of a site; it concerns the species and it may be limited in time (noise, source of light etc.). The intensity, duration and frequency of repetition of disturbance are therefore important parameters in the implications for species from the disturbance stimuli.

The overall objective of the Birds Directive is that '*Member States shall take the requisite measures to maintain the population of the species...at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level.*' This can be interpreted as being equivalent to favourable conservation status of a species, as

a key measure for achieving favourable conservation status is the European site network, which includes SPAs designated under the Birds Directive (JNCC, 2018). Therefore, to assess whether a disturbance is significant in relation to the conservation objectives of the site, reference can be made to the definition of the favourable conservation status of a species given in Article 1(i), on the basis of the factors below.

- *'Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable element of its natural habitats'.*
- Any event, activity or process contributing to the long-term decline of the population of the species on the site can be regarded as a significant disturbance.
- *'The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future'.*

Any short, medium or long-term event, activity or process contributing to the reduction or to the risk of reduction of the range of a species within the site can be regarded as a disturbance and any event, activity or process contributing to the reduction of the size of the available habitat of the species can also be regarded as a disturbance. However, whether these disturbances would affect the population in the long term is dependent on whether there is, and will continue to be, a sufficiently large area of habitat to maintain its populations on a long-term basis.

Factors such as intensity, frequency and duration of the disturbance may be taken into account to determine its significance, which may vary from one species to another and according to different times and different conditions (e.g. food resources, or through the presence of sufficient undisturbed areas nearby). In that regard, for the Firth of Forth SPA, effects such as noise, vibrations and visual stimuli from the construction of the Scheme are capable of causing significant disturbances for the qualifying bird species. Any long-term effects from such disturbance can be related to the:

- timing of the disturbance in the context of the life cycle of the species;
- susceptibility of a species to disturbance and implications for fitness and fecundity from this susceptibility;
- functional importance of the habitat disturbed to the species affected; and
- in combination effects not just with other plans and projects but environmental factors such as severe weather events.

To understand the implications of the identified disturbance LSEs from construction and operation (maintenance activities) of the Scheme, they are being considered in the context of the site's conservation objectives and its contribution to the coherence of the network. For the disturbance from construction to have no AESI, the disturbance of a species from a short, medium or long-term effect must not compromise the other conservation objectives, which may include leading to a long-term change in the:

- population of the species as a viable component of the site (dependant on magnitude of change);
- distribution of the species within the site; and/or
- distribution and extent of habitats supporting the species.

Noise, vibration and visual effects (human and vehicle/plant movements) during construction and maintenance activities have the potential to cause disturbance and displacement of qualifying species of the Firth of Forth SPA present within the Zol. Although studies have shown that certain bird species have the ability to habituate to regular noises and visual disturbances, potential long-term effects of disrupted foraging and roosting behaviour could lead to decreased body condition and a reduction in reproductive success and individual survival (Smit and Visser, 1993).

In terms of foraging habitat, displacement from feeding opportunities not only reduces a bird's energy intake but may also lead to an increase in stress and energy expenditure as a result of the energetic costs of flying to alternative foraging areas (Johnston et al., 2013). Displacement could also have knock-on ecological effects such as increased competition (within and/or between different species) for a common food source. Should areas be

subject to heavy or on-going disturbance, waterbirds could be disturbed so frequently that their displacement essentiality results in temporary habitat loss from that area (National Parks and Wildlife Service, 2014).

Waders are particularly vulnerable to disturbance whilst roosting during high tide (Dias et al., 2006; Whitfield et al., 2008; Catry et al., 2011; Glover et al., 2011). When disturbance effects reduce species fitness (reduced survival or reproductive success), consequences at population level may result. At certain times of year (i.e. during cold spells in the winter) the effect of this could be particularly severe, potentially resulting in bird mortality. If birds are repeatedly reacting to disturbance, over time body condition could decrease affecting mortality, emigration and reproductive success and could result in short- and/or long-term individual and population implications.

Several studies have identified different disturbance responses of bird species, linked to the type of disturbance stimuli, the bird community present and their activity, the extent and topography of the site, the time of year and weather conditions (Cutts and Allen, 1999). The hearing frequency range of birds is similar to that of humans, between 20 and 20,000Hz. Various studies show birds react to noise levels varying from 42dBA to 117dBA. Bird response to construction activity is variable, with minimum distances to disturbance from as low as 50m up to 500m (Cutts and Allen, 1999). A study by Linssen et al. (2019) found that the total distance travelled by roosting oystercatchers during a high tide period after disturbance ranged from 1km – 2.9km. This study also found that although travel distance increased during a high tide disturbance event, daily energy expenditure was only marginally affected.

Generic waterbird responses to disturbance from a range of activities including construction work have been collated and summarised in Table 4.16 and are based on observations of construction studies on the Humber Estuary (Cutts and Allen, 1999; Cutts et al., 2013).

Table 4.16: Disturbance effects on wintering estuarine birds from various construction and maintenance activities.

Activity Description	Disturbance Effect
Personnel and plant on mudflat	High
Third party on mudflat	High
Personnel and plant on seaward toe and face	High to Moderate
Intermittent plant and personnel on crest	High to Moderate
Third party on bank	High to Moderate
Irregular piling noise (above 70db)	High to Moderate
Long-term plant and personnel on crest	Moderate
Regular piling noise (above 70db)	Moderate
Irregular piling noise (50db – 70db)	Moderate
Regular noise (50db – 70db)	Moderate to Low
Occasional movement of crane	Moderate to Low
Noise below 50db	Low
Long-term plant only on crest	Low
Activity behind flood bank (inland)	Low

Disturbance effects were researched within the Forth estuary during construction of the Clackmannanshire Bridge (Dwyer, 2010) with the subsequent findings of the research used to inform the assessment of severity of disturbance effects during construction and maintenance of the Scheme. The project involved the construction of a bridge directly impacting mudflat and saltmarsh habitat utilised by birds associated with the Firth of Forth SPA. The observed responses varied between species: dunlin, curlew shelduck, wigeon, red-breasted merganser and

goldeneye numbers increased in the study area; knot, oystercatcher, and pink-footed goose showed no significant changes in numbers; and redshank, bar-tailed godwit, cormorant and lapwing showed a decrease in numbers close to the construction area. The increase in numbers for some species was attributed to the creation of new areas of habitat as part of mitigation for the project including increased nocturnal foraging ability for some species during tidal cycles as a result of construction lighting which would have otherwise been avoided.

Dwyer (2010) observed that birds in areas affected by construction noise over the estuary showed increased vigilance – thought to be a response to the construction noise masking the detection of predators. This resulted in a 19% reduction in redshank foraging time at one site. Similar effects were also noted in response to construction work on the Stirling-Alloa-Kincardine Railway (Dwyer, 2010) where reductions in foraging time were noted in response to increased vigilance to workers and vehicles on the railway (from 38% in 2008/09 to 19% in 2007/08). Additionally, juvenile redshank numbers decreased at high productivity feeding areas that were subject to disturbance during construction of the Clackmannanshire Bridge, in favour of areas further away with lower prey availability, for example at Kinneil shore. The areas which showed an increase in bird density had a lower carrying capacity for birds resulting in increased competition (within and/or between different species) for a common food source. Kincardine shore was used later in the winter due to low prey and high predation risk but was used earlier in the season during construction winters as a result of preferred habitat not being available for foraging and thus forcing birds to utilise less optimal habitat (i.e. habitat with less prey availability for foraging and within which there was a greater risk of predation along Kincardine shore).

The effects in this study appeared to be short-term (i.e. just the duration of the construction) and not impacting at the population level; numbers of redshank in the Forth were considered to have recovered in the first winter following completion of the bridge. Birds can show a variety of other responses to compensate for reduced feeding opportunities in disturbed areas: in the Forth, redshank and shelduck have been observed to increase their foraging time at mid and low tides, and shelduck also spent more time feeding in the water than on land.

Analysis of the Scheme's bird data show that there are large numbers of birds of a high diversity of species roosting within the Zol during the winter. Key roost areas that fall within the Zol are the rocky breakwater west of the Port of Grangemouth and the estuary edge north of the petrochemical plant (the sheltered bay). Bird species present at these locations especially could be impacted during the construction.

Birds were infrequently recorded within the Zol during low tide, as the preferred foraging habitat (notably mudflats at Kinneil Kerse and Skinflats) are outwith the Zol. One exception is an area at the mouth of the River Avon where birds were recorded foraging on over 150 occasions across the three survey periods. Davies (2001) demonstrated that the benthic community of the upper shore around Grangemouth and Kinneil was less diverse and with lower abundances than the lower shore which would further explain the infrequent observations of foraging birds in this location. Given the considerable area of alternative foraging habitat in close proximity to the site the potential for impacts on foraging birds at low tide is considered low. The main impacts from disturbance will be on roosting birds at high tide when birds have no choice but to move to supratidal (above the spring high tide line) roosts and are therefore at their most vulnerable, given the reduced amount of alternative habitat available at high tide.

The noise monitoring assessment shows where acceptable noise levels (≤ 70 dB) will be experienced for six phases of construction. Construction noise levels are predicted to attenuate to 70dB at 45m for embankment construction, 41m for sheet pile walls, and at 30m for coastal revetment works (Figures 15, 16 and 18) – the noisiest activities adjacent to the estuary. Large aggregations of birds were recorded at four locations; Bothkennar Pools (more than 300 from Scheme), the breakwater adjacent to the port (more than 50m from Scheme), the sheltered bay adjacent to the petrochemical plant (more than 50m from the Scheme) and the mudflats and creeks at the mouth of the River Avon. During the noise monitoring of GI works noise levels of up to 76dB were recorded along the estuary edge during a range of ground investigation activities. No noise and visual barriers were installed during this phase of GI works, yet bird monitoring undertaken in tandem with the GI noise monitoring noted that birds roosting on the breakwater had no observable reaction to noise generated by the works. There were occasional reactions to specific noise events by birds elsewhere along the estuary edge, but no birds flew more than 30m from the disturbance. Noise levels higher than 70dB are not predicted at Bothkennar Pools, the breakwater or the sheltered bay areas which contain large aggregations of birds. At the mouth of the River Avon,

only birds within 30m of the coastal revetment works could potentially be disturbed. Therefore, this further demonstrates that a Zol of 300m from works is precautionary in the context of noise disturbance.

4.8 Effects Pathways: Loch Leven SPA and Ramsar site

LSEs identified at Stage 1 (Screening) that might compromise the conservation objectives of the Loch Leven SPA/Ramsar site include:

- direct habitat loss; and
- disturbance and displacement (noise, vibration and visual) leading to indirect habitat loss.

4.8.1 Habitat Loss

No land-take from Loch Leven SPA/Ramsar site is required for the Scheme. However, the Scheme has the potential for temporary habitat loss of up to 0.43ha, of which 0.25ha is mudflat habitat, within the Forth estuary. The Scheme could result in the permanent alteration of up to 1.15ha within the Forth estuary, of which 0.59ha is mudflat habitat. The loss of this supporting habitat may result in localised fragmentation/loss of habitat for qualifying species of the SPA should they utilise the Firth of Forth. Cormorant is known travel between Loch Leven and other sites, including the Firth of Forth (Wright, 2003). No other individuals of the qualifying species of Loch Leven SPA are known to travel between Loch Leven and the Firth of Forth.

The habitat lost would be proportionally small in comparison to the alternative habitat available in the Forth estuary for those species that could be affected. Studies have shown that cormorant regularly travel 45km with occasional journeys further afield (Wright, 2003) and can therefore utilise other sites.

4.8.2 Disturbance

None of the qualifying species will be disturbed as a result of the Scheme whilst wintering on Loch Leven. Cormorant may be disturbed if visiting the Firth of Forth from Loch Leven; however, individuals will be able to utilise the widely available alternative habitat in the Forth Estuary.

4.9 Assessment of Impacts

Table 4.18 assesses the potential impacts of habitat loss and disturbance/displacement identified from the Scheme on qualifying species. Species which were not recorded within the Zol (common scoter) or study area (Slavonian grebe, long-tailed duck and velvet scoter) are not included in the assessment as no LSEs have been identified.

Habitat loss was considered in relation to the following conservation objectives of the Firth of Forth/Loch Leven SPA:

- To avoid deterioration of the habitats of the qualifying interests or significant disturbance to the qualifying interests, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying interests that the following are maintained in the long term:
 - distribution of the species within site;
 - distribution and extent of habitats supporting the species.

Disturbance/displacement was considered in relation to the following conservation objectives of the Firth of Forth/Loch Leven SPA:

- To avoid deterioration of the habitats of the qualifying interests or significant disturbance to the qualifying interests, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying interests that the following are maintained in the long term:
 - population of the species as a viable component of the site;

- distribution of the species within site;
- no significant disturbance of the species.

The potential physical and ecological effects of the Scheme were assessed to understand their implications for the conservation objectives of the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar site to understand whether either site's integrity could be compromised. Cormorant are considered the only qualifying species of the Loch Leven SPA/Ramsar site that could be affected by the Scheme as they are known to travel to the Firth of Forth. As cormorant are also a qualifying species of the Firth of Forth SPA, and the conservation objectives of the two sites are the same, the assessment of impacts text will focus on the Firth of Forth SPA.

A total of 23 species were identified within the ZOI for the Scheme, for which there is a potential for LSE (or the potential for LSE cannot be excluded). For a conclusion of no adverse effects on site integrity the impacts identified must not alter the maintenance of the population of the species as a viable component of the site, the distribution of the species within site, the distribution and extent of habitats supporting the species, the structure, function and supporting processes of habitats supporting the species and ensure no significant disturbance of the species occurs.

How the area of habitat permanently or temporarily lost is used prior to construction, and if it could be utilised in a similar way post construction, will be considered to determine the implications of habitat loss on site integrity.

The implications of disturbance for site integrity is dependent on a number of factors:

- location or the distance of the development from the species of interest;
- habituation of birds to existing disturbance; and
- timing of the development.

In addition, the following was considered in the assessment:

- the number of birds displaced from the ZOI as a result of the works and to what distance, e.g. small localised movement within the SPA or movement out of the SPA. The number of birds has been represented as a percentage of the SPA population to help highlight important numbers and key locations; however, it is recognised that all qualifying species carry the same level of protection regardless of the numbers present;
- the duration of time the displaced birds are likely to be affected at the most sensitive time e.g. during the high tide period;
- the number of times displacement will likely occur, i.e. will the displacement occur constantly throughout the day or infrequently; and
- the results of the GI noise monitoring.

4.10 Mitigation

Mitigation measures aimed at avoiding or reducing adverse effects on site integrity as a result of the Scheme are detailed in Table 4.17 and key mitigation items are also summarised within Table 4.18 for each applicable qualifying feature.

Whilst some of these mitigation measures broadly align with measures included within Chapter 10 (Biodiversity) and Chapter 16 (Schedule of Environmental Commitments) of the EIA Report, mitigation presented in this document is specifically required to address potential adverse effects identified within the HRA. Falkirk Council, as the Competent Authority for the HRA, shall ensure that all mitigation or compensatory measures finalised through the HRA process form part of the Scheme construction specifications (with any additional measures identified through HRA being conditioned as part of the deemed planning consenting process on Scheme confirmation).

The application of standard mitigation commitments, legislative requirements and industry standard best practice (e.g. mitigation of potential pollution impacts through adherence to standard best practice and guidelines, such

as the SEPA Guidance for Pollution Prevention (GPPs) and Pollution Prevention Guidelines (PPGs)) (Netregs 2023) will also assist in avoiding or reducing potential adverse effects on site integrity of the Firth of Forth SPA/Ramsar site.

With regards to Mitigation Item HRA10, viewsheds have been undertaken to identify the most effective screen height, which was then considered against practicality. For example, a 4m screen would block most, if not all, of the works from view of the birds. However, maintaining this height of screen along an exposed estuary would be difficult and create potential health and safety issues during high winds. Therefore, a 2m noise and visual barrier screen will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay and will remain in place for the duration of the works. Viewshed analysis shows that screens of this height reduce visibility from the works area, especially when works are taking place 'in-water' along the edge of the estuary. It is accepted that this height of screen will not conceal all activities and the top of some construction machinery will be visible, such as piling rigs and excavator arms. As noted in Section 4.4, no noise and visual barriers were installed during Phase 5 of the GI works and disturbance recorded was minimal. Noise and visual barriers 2m in height were installed as mitigation during later phases of the Scheme GI works that were conducted adjacent to the estuary in Flood Cells 2 and 6: ecologists on site during works did not observe any potentially disturbing events during the GI works that caused birds to fly away from the area. There is likely to be some level of habituation to existing activities that are taking place along North Shore Road around the Port of Grangemouth and within the petrochemical plant.

Table 4.17: Mitigation measures to avoid or reduce potential for adverse effects on the European sites network

Mitigation Item	Timing of Measure	Description	Purpose / Objective
HRA1	Pre-construction phase	An Outline Construction Environmental Management Plan (CEMP) will be prepared and made available prior to confirmation of the Scheme. Prior to construction the contractor will develop, update, and maintain the CEMP, which must be approved by Falkirk Council. The CEMP will include an Ecological Management Plan (EMP). The contractor will develop the EMP in consultation with the relevant stakeholders, including NatureScot. The EMP will include Species Management Plans which, as a minimum, will include the following: - the scope of pre-construction surveys required to verify and, where required, update the baseline ecological conditions set out in this HRA. The scope of these surveys will be confirmed with Falkirk Council (and NatureScot where required) prior to them being undertaken. - details of proposed mitigation measures and any required exclusion zones to avoid or reduce potential impacts on the qualifying species and any unnecessary encroachment into adjoining areas of the Firth of Forth SPA/Ramsar site. - restrictions on the timing of construction works to avoid or reduce impacts on the qualifying species of the Firth of Forth SPA/Ramsar site. (HRA5 provides some additional details) - appropriate watching briefs during construction as detailed in the role and expectation of the ECoW. - details of proposed post-construction monitoring requirements to ensure mitigation measures are implemented and are functioning as expected during	To ensure compliance with legislation and commitments within this HRA.

		the operational phase. The EMP will be informed by pre-construction surveys and updated as appropriate with additional mitigation measures where required. The EMP will also include a Landscape and Ecological Habitat Management Plan (LEHMP).	
HRA2	Pre-construction phase/ Construction phase	Monitoring surveys will be undertaken by the employer's ecologist across Sectors 4-11 for the winter period prior to construction works adjacent to the Firth of Forth SPA/Ramsar site. Surveys are expected to follow the Through the Tide Count (TTC) method, but the exact survey method will be determined prior to commencement, in consultation with NatureScot.	To update the baseline data collected for the Scheme, which can then be used to monitor bird responses to construction activities.
HRA3	Pre-construction phase/ Construction phase	Prior to construction a suitably qualified (or team of suitably qualified) ECoW will be appointed by the Contractor and will be responsible for implementation of an Ecological Management Plan. The ECoW will: - provide ecological advice over the entire construction programme; - undertake or oversee a bird watching brief for works conducted in the vicinity of the Firth of Forth SPA/Ramsar site. See HRA7 for more details. (Separate construction monitoring is detailed in HRA8 and pre-construction monitoring is detailed in HRA2); - ensure mitigation measures are implemented to avoid and reduce impacts on qualifying species; and - monitor the implementation of the mitigation measures during the construction phase to ensure compliance with legislation, and commitments within this HRA and the EIA Report for the Scheme. The ECoW will be a member of the Chartered Institute of Ecology and Environmental Management (CIEEM) and will have previous experience in similar ECoW roles. All ECoWs will be approved by Falkirk Council to be appropriately qualified for the role and compliance will be monitored by an employer's ecologist acting on behalf of Falkirk Council. The ECoW will be appointed in advance of the main construction programme commencing to ensure any advance mitigation measures required are implemented, in collaboration with the employer's ecologist.	To ensure compliance with legislation and commitments within this HRA.
HRA4	Pre-construction phase/ Construction phase	Any temporary lighting arrangements installed for the construction phase will be designed to ensure minimal light spill outwith the boundary of the construction sites and associated site compounds. The ECoW will monitor construction site lighting to identify any potential adverse impacts on birds. Preventative measures (e.g. installation of shields) will be taken if any adverse impacts are detected.	To avoid or reduce light disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.
HRA5	Construction phase	Any works undertaken adjacent to the Firth of Forth SPA/Ramsar site within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between.	To avoid or reduce noise and visual disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.
HRA7	Construction phase	The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site to observe construction activities and any notable reaction of the qualifying species as a result of these.	To determine if there is any notable disturbance to qualifying features of the Firth of Forth SPA/Ramsar site and

		The ECoW will determine when to stop works and the potential requirement for any further mitigation in line with those outlined in the Bird Species Management Plan. Whilst significant disturbance to birds during works will be avoided where possible, it is acknowledged that disturbance could occur during construction; therefore, compensatory habitat has been provided.	implement appropriate mitigation where necessary.
HRA8	Construction phase	During construction, each winter where there are works adjacent to the Firth of Forth SPA/Ramsar site, monthly monitoring surveys will be undertaken by the employer's ecologist across Sectors 4-11. Surveys are expected to follow the Through the Tide Count (TTC) method, but the exact survey method will be determined prior to commencement, in consultation with NatureScot.	To compare survey results with baseline data and determine if there are any changes in abundance and distribution of SPA qualifying species within Sectors 4 – 11.
HRA9	Construction phase	Plant and personnel will be constrained to a prescribed working corridor to minimise the damage to habitats and potential direct mortality and disturbance to birds located adjacent to the Scheme Site Boundary.	To avoid or reduce habitat loss and disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.
HRA10	Construction phase	Where safe to do so, 2m noise and visual barrier screens will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay. The barriers must be appropriately positioned to help reduce noise and visual disturbance and will remain in place for the duration of works in these areas.	To avoid or reduce noise and visual disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.
HRA11	Construction phase	Within 300m of the Firth of Forth SPA, the ECoW will advise the contractor where a 'soft-start' to machinery is required to avoid sudden and unexpected disturbance during construction. Each time machinery 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. For the first seven days after the commencement of works in each area, the soft-start must be applied each time the machinery is stopped, even if this is only for very short periods. Subject to ECoW assessment of bird responses to the activity, the duration of periods of inactivity requiring a soft-start will be increased incrementally over this seven-day period and after seven days a soft-start will only be required at the start of works each day or after an extended period of inactivity.	To avoid or reduce noise and vibration disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.
HRA12	Construction/ Post-construction	On completion of the works all temporary access tracks and working platforms will be removed in their entirety from the SPA.	To ensure compliance with legislation and commitments within this HRA.
HRA13	Post-construction	The LEHMP will include measures to reduce damage and restore the intertidal areas temporarily lost. Post-construction monitoring will be undertaken, in accordance with the LEHMP, to demonstrate effectiveness of the restoration.	To ensure compliance with legislation and commitments within this HRA.

Table 4.18: Stage 2 Appropriate Assessment table of impacts for qualifying species

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
Bar-tailed godwit	<u>Habitat Loss</u> Bar-tailed godwit was not recorded under the permanent or temporary habitat loss footprint during surveys. The absence of the species under the footprint of the Scheme and records of bar-tailed godwit elsewhere within the survey areas suggests that the birds favour other areas within the Firth of Forth SPA/Ramsar site. Therefore, the area lost as a result of the Scheme is not functionally important supporting habitat for this species and no impacts on bar-tailed godwit are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required: bar-tailed godwit was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Bar-tailed godwit was recorded within the Zol frequently at high tide. The primary areas of roosting were at the mouth of the River Avon, in Kinneil Lagoons and north of the petrochemical plant (sheltered bay). A peak count of 480 birds (24% of the cited SPA population) was recorded at high tide roosting north of the petrochemical plant. Bar-tailed godwit are sensitive to disturbance, especially at roost sites (Woodward et al., 2015). Given the large aggregations that roost at several hotspots within the Zol, displacement due to noise and visual stimuli during construction is likely to occur, which could alter the distribution of the species within the site. Bar-tailed godwit roosts within 300m of works may be subject to disturbance and displacement during construction and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme, and therefore the population of the species as a viable component of the site will not be impacted.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: - Any temporary lighting will be designed to ensure minimal light spill (HRA4). - Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
		In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Bar-tailed godwit was recorded foraging on multiple occasions within the Zol, with most activity recorded in Sectors 9 and 10. A peak count of 360 birds (18% of the cited SPA population) was recorded at the mouth of the River Avon. Bar-tailed godwit utilise the intertidal sand and mudflats within the SPA to forage for their preferred prey of bivalves such as <i>Macoma balthica</i>, <i>Scrobicularia plana</i> and <i>Mya arenaria</i>. At some sites, polychaete worms form a larger proportion of the diet and the species is relatively adaptable, utilising other habitats for foraging where available, such as terrestrial grassland, coastal marshes and freshwater lagoons (Woodward et al., 2015). These birds are considered to have a high site fidelity, but small numbers will move sites within or between winters. As there is alternative suitable habitat within the estuary for bar-tailed godwit to feed, no impacts are predicted on foraging bar-tailed godwit, in relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to bar-tailed godwit would remove impacts that could compromise the conservation objectives for foraging bar-tailed godwit.	No potential for AESI
Cormorant	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Cormorant was recorded under the temporary habitat loss footprint on four occasions during high and rising tides (peak count of 11 birds). Cormorant was also recorded within the wider survey area. They are widespread and common within the Firth of Forth and make use of structures such as buoys, breakwaters, walls and rocks when roosting. Given the low numbers recorded infrequently under the Scheme footprint, the habitats lost either temporarily or permanently as a result of the Scheme are not considered to be functionally important for cormorant, and no impacts on cormorant are predicted in relation to habitat loss.	No mitigation is required. However, to ensure that the conservation objectives for cormorant are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of cormorant and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Cormorant was recorded roosting most frequently within Sectors 6 and 7, making use of the breakwater and structures around the entrance to the Port of Grangemouth. The area that could potentially be disturbed by works would be proportionally small in comparison to the area these birds typically utilise. Cormorant tolerate high levels of human activity and the presence of artificial structures (McKay et al., 1999; Dierschke et al., 2016) so are less vulnerable to noise and visual disturbance. Given the high mobility, opportunistic use of a large number of different sites for roosting, and low sensitivity to human activity and artificial structures, it is highly unlikely that construction work associated with the Scheme would affect the natural patterns of movement and distribution of cormorant. No impacts on roosting cormorant are predicted in relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for roosting cormorant.	No potential for AESI
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Cormorant feed in open water and are highly mobile during the non-breeding season. Tracked individuals have been recorded making extensive journeys (up to 45km) between sites throughout Scotland depending on food availability (Forrester et al., 2007), moving not only between estuaries but also between coastal and inland feeding sites. Tracking identified that cormorant wintering on the Firth of Forth typically roost at Loch Leven but can forage in areas up to 50km from that site, including the Firth of Forth and many other sites (Wright, 2003). The habitat potentially disturbed would be proportionally small in comparison to the area these birds typically utilise. Given the high mobility, opportunistic use of a large number of different foraging areas (both within and outside of the SPA) and low sensitivity to human activity, it is unlikely that construction of the Scheme would affect the natural patterns of movement and distribution of cormorants.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging cormorant.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	No impacts on foraging cormorant are predicted in relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.		
Curlew	<u>Habitat Loss</u> Curlew was not recorded under the permanent or temporary habitat loss footprint during surveys. The absence of the species during surveys suggests that there are other areas within the SPA/Ramsar site favoured by curlew during the winter, and that the area lost as a result of the Scheme is not functionally important supporting habitat for this species. No impacts on curlew are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required: curlew was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Curlew was recorded within the ZOI frequently at high tide. The primary areas of roosting were at the mouth of the River Avon, in Kinneil Lagoons and north of the petrochemical plant (sheltered bay). A peak count of 430 birds (22% of the cited SPA population) was recorded at high tide roosting in Kinneil Lagoons. Generally, curlew roost communally, usually along salt marshes and sand banks (Berg, 1993). Given the large aggregations that roost at several hotspots within the ZOI, displacement due to noise and visual stimuli during construction is likely to occur, which could alter the distribution of the species within the site. Disturbance and displacement of roosting birds within 650m of works is possible at high tide (i.e. for short periods) during construction and also potentially during maintenance works. Studies have indicated that curlew are wary of moderate and high-level visual disturbances and do not habituate to works quickly. They can be intolerant of people, allowing an approximate approach range of 120m-300m before flushing when confronted with a lone walker on a mudflat (Cutts et al., 2013). Curlew are considered to have a high site fidelity and are reliant on a site (intertidal mud and sandflats) but do utilise alternative habitats at certain times (e.g. during high tide). Any disturbance is predicted to be localised, potentially displacing birds to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Curlew utilise grassland surrounding the site for both foraging and roosting (MacArthur Green, 2017) outside of the ZOI: this area will not be impacted during construction works. Displacement outwith the SPA is not predicted given the availability of	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: - Any temporary lighting will be designed to ensure minimal light spill (HRA4). - Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Curlew was recorded within the ZOI foraging on multiple occasions, predominantly at the mouth of the River Avon and east of the petrochemical works. Curlew utilise the intertidal sand and mudflats within the SPA for foraging and also forage across grassland surrounding the site (MacArthur Green, 2017). Within intertidal areas they feed on larger prey items such as crabs, large worms and bivalves. Their de-curved bill is ideally suited to extracting deep-living worms such as lugworms (<i>Arenicola marina</i>). Curlew are also known to heavily utilise agricultural grassland as foraging sites, especially during periods of high tide. As curlew rely on large prey, this takes longer to extract and consume than the typically smaller prey of many other wader species. As a consequence, curlew are territorial foragers and individuals are usually well dispersed across the estuary while feeding (Berg, 1993) to avoid competitive conflicts. This foraging behaviour results in curlew being vulnerable to disturbances. Given their diet of larger prey, curlew is considered to have a high site fidelity and are reliant on a site (intertidal mud and sandflats) but do utilise alternative habitats at certain times (e.g. during high tide). Observed curlew reaction to disturbance events during construction of flood defences suggests that they have a minimum feeding range of 150m from works, which may reduce to 100m after habituation (Cutts and Allen, 1999). In another example, observation of two disturbed sites, one with highly disturbing works and one with moderately disturbing works, identified curlew foraging regularly within 100m. No reactions were observed to machinery operation. Given the considerable area of alternative foraging habitat in close proximity to the site, notably mudflats at Kinneil Kerse and Skinflats, and surrounding farmland, no impacts on foraging curlew are predicted in relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to curlew would remove impacts that could compromise the conservation objectives for foraging curlew.	No potential for AESI
Dunlin	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is	No mitigation is required. However, to ensure that the conservation objectives for dunlin are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	mudflat habitat). Dunlin was recorded on five occasions under the permanent and temporary habitat loss footprint of the Scheme. A peak count of 8,000 birds (84% of the cited SPA population) was recorded in Sector 10 in 2016. Dunlin was the most abundant species recorded during the surveys with birds recorded across most of the study area through each tidal state. A study carried out by Conklin and Colwell (2007) looked at high tide roost fidelity of wintering dunlin. During the study, despite dunlin showing high fidelity to the study area, fidelity to particular roosts was relatively low and highly variable. At night, dunlin used fewer roosts, were more faithful to primary roosts, and moved shorter distances between successive roosts than during the day. Day and night roosts differed in location, habitat, and distance from tidal flats. The results of this study highlighted that unlike other species (e.g. curlew) dunlin do not exhibit the traditional roosting behaviour and are more sporadic moving between several roost sites. This is similar to the survey findings in that dunlin was observed to have a high fidelity to the study area and large flocks of dunlin (2,000 -11,000 birds) were recorded roosting across several different locations within this area. Although a large number of dunlin (8,000) was recorded on one occasion under the construction footprint for the Scheme, this individual record suggests that there are other areas within the SPA/Ramsar site utilised by dunlin during the winter and that the area under the footprint of the Scheme is not regular supporting habitat for this species. It is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations. In addition, the findings by Davies (2001) demonstrated that the benthic community of the upper shore around Grangemouth and Kinneil was less diverse and in lower abundances than the lower shore. The habitats lost either temporarily or permanently as a result of the Scheme are not considered to be functionally important for dunlin and no impacts on dunlin are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	dunlin and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Dunlin was the most abundant species recorded during the surveys, with birds recorded roosting across most of the ZOI through all tidal states. As with Conklin and Colwell's (2007) study, birds were recorded in large aggregations throughout the ZOI and there was no regular roost site – birds moved between several roost sites. The highest numbers were recorded along the breakwater west of the Port of Grangemouth, in the sheltered bay north of the petrochemical plant, at the mouth of	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: • Any temporary lighting will be designed to ensure minimal light spill (HRA4).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	the River Avon, and in Kinneil Lagoons east of the petrochemical plant where birds roosted at high tide. A peak count of 11,000 birds (115% of the cited SPA population) was recorded in January 2017 roosting at high tide in the sheltered bay. Although dunlin is relatively tolerant of disturbance, large aggregations of birds were recorded roosting throughout the Zol. Displacement due to noise and visual stimuli during construction, and also potentially during maintenance works, could occur which could alter the distribution of the species within the site. Dunlin roosts within 300m of works may be subject to disturbance and displacement during works, but only at high tide (i.e. for short periods), as this is when fewest alternative roost sites are available. Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement out of the SPA is not predicted given the availability of alternative roost sites and therefore the population of the species as a viable component of the site will not be impacted.	- Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Dunlin was recorded foraging across the study area in large aggregations of birds. Surveys recorded birds moving with the tide, foraging and constantly on the move. Birds were also noted to feed extensively across mudflats to the north and northwest of the petrochemical plant outside of the Zol. Dunlin is relatively tolerant of disturbances. Whilst there are large aggregations that forage throughout the Zol, there is a considerable area of alternative foraging habitat in close proximity. Given the large area of alternative foraging habitat, notably mudflats at Kinneil Kerse and Skinflats, no impacts are predicted on foraging dunlin. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging dunlin.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
Eider (650m visual Zol)	<u>Habitat Loss</u> Eider was not recorded within the temporary or permanent habitat footprint of the Scheme. The absence of the species under the footprint of the Scheme and records of eider elsewhere within the survey areas suggests that the birds favour other areas within the Firth of Forth SPA/Ramsar site. Therefore, the area lost as a result of the Scheme is not functionally important supporting habitat for this species and no impacts on eider are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required: eider was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Eider was recorded infrequently during the winter bird surveys and are mostly associated with the outer Forth rather than the inner Forth (Bryant, 1987; Forrester et al., 2007). There were infrequent records (4 records) of eider within the 650m Zol for this species, with a peak count of 5 birds in October 2016. There were no records of eider within the 650m Zol at high or rising tide during the 2022/23 surveys. As numbers nationally have remained relatively stable, declines in the Forth are thought to be attributable, at least partially, to site-specific pressures. However, given the low numbers of birds present within the Zol, it is unlikely that the distribution or population size of eider within the site will be significantly affected by the works. No impacts are predicted on roosting eider. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for roosting eider.	No potential for AESI
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Eider was recorded in low numbers on four occasions within the Zol during the surveys. Birds were feeding and loafing in open water and therefore less prone to disturbance from onshore activities. Due to the low number of the observations, it is unlikely that the distribution or population size of eider within the site will be significantly affected by the works, and therefore no impacts on foraging eider are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging eider.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
Golden plover (650m visual Zol)	<u>Habitat Loss</u> Golden plover was not recorded under the permanent or temporary habitat loss footprint during surveys. The absence of the species during surveys suggests that there are other areas within the SPA/Ramsar site favoured by golden plover during the winter, and that the area lost as a result of the Scheme is not functionally important supporting habitat for this species. No impacts on golden plover are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required: golden plover was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Golden plover was recorded within the Zol at high tide. The primary area for roosting birds was Kinneil Lagoons, with birds also roosting at the mouth of the River Avon and north of the petrochemical plant (sheltered bay). Birds were also recorded using Bothkennar Pools and the breakwater. A peak count of 436 birds (14.8% of the cited SPA population) was recorded at Kinneil Lagoons. Although golden plover exhibits more tolerance to disturbance than other waders (SNH, 2016b), disturbance and displacement of roosting birds is possible at high tide. Golden plover roosts within 300m of works may be subject to disturbance and displacement during construction and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: - Any temporary lighting will be designed to ensure minimal light spill (HRA4). - Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
		will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Golden plover was recorded foraging on multiple occasions within the ZOI, predominantly at the mouth of the River Avon and north of the petrochemical plant (sheltered bay). The infrequent encounters of golden plover within the ZOI suggests that there are other areas within the SPA/Ramsar site favoured by golden plover during the winter, and that the area around the Scheme is not important supporting habitat for this species. It is therefore concluded that there will be no impacts are predicted on foraging golden plover, in relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to roosting golden plover would remove impacts that could compromise the conservation objectives for foraging golden plover.	No potential for AESI
Goldeneye	<u>Habitat Loss</u> Goldeneye was not recorded under the permanent or temporary habitat loss footprint during surveys. Goldeneye is generally associated with open water habitats in the outer Forth during winter. The absence of the species during surveys suggests that there are other areas within the SPA/Ramsar site favoured by goldeneye during the winter, and that the area lost as a result of the Scheme is not functionally important supporting habitat for this species. No impacts on goldeneye are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required: goldeneye was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/ displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Goldeneye was recorded in low numbers during the winter bird surveys (peak count of 23 birds equates 0.8% of cited SPA population). Goldeneye are associated predominantly with the sub-tidal area and outer Forth and do not come ashore during the winter months (Bryant, 1987: Forrester et al., 2007). The declines in numbers of goldeneye on the Forth have been linked to improvements in sewage treatment, as feeding flocks were only recorded at outfalls where sewage continued to be discharged in large quantities (Campbell, 1984). The contrast between the declining site trend	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for roosting goldeneye.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	and both the regional and British trends suggests that declining numbers are possibly due to site-specific pressures. It is therefore considered unlikely that goldeneye would be significantly affected by the Scheme and no impacts on roosting goldeneye in are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.		
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Goldeneye was recorded within the Zol during the surveys at the mouth of the River Avon in multiple survey months, with a peak count of 23 birds. Goldeneye were also recorded infrequently in small numbers in Sectors 5 and 6 (highest peak count of six birds). Birds were feeding and loafing in open water and therefore less prone to disturbance from onshore activities. Due to the low number of the observations, it is unlikely that the distribution or population size of goldeneye within the site will be significantly affected by the works, and therefore no impacts are predicted on foraging goldeneye in relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging goldeneye.	No potential for AESI
Great crested grebe	<u>Habitat Loss, Disturbance/Displacement (high tide roosts and foraging birds)</u> Great crested grebe was not recorded under the permanent or temporary habitat loss footprint during surveys. No impacts are predicted in relation to habitat loss. Great crested grebe was not recorded roosting within the Zol and is unlikely to be significantly disturbed as this species predominantly relies on open water habitats (SNH, 2016b) outwith the Zol. No impacts are predicted in relation to disturbance of high tide roosts. Great crested grebe was recorded foraging infrequently within the Zol during the surveys, primarily to the east and northeast of the Scheme in open water near Kinneil Kerse during high tides. A peak count of 11 birds (1.5% of the cited SPA population) was recorded foraging northeast of the Port of Grangemouth in November 2016. Great crested grebe do not rely on any specific foraging habitat within the Zol, as they are open water feeders which predominantly feed on fish, insects, crustaceans and molluscs and so there is an abundance of nearby suitable habitat. No impacts are predicted in relation to disturbance of foraging birds.	No mitigation is required: great crested grebe was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme and was also not recorded roosting within the Zol. Foraging great crested grebe was also recorded infrequently within the Zol. Mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging and roosting great crested grebe.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.		
Grey plover	<u>Habitat Loss, Disturbance/Displacement (high tide roosts and foraging birds)</u> Grey plover was not recorded under the permanent or temporary habitat loss footprint during surveys. No impacts are predicted in relation to habitat loss. Grey plover was recorded roosting within the Zol during the surveys on two occasions with a peak count of 7 birds (1% of the cited SPA population). The declining trend in the SPA appears to be tracking the Scottish trend, however there is some evidence that the distribution of this species is shifting north-eastwards in response to climate change (Woodward et al., 2015). No impacts are predicted in relation to disturbance of high tide roosts. Grey plover was recorded foraging within the Zol on multiple occasions at all tidal states in Sectors 4, 9 and 12. Grey plover feed intertidally on worms, molluscs and crustaceans in mudflats, of which there is an abundance of within the Zol. No impacts are predicted in relation to disturbance of foraging grey plover. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required: grey plover was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme. Grey plover was recorded roosting infrequently within the Zol, and there is ample suitable habitat for foraging grey plover. Mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging and roosting grey plover.	No potential for AESI
Knot	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is	No mitigation is required. However, to ensure that the conservation objectives for knot are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	mudflat habitat). Knot was recorded only once roosting within the temporary habitat loss footprint (in 2015) and no records fall within habitat that will be permanently altered. The main roosting sites for knot are located at the mouth of the River Avon and north of the petrochemical plant (sheltered bay) outwith the habitat loss areas. The survey data identifies that the habitat within the Scheme boundary is not a regular roost site for knot and it is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations. The areas of temporary and permanent habitat loss as a result of the Scheme are not considered to be functionally important for knot and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	knot and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Knot was recorded within the ZOI frequently at high tide. Knot are sensitive to disturbance, especially at roost sites (Woodward et al., 2015). Although Pienkowski and Clark (1979) state that knot exhibit little site fidelity during the winter months, the data suggests that the ZOI is an important area for roosting knot as large aggregations of birds were recorded roosting at several locations. The primary areas of roosting were at the mouth of the River Avon, in Kinneil Lagoons and north of the petrochemical plant (sheltered bay). A peak count of 7,300 birds (78.9% of the cited SPA population) was recorded at high tide roosting at the mouth of the River Avon. Knot roosts within 300m of works may be subject to disturbance and displacement during construction, and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: • Any temporary lighting will be designed to ensure minimal light spill (HRA4). • Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). • The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). • Plant and personnel will be constrained to a prescribed working corridor (HRA9). • Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). • The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
		In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Knot was recorded on nine occasions within the Zol foraging during low tides with a low tide peak count of 3,700 birds (39% of the cited SPA population) recorded east of the Port of Grangemouth in the mouth of the River Avon. Knot feed in very large flocks on open mudflats feeding on mainly molluscs, including tellins (<i>Macoma balthica</i>), mussels (<i>Mytilus edulis</i>), cockles (<i>Cerastoderma edulis</i>) and mudsnails, the latter especially in early winter. Flocks will move with the tide and may cover very extensive areas of mudflat (Woodward et al., 2015). Knot carry out widespread movements within the Forth Estuary and exhibit little site fidelity during the winter months (Pienkowski and Clark, 1979). Given the infrequent occurrences (but occasional large flocks in Sectors 9 and 10) of knot foraging within the Zol during the surveys and the alternative foraging habitat located around Skinflats and Kinneil Lagoons, no impacts are predicted on foraging knot, relation to disturbance/displacement. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging knot.	No potential for AESI
Lapwing	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Lapwing was recorded only twice roosting within the permanent habitat loss footprint, in March 2016 and January 2017. Lapwing utilise pasture, wet meadows, saltmarsh, estuaries and arable farmland in winter for roosting and foraging. The survey data indicates that the area within the work footprint is not an important regular roost site for lapwing and it is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations. The areas of temporary and permanent habitat loss as a result of the Scheme are not considered to be functionally important for lapwing and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure	No mitigation is required. However, to ensure that the conservation objectives for lapwing are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of lapwing and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	distribution of species within the site and ensure distribution and extent of habitats supporting the species.	In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	
	<u>Disturbance/ displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Lapwing was recorded within the Zol frequently at high tide, along the moving tideline and nearby fields, however numbers varied throughout the survey area over the two years. Lapwing was absent from Sectors 4, 7 and 8, with only three records in Sector 5 during the winter months. The primary areas of roosting were at the southern end of the breakwater, at the mouth of the River Avon and in Kinneil Lagoons. A peak count of 750 birds (18% of the cited SPA population) was recorded at rising tide roosting within Kinneil Lagoons. Given the large aggregations that roost at several hotspots within the Zol, displacement due to noise and visual stimuli during works is likely to occur, which could alter the distribution of the species within the site. Lapwing roosts within 300m of works may be subject to disturbance and displacement during the construction period and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: - Any temporary lighting will be designed to ensure minimal light spill (HRA4). - Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	Potential for AESI
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts for roosting lapwing would remove with the potential to compromise the conservation objectives for foraging lapwing.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Lapwing was recorded within the Zol foraging on multiple occasions, predominantly to the south of the breakwater and at the mouth of the River Avon. Lapwing utilise farmland for foraging; arable fields adjacent to the Scheme and outside of the Zol will be unaffected by the construction. These areas, along with the considerable area of alternative foraging habitat in the estuary, will act as a refuge for displaced birds. It is therefore concluded that there will be no predicted impacts on foraging lapwing. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.		
Mallard	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Mallard was recorded seven times within the temporary habitat loss footprint during the surveys, with a peak count of 20. Therefore, it is considered that the habitats lost either temporarily or permanently as a result of the Scheme are not functionally important for mallard, and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required. However, to ensure that the conservation objectives for mallard are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of mallard and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Mallard was recorded roosting throughout the Zol at high tide in all survey Sectors except for Sector 4 throughout the survey period. A peak count of 180 birds (7% of the cited SPA population) was recorded north of the Port of Grangemouth. Given the moderate aggregations that roost at several hotspots within the Zol, displacement due to noise and visual stimuli during works is possible at high tide, which could alter the distribution of the species within the site. Although mallard is relatively tolerant of moderate and high-level visual disturbance and will habituate rapidly to activity (Cutts, et al., 2013) disturbance and displacement of roosting birds during construction, and potentially during maintenance works, could occur at high tide. Mallard	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: • Any temporary lighting will be designed to ensure minimal light spill (HRA4). • Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	roosts within 300m of works may be subject to disturbance and displacement during works but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	- The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Mallard was recorded foraging within the ZOI often during surveys, particularly around Sectors 8, 9 and 10. Mallard is omnivorous and an opportunistic feeder, consuming seeds and vegetative parts of aquatic plants, and variable amounts of terrestrial and aquatic invertebrates. Given the considerable area of alternative foraging habitat in close proximity to the site, notably the mudflats at Kinneil Kerse and Skinflats, no impacts are predicted on foraging mallard. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to mallard would remove impacts that could compromise the conservation objectives for foraging mallard.	No potential for AESI
Oystercatcher	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Oystercatcher was not recorded under the permanently altered habitat or habitat unavailable during construction during the surveys.	No mitigation is required. However, to ensure that the conservation objectives for oystercatcher are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of oystercatcher and will protect the structure and function of the habitats that support the species within the sites: A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	The survey data indicates that the area within the work footprint is not an important regular roost site for oystercatcher and it is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations. The habitats lost either temporarily or permanently as a result of the Scheme are not considered to be functionally important for oystercatcher and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site and ensure distribution, and extent of habitats supporting the species.	- Plant and personnel will be constrained to a prescribed working corridor. - On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Oystercatcher was recorded within the Zol at rising/high tide. The primary area for roosting birds was along the breakwater, at the mouth of the River Avon and north of the petrochemical plant (sheltered bay). A peak count of 588 birds (7.5% of the cited SPA population) was recorded roosting north of the petrochemical plant. Large aggregations were recorded moving out of the Zol at high tide, however several roosting hotspots were still evident. Given the large aggregations that roost at several hotspots within the Zol, displacement as a result from noise and visual stimuli during works is possible at high tide, which could impact on the distribution of the species within the site. Although oystercatcher is relatively tolerant to disturbance, the potential for displacement of roosting birds is still predicted at high tide. Roosts within 300m of works may be subject to disturbance and displacement throughout the construction and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: - Any temporary lighting will be designed to ensure minimal light spill (HRA4). - Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
		will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Oystercatcher was recorded within the Zol foraging on multiple occasions throughout the survey period. Oystercatchers are tolerant to disturbance and can habituate to ongoing activity. As birds are likely to habituate to disturbance and any birds which are displaced are likely to be able to re-distribute to other suitable foraging locations within 1km, no impacts on foraging oystercatcher are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to oystercatcher would remove impacts that could compromise the conservation objectives for foraging oystercatcher.	No potential for AESI
Pink footed goose (650m visual Zol)	<u>Habitat Loss, Disturbance/Displacement (high tide roosts and foraging birds)</u> Pink footed goose was not recorded under the permanent or temporary habitat loss footprint during surveys. No impacts in relation to habitat loss are predicted. Disturbance could result in disrupted foraging/roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Pink footed goose was recorded on the edge of the Zol roosting or foraging in Sector 4 with a peak count of 1,370 birds, on the boundary of Bothkennar Pools and mudflats, with other peak count records ranging from 1 - 600 birds throughout Sectors 4, 5, 6, and 7. Pink footed goose utilise fields surrounding the site for foraging and are influenced by the cropping regime and changes throughout the winter in response to food availability. They will feed on a variety of crops including stubble fields, potato remains, beet remains, grass, and winter-sown cereals. Research has shown that there can be a preference for stubble fields in the autumn and early winter and grassland later in the winter (Mitchell, 2012). Pink footed goose will roost overnight on open water within the estuary or open water (such as Bothkennar Pools or Kinneil Lagoons), or they will roost in large open agricultural spaces such as the fields to the south of Sector 4. There are multiple areas of suitable habitat for roosting pink footed goose adjacent to the Zol. No impacts are predicted in relation to disturbance of foraging or roosting birds. The infrequent encounters of pink footed goose within the Zol suggests that there are other areas within the SPA/Ramsar site that are favoured during the winter for roosting and foraging. Therefore, it is considered that the Zol does not contain important supporting habitat for this species and no impacts on pink footed goose are predicted. The following conservation objectives	No mitigation is required: pink-footed goose was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme and was recorded infrequently within the 650m Zol. Mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging and roosting pink-footed goose.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	will be maintained: ensure population of the species as a viable component of the site, ensure distribution of the species within the site, and no significant disturbance of the species.		
Red-breasted merganser	<u>Habitat Loss</u> Red-breasted merganser was not recorded under the permanent or temporary habitat loss footprint during surveys. The absence of the species during surveys suggests that there are other areas within the SPA/Ramsar site favoured by red-breasted merganser during the winter, and that the area lost as a result of the Scheme is not functionally important supporting habitat for this species. No impacts on red-breasted merganser are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site and ensure distribution and extent of habitats supporting the species.	No mitigation is required: red-breasted merganser was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Red-breasted merganser was recorded at high tide predominantly near the breakwater, north-east of the Port of Grangemouth and at the mouth of the River Avon. Red-breasted merganser are associated with the sub-tidal area of the Firth of Forth and rarely come ashore during the winter months and hence are not sensitive to increased activity from development from land (Gillingwater, 2018). Therefore, this species is unlikely to be significantly disturbed and/or deterred from the area as a result of the Scheme and they are predicted to readily redistribute within their natural range in the Firth of Forth. Therefore, no impacts on roosting red-breasted merganser are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure the distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for roosting red-breasted merganser.	No potential for AESI
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Red-breasted merganser was recorded at high tide predominantly near the breakwater, north-east of the Port of Grangemouth and at the mouth of the River Avon. Red-breasted merganser are associated with the sub-tidal area of the Firth of Forth and rarely come ashore during the winter months and hence are not sensitive to increased activity from development from land (Gillingwater, 2018). Therefore, this species is unlikely to be significantly disturbed and/or deterred from the area as a result of the Scheme and they are predicted to readily redistribute	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging red-breasted merganser.	

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	within their natural range in the Firth of Forth. Therefore, no impacts on foraging red-breasted merganser are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure the distribution of the species within the site and no significant disturbance of the species.		
Red-throated diver (650m visual Zol)	<u>Habitat Loss</u> Red-throated diver was not recorded under the permanent or temporary habitat loss footprint during surveys. Red-throated diver is generally associated with open water habitats in the outer Forth during winter. The absence of the species during surveys suggests that there are other areas within the SPA/Ramsar site favoured by red-throated diver during the winter, and that the area lost as a result of the Scheme is not functionally important supporting habitat for this species. No impacts on red-throated diver are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required: red-throated diver was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme.	No potential for AESI
	<u>Disturbance/ displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Red-throated diver was recorded in Sector 7 only and in low numbers during the winter bird surveys, with one record of two birds in both November 2016 and November 2022 and one record of one bird in December 2022. Red-throated diver are associated predominantly with the sub-tidal area and outer forth and do not come ashore during the winter months (Lack, 1986). The contrast between the declining site trend and both the regional and British trends suggests that declining numbers are possibly due to site-specific pressures. It is therefore considered unlikely that red-throated diver would be significantly affected by the Scheme and no disturbance/displacement impacts on foraging red-throated diver are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for roosting red-throated diver.	No potential for AESI
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Red-throated diver were only recorded within Sector 7 during the surveys on three occasions, and red-throated diver are associated with the sub-tidal area and outer forth. Birds were feeding and	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other qualifying species would remove impacts that could compromise the conservation objectives for foraging red-throated diver.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	loafing in open water and therefore less prone to disturbance from onshore activities. Due to the low number of the observations, it is unlikely that the distribution or population size of red-throated diver within the site will be significantly affected by the works, and therefore no impacts on foraging red-throated diver are predicted. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.		
Redshank	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Some potentially suitable high tide roost habitat would be lost. However, surveys have shown few instances of roosting birds in this location; during the two years of survey data, with 12 records with a peak count of 266 birds (6% of SPA population) roosting within the permanently altered habitat along the upper shoreline east of the petrochemical plant. In addition, there are six records with a peak count of 114 birds (2% of cited SPA population) of redshank recorded under the habitat that will be unavailable during construction. It is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations for redshank along the extent of the shoreline north of the petrochemical plant (sheltered bay) and south to Kinneil Lagoons. The habitats lost either temporarily or permanently as a result of the Scheme are not considered to be functionally important for redshank and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required. However, to ensure that the conservation objectives for redshank are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of redshank and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Large aggregations of roosting redshank occur throughout the winter at high tide in Sectors 6, 7, 8, 9 and 10. Occurrences of redshank were much lower in Sectors 5 and 11 with the species virtually absent in Sector 4 during the winter months. Given the large aggregations that roost at several hotspots within the Zol, displacement as a result from noise and visual stimuli during construction is likely to occur, impacting on the distribution of the species within the site. Redshank roosts within 300m of works may be subject to disturbance and displacement during the construction and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: • Any temporary lighting will be designed to ensure minimal light spill (HRA4). • Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Pools (from Sectors 6 and 7) and surrounding farmland and/or Kinneil Lagoons (from Sectors 8 to 11). Displacement outwith the SPA is not predicted given the availability of alternative roost sites and therefore the population of the species as a viable component of the site will not be impacted.	- The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Redshank was only recorded foraging at low tide on 8 occasions within the ZOI during the surveys. The infrequent observations of redshank at low tide suggests that habitat within the ZOI is not important for foraging redshank. In addition, the findings by Davies (2001) demonstrated that the benthic community of the upper shore around Grangemouth and Kinneil was less diverse and in lower abundances than the lower shore. During bird monitoring for GI works, redshank were the only species to react to GI related anthropogenic Potential Disturbance Events (PDE) on multiple occasions; dunlin and shelduck were the only other species to react on one occasion each. Redshank generally reacted to the disturbance from GI works by moving further away, up to a maximum of 30m, from their original location. Given the considerable area of alternative foraging habitat in close proximity to the site, notably mudflats at Kinneil Kerse and Skinflats, no impacts on foraging redshank are predicted. The following conservation objectives will be maintained: ensure distribution of the species within the site and no significant disturbance of the species are predicted.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to redshank would remove impacts that could compromise the conservation objectives for foraging redshank.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Impacts from lighting are not predicted given the existing lighting around the port/petrochemical plant area. Dwyer (2010) noted that redshank appeared to use lighting around the Port of Grangemouth to extend feeding time therefore potentially having a positive impact to foraging redshank.		
Ringed plover	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA, (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Ringed plover was recorded only once foraging within the permanently altered habitats in 2023. The survey data indicates, a single record of six birds foraging, that the area within the work footprint is not an important regular roost site for ringed plover and it is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations. The habitats lost either temporarily or permanently as a result of the Scheme are not considered to be functionally important for ringed plover and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site and ensure distribution and extent of habitats supporting the species.	No mitigation is required. However, to ensure that the conservation objectives for ringed plover are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of ringed plover and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Ringed plover was recorded roosting within the ZOI at high tide predominantly in Sectors 9 and 10. A peak count of 210 birds (64% of the cited SPA population) was recorded roosting, foraging and loafing north of the petrochemical plant (sheltered bay) in September 2016. Ringed plover is an extremely tolerant species that habituates to anthropogenic activities rapidly. They are also tolerant of people, allowing people to approach as close as 30-50m before flushing when confronted with a lone walker on the mudflat (Cutts et al., 2013). At distances of over 100m from activity birds rarely showed any sign of disturbance and appeared often unperturbed when other species in their vicinity were reacting. Ringed plover roosts within 300m of works may be subject to disturbance and displacement throughout the construction period but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: • Any temporary lighting will be designed to ensure minimal light spill (HRA4). • Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). • The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7).	Potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Displacement outwith the SPA is not predicted given the availability of alternative roost sites and therefore the population of the species as a viable component of the site will not be impacted.	- Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Ringed plover was recorded foraging on seven occasions within the Zol, with a peak count of 33 birds (10% of the cited SPA population) recorded at the mouth of the River Avon. Given the infrequent occurrences of birds recorded foraging within the Zol, and the alternative foraging habitat located around Skinflats and Kinneil Lagoons, no impacts on foraging ringed plover are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure the distribution of the species within the site, and no significant disturbance of the species.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to ringed plover would remove impacts that could compromise the conservation objectives for foraging ringed plover.	No potential for AESI
Sandwich tern	<u>Habitat Loss, Disturbance/Displacement (high tide roosts and foraging birds)</u> Sandwich tern was not recorded under the permanent or temporary habitat loss footprint of the Scheme. The Firth of Forth is recognised as an important area for large numbers of Sandwich tern that congregate in the Forth post-breeding. Three small flocks (approximately 1% of the cited SPA population) were recorded roosting within the study area in August 2015 (4 birds) and September 2016 (two separate flocks of four and five birds). Five terns roosted on mud at low tide approximately 300m from the foreshore at the petrochemical plant and four birds roosted 80m north of the port entrance. All birds moved on as the tide approached. All other records were of birds in flight and foraging. There was a single peak count of four birds in September 2016 in sector 7 within the Zol. As only infrequent, low numbers	No mitigation is required: Sandwich tern was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme and birds were recorded infrequently within the Zol.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	of terns were recorded at a distance from the works area, it is considered that the immediate area surrounding the Scheme is not functionally important for terns. Therefore, no impacts on Sandwich tern are predicted in terms of the conservation objectives for the species.		
Scaup (650m visual Zol)	<u>Habitat Loss, Disturbance/Displacement (high tide roosts and foraging birds)</u> Scaup have not been recorded in areas due to be permanently altered or areas unavailable during construction. A peak count of 28 scaup (6.4% of the cited SPA population) was recorded foraging in Sector 10 during rising and high tide. Substantial declines in scaup occurring on the Firth of Forth has been directly linked to sewage treatment improvement works - reduced sewage outputs leading to reduced mollusc abundance which supported less scaup (Campbell, 1984). Scaup is now only recorded in very low numbers in winter (Cook et al., 2013). Scaup was recorded within the 650m Zol in relatively small numbers, feeding and loafing in open water and therefore less prone to disturbance from onshore activities. As these birds have been recorded on open water, rather than close to the shoreline, it is unlikely that the distribution or population size of scaup within the site will be significantly affected by the works, and therefore no impacts on scaup are predicted in terms of the conservation objectives for the species.	No mitigation is required. Scaup was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme and scaup are more likely to be found on open water.	No potential for AESI
Shelduck (650m visual Zol)	<u>Habitat Loss</u> One record of 168 shelduck was noted under the habitat unavailable during construction and permanently altered habitat during the 2016 surveys, with a further three records (two, four and six birds) noted under these areas during 2023 surveys. The infrequent records within the works footprint suggests that there are other areas within the SPA/Ramsar site favoured by shelduck during the winter, and that the area lost as a result of the Scheme is not functionally important supporting habitat for this species. No impacts on are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation measures are required. However, to ensure that the conservation objectives for shelduck are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of shelduck and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	No potential for AESI
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to other	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Shelduck was recorded roosting at high tide predominantly in Sectors 6 – 10 throughout the survey period. A peak count of 1,440 birds (32% of the cited population) was recorded at rising tide roosting in Sector 5 in September 2016. This is likely to include a large proportion of the annual moulting flock present within the Forth Estuary each year from July until September. Shelduck are extremely sensitive to moderate and high-level visual disturbance. Within the inner Forth estuary, Kinneil Kerse supports a large flock of moulting shelduck, a rare feature in Britain (Bryant, 1987; SNH, 2000; JNCC, 2001) and a peak count of 4,700 bird was recorded in August 2016 at low tide within the study area. A key pressure for the species is disturbance to potentially flightless moulting birds in the vicinity up to early October. Roosting birds within 300m of works may be subject to disturbance and displacement during the construction period and also potentially during maintenance works. Shelduck roost on open water as well as on land and, if disturbed, are likely to displace to an alternative area of open water a short distance further away from the disturbance source. The extent of nearby available open water is very large, therefore no adverse effects on site integrity are anticipated via impacts to roosting shelduck.	qualifying species would remove impacts that could compromise the conservation objectives for roosting shelduck.	
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Shelduck was frequently recorded foraging intertidally around the Port of Grangemouth, north of the petrochemical plant (sheltered bay) and east of Bothkennar Pools. A count of 446 foraging birds was recorded on a lowering tide in September 2015 in Sector 7, with birds foraging throughout all months of the surveys undertaken. A peak count of 4,700 birds (104% of the cited population) was recorded at low tide roosting, loafing and foraging at Sector 10 in August 2016. This is likely to include a large proportion of the annual moulting flock present within the Forth Estuary each year from July until September. Cutts and Allen (1999), in relation to flood defence works at Saltend on the Humber Estuary, observed that shelduck are susceptible to disturbance associated with construction activities, with a shift in location from preferred feeding areas within 250m of the works site in upper estuary areas. The diet of shelduck consists predominantly of salt-water molluscs primarily mud snail (<i>Hydrobia ulvae</i>) which is present in almost all estuaries, and often in large numbers. Spatial distribution is strongly influenced by the behaviour of this prey, particularly in relation to water depth. Shelducks are considered to have a high site fidelity and are totally reliant on wetland habitats due to unsuitable surrounding habitats and/or species limited habitat requirements.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to ringed plover would remove impacts that could compromise the conservation objectives for foraging shelduck.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Given the considerable area of alternative foraging habitat in close proximity to the site, notably mudflats at Kinneil Kerse and Skinflats, no impacts on foraging shelduck are predicted. The following conservation objectives will be maintained: ensure population of the species as a viable component of the site, ensure the distribution of the species within the site and no significant disturbance of the species		
Turnstone	<u>Habitat Loss, Disturbance/Displacement (high tide roosts and foraging birds)</u> Turnstone was not recorded in areas for permanently altered habitat or habitat unavailable during the construction period during any of the surveys for the Scheme. Turnstone is uncommon in the inner Forth (Symonds et al., 1984) and recent surveys reflect this with a peak count of four birds (0.5% of the cited SPA population) recorded along the breakwater in November 2016 and October 2022. Turnstone rely on rocky/stony shores (SNH, 2016b) and therefore tend to occur more in the outer than inner Forth. Given the low occurrence of birds around the Scheme it is likely that birds displaced during construction and potentially during maintenance works will be able to relocate within the local area, as was indicated by studies of the effects of the construction of Clackmannanshire Bridge on shorebirds (Dwyer, 2010). It is concluded that there will be no impacts on turnstone in terms of the conservation objectives for the species.	No mitigation is required. Turnstone was not recorded utilising habitat that will be temporarily unavailable or permanently altered as a result of the Scheme and was recorded infrequently in low numbers within the Zol.	No potential for AESI
Wigeon (650m visual Zol)	<u>Habitat Loss</u> Construction of the Scheme will result in temporary habitat loss of up to 0.43ha within the SPA (of which 0.25ha is mudflat habitat) and the permanent alteration of up to 1.15ha (of which 0.59ha is mudflat habitat). Wigeon was recorded only twice within the habitat temporarily or permanently unavailable – in January and March 2023, roosting in Sectors 10 and 9 respectively. The survey data indicates that the area within the work footprint is not an important regular roost site for wigeon and it is considered that the area of habitat lost would be negligible given the amount of remaining alternative roosting locations. The habitats lost either temporarily or permanently as a result of the Scheme are not considered to be functionally important for wigeon and no impacts are predicted in relation to habitat loss. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.	No mitigation is required. However, to ensure that the conservation objectives for wigeon are not compromised, the following measures will be undertaken. The measures will prevent a change in the distribution of wigeon and will protect the structure and function of the habitats that support the species within the sites: • A LEHMP will be developed which will include measures to reduce damage and restore the intertidal areas temporarily lost. • Plant and personnel will be constrained to a prescribed working corridor. • On completion of works all access tracks and working platforms will be removed in their entirety from the SPA. In addition to the avoidance and mitigation measures detailed above, an ECoW will be appointed who will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	<u>Disturbance/Displacement (high tide roosts)</u> Disturbance could result in disrupted roosting behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Wigeon was recorded roosting during rising and high tides throughout the Zol with hotspots east of the Port of Grangemouth, north of the petrochemical plant (sheltered bay) and at the mouth of the River Avon. Given the moderate aggregations that roost at several hotspots within the Zol (1 – 660 birds), displacement due to noise and visual stimuli during construction is possible at high tide, impacting on the distribution of the species within the site. Wigeon roosts within 300m of works may be subject to disturbance and displacement during the construction period, and also potentially during maintenance works, but only at high tide (i.e. for short periods). Disturbance is predicted to be localised, with birds potentially displaced to Bothkennar Pools and surrounding farmland and/or Kinneil Lagoons. Displacement outwith the SPA is not predicted given the availability of alternative roost sites within 1km of the Scheme and therefore the population of the species as a viable component of the site will not be impacted.	Given the complexities and scale of the Scheme, the construction of the flood defences along the site cannot be exclusively undertaken outside of the wintering bird season (October – March inclusive). The following measures will be undertaken during construction in order to prevent disturbance impacts on important overwintering bird populations: - Any temporary lighting will be designed to ensure minimal light spill (HRA4). - Any works undertaken adjacent to the SPA within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between (HRA5). - The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site (HRA7). - Plant and personnel will be constrained to a prescribed working corridor (HRA9). - Where safe to do so, visual and noise screening will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay to screen the movement of vehicles, plant and site personnel from birds (HRA10). - The contractor will employ a 'soft-start' to noisy activities, as advised by the ECoW (HRA11). In addition to the avoidance and mitigation measures detailed above, the appointed ECoW will ensure these mitigation measures are implemented to avoid and reduce impacts on qualifying species. Monitoring surveys will also be undertaken by the employer's ecologist throughout construction to demonstrate the effectiveness of the mitigation.	Potential for AESI
	<u>Disturbance/Displacement (foraging birds)</u> Disturbance could result in disrupted foraging behaviour, which could lead to decreased body condition and a reduction in reproductive success and individual survival. Wigeon was recorded within the Zol foraging frequently across the entire survey area. Wigeon feed predominantly on leaves, seeds, stems and root bulbs of pond weeds, fine grasses, horsetails and eelgrass, as well as algae (Owen and Thomas, 1979). Wigeon are gregarious, forming large flocks and can feed at night, especially in marine habitats. Wigeon flocks feed close to the water's edge.	No mitigation is required. However, mitigation measures that are proposed to prevent high tide roost disturbance impacts to wigeon would remove impacts that could compromise the conservation objectives for foraging wigeon.	No potential for AESI

Qualifying Interest	Assessment of Impacts	Avoidance and Mitigation	Potential for Adverse Effects on Site Integrity (AESI)
	Within estuaries wigeon will feed on seagrass (<i>Zostera</i> spp.). The nearest record of mixed <i>Zostera</i> spp. is at Carriden Bay approximately 5km from the Scheme (Zoutenbier et al., 2016). Wigeon are also known to graze on arable fields. Given the considerable area of alternative foraging habitat in close proximity to the site, notably mudflats at Kinneil Kerse and Skinflats, surrounding arable land and the known <i>Zostera</i> spp. site at Carriden Bay, no impacts are predicted on foraging wigeon, in relation to disturbance/displacement. The following conservation objectives will be maintained: to avoid the deterioration of habitats, ensure distribution of species within the site, and ensure distribution and extent of habitats supporting the species.		

4.11 AA Conclusion

No AESI has been identified due to loss of habitat as a result of the Scheme. Potential AESI have been identified as a result of disturbance to roosting birds for 11 qualifying interest species of the Firth of Forth SPA/Ramsar site during construction and maintenance works. Large numbers of birds aggregate at roost areas across the ZOI at certain times of year and states of tide.

After mitigation, potential impacts on cormorant, and therefore the Loch Leven SPA/Ramsar site, will not result in an AESI.

Timing works to fully avoid disturbance impacts during sensitive periods is not considered possible due to the large-scale nature of the Scheme. In addition, visual screens high enough to fully conceal all works from qualifying species are not practical. Screens 2m in height will be installed at relevant locations along the estuary frontage to minimise effects by reducing the visual/noise impacts, in conjunction with other mitigation measures. However, with the precautionary principle underpinning the HRA approach, the inability to time the construction programme to fully avoid sensitive periods and fully screen works from view, an AESI cannot be discounted.

If displacement is sufficiently severe in its intensity, frequency and/or duration it could potentially constitute an AESI, for example, if there were a reduction in numbers of birds in the Firth of Forth SPA/Ramsar site, displacement to less suitable or unsuitable areas of habitat within the SPA, and/or loss of body condition potentially affecting survival and future breeding success rates. Whilst high-severity disturbance events are considered likely to be rare, a degree of uncertainty exists around the residual disturbance after mitigation, and therefore a low likelihood of AESI still remains.

Due to there being a low risk of AESI, the provisions of Article 6(4) of the Habitats Directive 92/43/EEC need to be met. Further information is provided in Section 6: Stage 3 (Alternative Solutions) and Section 7: Stage 4 (Imperative Reasons of Overriding Public Interest) and an appropriate package of compensatory measures is described in Section 8 (Compensation).

5. Provisions of Article 6(4): Statement about Alternative Solutions, Imperative Reasons of Overriding Public Interest and Compensatory Measures

The question underpinning the HRA is: Can it be ascertained that the proposal will not adversely affect the integrity of the site beyond reasonable scientific doubt?

Whether the Scheme would not have an adverse effect on the integrity of the site has been determined by assessing whether, following the implementation of the mitigation measures identified in this document, it would affect the achievement of one or more conservation objectives set for the Firth of Forth SPA and Ramsar site. As stated in Section 4.11 (AA Conclusion), it is concluded that the Scheme could potentially compromise the conservation objectives due to disturbance of 11 qualifying interest species.

Based on available data and professional judgement, it is considered that the risk of an adverse effect on site integrity of the Firth of Forth SPA and Ramsar site is extremely small. However, as the precautionary principle underpins the HRA approach, it is concluded that the risk of AESI cannot be ruled out beyond reasonable scientific doubt. Due to the requirement to follow the precautionary principle, and the inherent uncertainties associated with ecological systems and assessments, it has been concluded that Scheme could have an adverse effect on site integrity in relation to disturbance of qualifying bird species during the construction and maintenance period.

As a potential AESI has been identified following application of the precautionary principle, there is a need to proceed to the later stages of Assessment of Implications on European Sites (AIES), namely considering alternative solutions, Imperative Reasons of Overriding Public Interest (IROPI) and compensatory measures.

The purpose of the Statement about Alternative Solutions, Imperative Reasons of Overriding Public Interest and Compensatory Measures (SASICOM) is to:

- assess whether there are feasible alternatives to the proposed Scheme design that would have no or less impact on the integrity of the SPA, taking into consideration buildability and cost effectiveness. In order for an alternative solution to be deemed feasible, it must meet the Scheme objectives (Section 6.2 Scheme Objectives);
- assess whether or not there are IROPI related to the Scheme; and
- identify the compensatory measures necessary to ensure that the coherence of the European site network is protected.

6. Stage 3 (Alternative Solutions)

6.1 Introduction

Stage 2 (Appropriate Assessment) concluded that it cannot be proven beyond reasonable scientific doubt that the Scheme construction and maintenance phases will avoid AESI with appropriate mitigation measures in place. Therefore, the provisions of Article 6(4) of the Habitats Directive 92/43/EEC need to be met. As the Scheme is of strategic national importance³ and there are imperative reasons of overriding public interest (as set out in Section 7 Stage 4), the Competent Authority (Falkirk Council) may wish to consent even if an AESI cannot be ruled out. However, before the Competent Authority can confirm the Scheme as proposed, it must be demonstrated that there are no feasible alternative solutions that can deliver the objectives of the Scheme (Section 6.2) without causing an AESI.

This chapter provides an assessment of possible alternative solutions. It:

- identifies the key objectives and requirements of the flood protection project;
- identifies all feasible alternative means of meeting the objectives; and
- assesses each identified feasible alternative against the criteria used in the AA to assess effects on the conservation objectives of the European sites.

6.2 Scheme Objectives

The need for the Scheme, and its priority status, is set out in the Forth Estuary Flood Risk Management Strategy (FEFRMS) published by SEPA and approved by the Scottish Ministers on 14 December 2015 (SEPA, 2015) and the associated Local Flood Risk Management Plan published by the City of Edinburgh Council (the Lead Local Authority) on 22 June 2016 (The City of Edinburgh Council, 2016). The relevant objectives from the FEFRMS are noted in Table 6.1 below.

Table 6.1: Forth estuary local flood risk management strategy objectives

Objective ID	Objective Description
10035	Reduce economic damages to residential and non-residential properties in Carron and Carronshore caused by flooding from the River Carron and coastal flooding
10036	Reduce economic damages to residential and non-residential properties in Falkirk caused by flooding from the River Carron
10040	Reduce economic damages to residential and non-residential properties in Grangemouth caused by river flooding and coastal flooding
10041	Reduce risk to people in Bonnybridge, Denny, Carron and Grangemouth from river and coastal flooding

During the early development of the Scheme, a set of general objectives⁴ were developed. These objectives were subsequently further refined into more focused and specific Scheme objectives. The Scheme objectives set out below provide the additional granularity and detail that is required to assess whether potential alternatives would meet the Scheme objectives. The Scheme objectives set out below include additional detail to the Scheme objectives that are included in the EIAR and option appraisal, relevant to the HRA process.

The Scheme objectives are as follows:

³ National Planning Framework 4, Scottish Government (2023)

⁴ <https://www.grangemouthfloodscheme.com/objectives>

- GFPS-OBJ1. Provide a 1 in 200-year (0.5% annual exceedance probability) standard of protection from coastal and fluvial flooding for residential and non-residential properties in Grangemouth and the surrounding communities of Wholeflats, Glensburgh, Langlees, Carron, Carronshore and Camelon (Stirling Road) (together “the Communities”).
- GFPS-OBJ2. Provide flood protection to important transport infrastructure in the Communities, including the A9 (including Stirling Road), A905 (Wholeflats Road and Inchyra Road) and B902 (Carron Road).
- GFPS-OBJ3. Provide flood protection to industry in the Communities, including the Port of Grangemouth, the petrochemical works and refinery (including the Kinneil Terminal).
- GFPS-OBJ4. Reduce risk to life and limit disruption from flooding within the Communities.
- GFPS-OBJ5. Reduce economic damages within the Communities arising from flooding.
- GFPS-OBJ6. Maintain and enhance the existing Grangeburn Road Flood Protection Scheme on the Grange Burn and deliver a flood relief channel capable of conveying increased flows to the River Avon.

In meeting these objectives, the Scheme will contribute to achieving Objectives 10035, 10036, 10040 and 10041 (identified in Table 6.1) and the implementation of Actions 100400006 and 100400017 of the Forth Estuary Flood Risk Management Strategy (Table 7.1).

6.3 Assessment of Alternative Solutions

Table 6.2 below details the options that the project team considered during the option appraisal stage, which includes ‘Do nothing’, ‘Do minimum’ and ‘Do something’ options. At options appraisal, many other alternatives were assessed that partially met Scheme objectives and were located away from the SPA. However, such options on their own would not be feasible as rather than preclude the need for downstream defences, they would only reduce their relative heights. These options focussed on fluvial and pluvial flooding and would not change the height or extent of flood defences along the estuary frontage or around the Port as flood defences are required to stop coastal flooding. Therefore, they are not considered in Table 6.2. Similarly, whilst the focus in Table 6.2 is those defences that are adjacent to the SPA, the overall project contains significant additional lengths of flood defence. Whilst the ‘Do nothing’ and ‘Do minimum’ options would not impact upon the SPA, they do not meet the Scheme objectives. As such, these options do not represent viable alternatives to the preferred option and can be discounted.

All the ‘Do something’ options that were considered (apart from the preferred option), also failed to meet some or all of the Scheme objectives and therefore also do not represent viable alternatives and can be discounted.

Table 6.2 demonstrates that Option 4 ‘Do Something: Flood defences at the edge of the Firth of Forth SPA’ (combined with additional defences that do not have LSE) is the only option that achieves all the Scheme objectives, indicating that there are no feasible alternatives for works at this location.

Table 6.2: Options considered during option appraisal

Option	Description	Achieves Scheme Objectives	Comments	Potential Effects on SPA/Ramsar
1	Do nothing option: construct no new flood defences and make no repairs of existing flood defences.	No	This option would not achieve Scheme Objectives GFPS-OBJ1, GFPS-OBJ2, GFPS-OBJ3, GFPS-OBJ4, GFPS-OBJ5 and GFPS-OBJ6. This option would not protect people, property or infrastructure or avoid economic damages and can therefore be discounted as it is not a viable alternative.	None, as no work proposed in or adjacent to SPA/ Ramsar.
2	Do minimum option: construct no new flood defences. Repair and maintain existing defences.	No	This option would not achieve Scheme Objectives GFPS-OBJ1, GFPS-OBJ2, GFPS-OBJ3, GFPS-OBJ4 and GFPS-OBJ5. This option would only provide limited protection to those properties and people protected by the existing defences on the Grange Burn and those that benefit from the flood relief channel. A significant number of people, properties and infrastructure would remain at risk of flooding with considerable economic damages and therefore this option can also be discounted as it is not a viable alternative.	None, as no work proposed in or adjacent to SPA/ Ramsar.
3	Do something option: Natural Flood Management	No	This option would not achieve Scheme Objectives GFPS-OBJ1, GFPS-OBJ2, GFPS-OBJ3, GFPS-OBJ4, GFPS-OBJ5 and GFPS-OBJ6. Natural flood management would only offer a very marginal reduction in fluvial flows, with significant numbers of people, property and infrastructure remaining at risk of flooding. Natural flood management in the coastal areas would not reduce the predicted extreme tide levels and therefore not reduce the risk of tidal flooding. This option can also be discounted as it is not a viable alternative.	Changes in land use across the whole Firth of Forth could change the behaviour of qualifying species within the SPA/Ramsar site.
4	Do something option: Flood defences at the edge of the Firth of Forth SPA (preferred option/ current proposal)	Yes	This option would achieve Scheme Objectives GFPS-OBJ1, GFPS-OBJ2, GFPS-OBJ3, GFPS-OBJ4, GFPS-OBJ5 and GFPS-OBJ6.	Permanent and temporary habitat loss. Disturbance to qualifying species during construction and maintenance (particularly roosting birds).
5	Do something option: Flood defences set back from Firth of Forth SPA within the Port of Grangemouth and petrochemical plant	No	This option would only partly achieve Scheme Objectives GFPS-OBJ1, GFPS-OBJ2, GFPS-OBJ3, GFPS-OBJ4 and GFPS-OBJ5. This option would not provide protection to industry within the Communities including the Port of Grangemouth and the petrochemical plant. Important infrastructure would also remain at risk. Significant economic damages would not be avoided and therefore this option can also be discounted as it is not a viable alternative.	Potential disturbance to qualifying species during construction and maintenance (likely only birds roosting at estuary edge).

Option	Description	Achieves Scheme Objectives	Comments	Potential Effects on SPA/Ramsar
6	Do something option: Tidal barrier/ barrage across the Firth of Forth.	No	This option would only partly achieve Scheme Objectives GFPS-OBJ1, GFPS-OBJ2, GFPS-OBJ3, GFPS-OBJ4 and GFPS-OBJ5. To accommodate the barrier and lock structure, this option would result in a band of temporary and permanent SPA habitat loss which would span the width of the Firth of Forth. Qualifying species could be disturbed during construction, operation and maintenance works. The option would require complex logistical, engineering and construction solutions. Additional flood defences would be required around parts of the perimeter of the petrochemical plant, adjacent to the River Avon and within 100m of the SPA to address the fluvial flood risk. These defences could disturb qualifying species. This option would not provide an affordable solution. The estimated cost is likely to be in the range of £5-10 billion, which is significantly greater than the total estimated economic benefits of the Scheme. The cost would also be unaffordable to both Falkirk Council and Scottish Government. This option would also fail to minimise negative environmental impacts and would result in significant impacts. Therefore, this option can be discounted as it is not a viable alternative.	Permanent and temporary habitat loss. Disturbance to qualifying species (waders and waterbirds) during construction, operation and maintenance works.

6.3.1 Alternative design options within the preferred option:

The preferred option, Option 4 'Do Something: Flood defences at the edge of the Firth of Forth SPA', requires new defences to be built along the SPA boundary. This may lead to AESI for the Firth of Forth SPA due to visual and noise disturbance and the option has undergone a number design iterations to mitigate this AESI as much as possible. Table 6.3 identifies the assessment of alternative delivery mechanisms and the final preferred option taken forward from this assessment. The key alternative delivery mechanisms focussed primarily on the localised alignment of the proposed flood defences (e.g. within or just outside the environmentally sensitive sites), and the different construction methodologies available.

Table 6.3: Alternatives considered to deliver the preferred 'Do Something' option (Option 4)

Ref	Description	Technically Feasible to Deliver	Issues/ benefits	Decision
Option: Construction of flood defences on alternative alignment				
A	Construct flood defences on top of river bank adjacent to site security fence outwith active petrochemical plant (current proposal)	Yes	- Avoids significant health and safety risks by separating flood defences from operational major accident hazard site. Flooding has the capacity to act as an initiating event to a COMAH Major Accident Hazard at a number of the industrial installations at Grangemouth. The scheme will significantly reduce this risk. (benefit) - All infrastructure (within the port and petrochemical plant) is protected from extreme sea levels and wave action. (benefit) - Opportunities for some bird roosting habitat to be created on top of coastal revetment. (benefit) - The petrochemical plant and the port can remain operational during construction phase. (benefit) - The permanent and temporary habitat loss at the margins of the SPA has been minimised throughout the design process. (benefit) - Potential adverse effect on site integrity of the SPA as disturbance to qualifying species roosting at high tide could not be fully mitigated during construction and maintenance. Therefore, compensation would be required. (issue) - Some coastal defences would require access tracks and works within an area of extremely soft sediment, which would require a bespoke engineering solution and an extended construction programme due to significantly reduced working time around tides. (issue)	Preferred location for proposed flood defences – temporary and permanent habitat loss is at the margins of the SPA, with potential for additional roosting habitat to be created. Significantly reduces the health and safety risks associated with flooding being an initiating event to a COMAH Major Accident Hazard. Allows the port and petrochemical plant to remain operational during construction phase and they are protected from flooding.
B	Construct flood defences on top of bank landward of site security fence i.e. within petrochemical plant	No	- Avoids temporary and permanent loss of habitat within the SPA. (benefit) - Avoids the requirement for access tracks and works within an area of extremely soft sediment to build some coastal defences, which would require a bespoke engineering solution and increase construction time due to significantly reduced working time around tides. (benefit) - Creates a significant health and safety risk by including flood defences within operational major accident hazard site. (issue) - Critical elements of the petrochemical plant (pipelines and railway line etc.) would remain at risk of flooding, thereby failing to meet a key scheme objective. In addition, flooding would remain as a potential initiating event for a COMAH Major Accident Hazard. (issue) - Access to the Forth and Tay Navigation Centre (within the port) would be prevented during a flood event, resulting in significant economic losses, thereby failing to meet a key scheme objective as well as potentially leading to safety concerns relating to vessel collisions and groundings. (issue) - Not protecting certain parts of the industrial complex could result in a major pollution incident if pipelines and other infrastructure were not protected and exposed to extreme sea levels and waves and the potential damage to this infrastructure. (issue)	Not taken forward due to significant safety risks and technically not feasible due to the number of pipelines and apparatus within the port and petrochemical plant.

Ref	Description	Technically Feasible to Deliver	Issues/ benefits	Decision
C	Construct flood defences further into the SPA e.g. at toe of bank rather than top of bank.	Yes	• Avoids significant health and safety risks by separating flood defences from operational major accident hazard site. (benefit) • All infrastructure (within the port and petrochemical plant) is protected from extreme sea levels and wave action. (benefit) • Flood defence structure would require a much larger construction footprint as it would effectively form a quay wall on the edge of the SPA, requiring longer piles and need larger construction plant to install the piles. (issue) • The duration of construction works would need to be extended to compensate for the poorer ground conditions likely to be encountered and the significantly reduced working time around tides. (issue) • Flood defences would encroach further into the SPA (than other options), which would result in greater temporary and permanent habitat loss within the SPA. (issue) • Potential adverse effect on site integrity of the SPA as disturbance to qualifying species roosting at high tide could not be fully mitigated during construction and maintenance. Therefore, compensation would be required. (issue) • A larger permanent works footprint would be required, which would take up more land within the SPA. (issue)	Not taken forward due to greater technical issues. This option is also likely to result in more temporary and permanent habitat loss within the SPA and result in more disturbance to qualifying species than Option A.
Option: Alternative methods of constructing flood defences				
D	Wall type: steel sheet piles with no concrete cladding Piling method: conventional vibrodriving piling rig with pre-auger Temporary works access: working from existing access roads or temporary stone haul roads installed on the landward side of the proposed flood defences	Yes	• Steel sheet piles can be installed using a wide range of construction plant to cater for the different physical conditions that could be encountered. (benefit) • This method allows for multiple items of construction plant to operate, which would help reduce the disturbance impact on the SPA. Defences could be constructed at a quicker rate and over a larger area, reducing the potential noise in a single location. (benefit) • If required (depending on ground/ physical conditions) the area where the piles will be installed can be pre-augured to reduce the risk of piles encountering an obstruction and minimise delays to construction. (benefit)	Preferred method for majority of flood defences, due to the speed of construction and potential for multiple areas to be worked on simultaneously. The construction method means a wide range of construction plant can be utilised, rather than specialist equipment. Option F is also defined as a preferred method for constructing flood defences.

Ref	Description	Technically Feasible to Deliver	Issues/ benefits	Decision
E	Wall type: sheet piles with no concrete cladding Piling method: pile pressing rig with crane to lift piles into rig Temporary works access: working from existing access roads or temporary stone haul roads	No	- The advantage of the pressing rig is its lower noise and vibration when compared to a conventional rig. The rig sits directly on top of the piles and moves along the top of the piles. (benefit) - This method of installing piles is slower than conventional methods, resulting in a longer construction period. (issue) - As the port and petrochemical plant are constructed on reclaimed ground, the likelihood of encountering obstructions is high. This method of installation is prone to delays due to encountering obstructions. (issue)	Not taken forward due to extended construction durations and significant risk of encountering obstructions in the ground preventing piles from being installed to required depths.
F	Wall type: bored piles with reinforced concrete wall stem. Piling method: Conventional continuous flight auger piling rig Temporary works access: working from existing access roads or temporary stone haul roads	Yes	- This method is necessary to address technical design concerns relating to the installation of driven sheet piles into the ground where soil improvement is proposed. (benefit) - This method of construction is slower than driving steel sheet piles. (issue) - Bored pile installation uses similar construction equipment to that used to install sheet piles and therefore there is no real difference in access requirements and/ or noise and disturbance. (benefit)	Preferred method along estuary shoreline between Grange Burn and River Avon.

6.4 Stage 3 (Alternative Solutions) Conclusion

The preferred option is Option 4 'Do Something: Flood defences at the edge of the Firth of Forth SPA', with the defences located at the top of the river bank/ coastal edge (sub-option A) which are formed using sheet piles (sub-option D) for the majority of defences: a concrete bored pile (sub-option F) is adopted along the estuary between Grange Burn and River Avon where sheet piles are technically unsuitable. Option 4 has been selected as it is likely to have the least AESI on the SPA and reduces the land take within the SPA. It can also be constructed in a timely manner and is a more technically feasible and viable option compared to the other options outlined in this chapter.

There are no feasible alternatives that would achieve a 1 in 200-year standard of flood protection for the area protected by the Scheme, which are less likely to cause AESI to the Firth of Forth SPA, achieve the Scheme objectives, and meet the provisions of Article 6(4) of the Habitats Directive 92/43/EEC. Therefore, the next stage of the HRA process (Stage 4) is to determine whether the Scheme as proposed has Imperative Reasons of Overriding Public Interest (IROPI).

7. Stage 4 (Imperative Reasons of Overriding Public Interest)

7.1 Introduction

As it has been demonstrated that there are no alternative solutions to the Scheme, the provisions of Article 6(4) of the Habitats Directive 92/43/EEC require that it is demonstrated that the Scheme must be carried out for imperative reasons of overriding public interest, in order that consent can be granted.

This section provides information to demonstrate that there are imperative reasons of overriding public interest (IROPI) that justify the consent of the Scheme, despite its potential impact on the SPA/ Ramsar site.

7.2 Policy and Legislation

As stated in Section 1.1 (Project Background), the need for a flood protection scheme for the Grangemouth area was identified through the Flood Risk Management planning process as set out in the Flood Risk Management Act (Scotland) 2009. The Forth Estuary Flood Risk Management Strategy published by SEPA in 2015 sets out a series of high-level Objectives and Actions relating to flood risk management in the Forth Estuary with Objectives 10035, 10036, 10040, 10041 (refer to Table 6.2) and the implementation of Actions 100400006 and 100400017 (refer to Table 7.1) being particularly relevant to the Scheme. Action 100400006 specifically identifies the Scheme and gives it a National Ranking of 1 out of 42 flood protection schemes. This ranking was given due to a combination of the number of properties at risk of flooding (approximately 1,400 at the time) and the potential economic damages (£6.0 billion) avoided following implementation of the Scheme.

Table 7.1: Forth estuary local flood risk management strategy actions

Action ID	Action Description
Flood Protection Scheme/ Works (100400006)	A flood protection scheme has been proposed for the Grangemouth area. It would include the River Carron, Grange Burn, River Avon and the Forth Estuary shoreline. The scheme would consist of flood defences, sediment management, tidal barriers/ gates and natural flood management and would provide a 1 in 200-year standard of protection. Implementation of this scheme is likely to span a 10-year period from 2017-2027.
Maintain Flood Protection Scheme (100400017)	Continue to maintain the existing Grangeburn Road Flood Protection Scheme on the Grange Burn. The scheme includes a flood relief channel conveying flows to the River Avon.

The NPF4 (Scottish Government, 2023), adopted in February 2023, is the long-term (to 2045) national spatial strategy for Scotland and replaces NPF3 (Scottish Government, 2014) and Scottish Planning Policy (Scottish Government, 2014). In conjunction with the Local Development Plan, NPF4 forms the statutory development plan for any given area of Scotland. Both plans are read together, however where there is any difference in policy content the more recent publication takes precedence. With regards to the Scheme, the Falkirk Local Development Plan 2 (FLDP2) (Falkirk Council, 2020) which was adopted by Falkirk Council in 2020, and NPF4 form the statutory development plan for the Falkirk area. A flood protection scheme for Grangemouth is identified as a National Development of strategic national importance in NPF4 and supported within the FLDP2, which states that it '*will address flood risk From the Forth Estuary the Rivers Carron and Avon, and the Grange Burn*'. The FLDP2 also notes that '*the LDP will need to ensure that no development takes place which would impede or unduly constrain options for the necessary works*' of the Scheme.

The Future Grangemouth Vision 2025 notes the construction of the Scheme as a key action (Scottish Enterprise and Chemical Sciences Scotland, 2017). Falkirk's Tax Incremental Finance Initiative, approved by the Scottish Ministers, supports the Grangemouth Investment Zone and included a specific action relating to the Scheme works.

The need for the Scheme is identified in national, regional, and local policies, strategies and plans. Additional information on these, including the Local Flood Risk Management Plan for the Forth Estuary Local Plan District

(Falkirk Council, 2023) and the Forth Estuary Flood Risk Management Strategy (SEPA, 2015), is provided in Section 1.1 (Project Background).

The Scheme will ensure that 2,760 residential properties, more than 6,000 people, 1,200 non-residential properties, 23km of roads and nationally important infrastructure (namely the Port of Grangemouth and petrochemical plant), are protected from current and future flood risk. The long-term protection of these national assets and the surrounding area is of imperative overriding public interest.

7.3 Imperative Need

As has been identified, the town of Grangemouth and surrounding communities are at risk of flooding with significant numbers of people and properties at risk. Existing flood defences provide limited benefit with properties starting to be affected by flooding from around the 1 in 5-year event (20% annual chance of occurring) to 1 in 10-year event (10% annual chance of occurring). Projected sea level rises due to climate change and increases in rainfall intensity will significantly increase the risk to people and property. Therefore, without the Scheme there would be an unacceptably high level of flood risk.

The Scheme is imperative to significantly reduce risk to life and property. In the interests of human health and public safety the Scheme will provide flood protection to an area which is currently at risk of flooding. The Scheme will also provide significant economic benefits to both the local and national economy due to the significant flood damage costs that would be avoided.

7.4 Public Interest

Regular and/or severe flooding may cause notable adverse effects on local communities by causing damage to residential, commercial and civic property, public spaces and infrastructure as well as human health. Living within a flood risk area can increase one's risk of mortality, injury, illness or stress and have an effect on social wellbeing (Penning-Rowsell et al. 2013; Scottish Executive, 2007). Regular flooding can also affect livelihoods due to increased maintenance costs, insurance premiums and disruption of commercial activity, and it can have a detrimental effect on residential and commercial property values and discourage investment in flood affected areas, leading to gradual economic decline (JBA, 2005).

The Scheme will provide long term flood protection to both public and privately-owned land in the Grangemouth area. The 2,760 residential and 1,200 non-residential properties at flood risk in the Grangemouth and surrounding area that the Scheme will protect is significant. In addition, the petrochemical plant and port are classified as nationally important infrastructure, whereby a temporary or permanent closure would have significant impacts on the Scottish and UK economies as well as environmental and social impacts and long-term reputational/commercial damage. The Scheme will provide long-term benefits to the local communities that are directly protected and also provide commercial confidence to the wider area and Scotland.

The Scheme will provide flood protection to an area which is currently at risk of flooding and will benefit the following:

- more than 6,000 people;
- 2,760 residential properties;
- 1,200 non-residential properties (including those within the port/industrial hub and within Grangemouth and surrounding communities);
- community buildings:
 - o one care home;
 - o one community centre;
 - o four medical facilities;
 - o three school facilities;
 - o one sports complex;

- o one library; and
 - o four places of worship.
- utility sites:
 - o one waste water treatment plant; and
 - o infrastructure for the following utilities and services: gas, electricity, telecommunications, water and sewage.
- transport:
 - o 23km of roads;
 - o one bus depot;
 - o core paths; and
 - o one private railway line.
- designated cultural heritage sites:
 - o nine listed buildings; and
 - o one UNESCO World Heritage Site (Antonine Wall).

7.4.1 Residential Properties/ Community Facilities

The Scheme will protect 2,760 residential properties and 11 community facilities. They will be protected from potential flooding impacts, ranging from lack of access and inconvenience where flood water surrounds their property, to the complete loss of possessions in the properties and significant damage to their homes. The latter could result in the need for residents to vacate their homes for 6-9 months or more whilst their homes are decontaminated, dried and restored to a habitable condition. The financial cost of such flooding is considerable and the impacts on health, particularly mental health, may be long term as those affected may live in fear of a repeat flood event.

7.4.2 Transport Infrastructure

The Scheme will protect around 23km of roads in Grangemouth and surrounding areas, enabling roads and footpaths to remain open during and after a flood event. This will provide considerable benefit through the reduction in delays caused from roads being partially closed or impassable. The A9, A904, A905 and Forth Clyde Way could all be affected by flooding without the Scheme. These roads provide crucial access/ egress from the petrochemical plant and port in the event of an emergency, with the A9 also providing a key route to Forth Valley Royal Hospital. The closure of these roads during a flood could increase the risk to life of people.

Without the Scheme the main access into the Port from Powdrake Road would need to be closed during a 1 in 200-year flood event, which would prevent all access and egress from the Port and result in economic damage and disruption within supply chains.

7.4.3 The Port of Grangemouth and Petrochemical Plant

The Port of Grangemouth and petrochemical plant are of national importance and need to be protected from flooding. Due to the size and complexity of the industrial area, it is difficult to quantify the exact monetary benefits of the Scheme. The economic assessment carried out for the Scheme quantified the benefits of protecting the port and petrochemical works to be in excess of £1.71 billion.

The INEOS petrochemical operated sites:

- employ over 1,650 people directly and a significantly larger number indirectly through the supply chain network, both locally to the central belt of Scotland further afield;
- produce over 1.3 million tonnes of chemical products annually at the site, including a range of fuels;

- have benefited from over £450 million of investment in the site recently and up to a further £1 billion planned in the coming years; and
- generated approximately 4% of Scotland's GDP (2016 figures) and is the first UK site to import US shale gas – ethane.

Any changes to the operational output from the petrochemical plant due to flooding would have severe short and medium-term impacts for the UK and the Scotland. The site is currently responsible for processing up to 40% of the oil and gas that is extracted from the UK's North Sea oil and gas fields and directly receives the Forties Pipeline (the main export pipeline from the UK's North Sea oil and gas fields). The flow of oil and gas from the Forties Pipeline is significant and any interruption in flow would have implications for the oil and gas production in the North Sea and the UK's fuel security. Whilst operational changes will occur at the current Petroineos site within the next few years, the site is expected to remain an industry hub as a fuel import/export facility.

Multiple pipelines are located throughout the site and link directly to the port, where further chemical separation/processing takes place. These pipes deliver surplus products (gases) from the refining process and are used by multiple operators at the Grangemouth petrochemical plant to produce products which are significant contributors to Scotland's GDP. Given the location of pipelines and storage tanks, it is possible that during a flood event this infrastructure could be damaged and lead to the release of chemicals and other products that could result in pollution and contamination.

The Forth and Tay Navigation Centre is located near the main entrance lock gates within the port. The navigation centre controls all commercial shipping in the Firth of Forth and Tay Estuary. Flooding of this facility would make it inoperable and shipping in the Firth of Forth and Tay Estuary would be impacted, by restricting vessel movements in and out of all their commercial ports.

A large number of commercial tenants are located within the Port of Grangemouth and would be impacted by a flood event. An estimated 9 million tonnes of cargo pass through the port each year, which represents as much as 30% of Scotland's GDP (Forth Ports Group, 2023). There would be significant economic losses associated with the re-routing of goods to other ports in the UK and the subsequent distribution by road and rail together with indirect costs associated with the significant delays in distribution that would occur.

7.4.4 Other Non-residential Properties

A significant number of small and large commercial businesses throughout the Scheme extent would be impacted by a 1 in 200-year flood event and also the more frequent events that the Scheme will protect against. These include small local shops, garages, restaurants and hotels through to nationwide businesses providing plant and equipment hire and manufacturing. These businesses sustain hundreds of local jobs and are a key contributor to the local economy.

7.4.5 Economic Benefits

Economic assessments conducted for the Scheme have calculated that implementation of the proposed flood defences would result in a benefit of at least £2.4 billion to the national economy. The assessments considered:

- Direct and indirect flood risk damages, including damages to vehicles; and
- Potential downtime in economic activity due to flood events in the absence of flood defence measures;
- Improved development opportunities in areas that would be prone to flooding in the absence of the Scheme;
- Health, mental health and risk to life;
- Evacuation and emergency services; and
- Net carbon benefits associated with flood damages being avoided.

7.4.6 Other Benefits

Additionally, the Scheme would have the following benefits which were not considered within the economic assessments:

- Creation of jobs (and training opportunities) associated with the construction of the Scheme;
- Reduced requirement for pollution and debris clean-up following a flood event;
- Reduced closure of roads and traffic diversions;
- Reduction in loss of education from affected school facilities and general flood related disruption; and
- Jobs protected as businesses continue to operate within the Scheme area.

7.5 Imperative Reasons of Overriding Public Interest

The Scheme must be carried out for imperative reasons of over-riding public interest. If no flood defences were provided to Grangemouth and the surrounding communities, this would have the inevitable (over time) consequence of increased and repeated flooding that would have fundamental, and potentially catastrophic, consequences for the communities and the economy at both a local and national level.

As described, the Scheme will deliver very substantial and long-term public benefits in protecting the following from flooding: communities, residential and commercial properties, and infrastructure (including the nationally important Port of Grangemouth).

As explained elsewhere within this HRA (Section 4), the risk of harm to the SPA is low and the approach taken is precautionary as it cannot be demonstrated beyond reasonable scientific doubt that there will not be an AESI arising from localised disturbance to roosting birds.

Consequently, measures have been proposed to avoid, reduce, mitigate and compensate for the potential impacts, in line with the mitigation hierarchy and HRA process. A suitable package of compensatory measures has been proposed at Kinneil and Bothkennar proportionate to the potential effects of the Scheme, and to ensure the overall coherence of the European Sites Network.

The public interest in the Scheme overrides the limited harm, or risk of harm, to the Firth of Forth SPA and Ramsar site. It has been demonstrated that the Scheme is required for imperative reasons of overriding public interest and the provisions of Article 6(4) of the Habitats Directive 92/43/EEC have been met.

8. Compensation

8.1 Introduction

With the precautionary principle underpinning the HRA's conclusions that there could be adverse effects on site integrity, and following confirmation of no alternative solutions and that the Scheme is required for imperative reasons of overriding public interest, compensatory measures must be taken to ensure that the overall coherence of the European site network is protected. Compensatory measures '*...aim to offset the negative impact of a project and to provide compensation corresponding precisely to the negative effects on the species or habitat concerned*' (European Commission, 2007). Compensatory measures should achieve a benefit at least equivalent to the loss or damage incurred by the site's qualifying species. The results of compensatory measures should normally be in place before damage occurs to the site (SNH, 2014).

As identified from the data, two main aggregations of birds at key high tide roost locations (the breakwater area directly west of the Port of Grangemouth and the sheltered bay at the estuary edge north of the petrochemical plant) will potentially be affected during construction and maintenance of the Scheme. Therefore, compensation for the temporary disturbance of birds at these two sites is required.

To maintain the integrity of the European site network, compensation roosting habitat needs to provide alternative habitat for the duration of construction of the Scheme, and during operational phase maintenance activities, which is at least functionally equivalent to that which is potentially lost (SNH, 2014). This section details the proposed compensation requirements.

8.2 Design Considerations for Roosting Bird Habitats

High tide roost selection by birds is most strongly affected by the proximity to large foraging areas, field of view and, to a lesser extent, by composition of the surrounding landscape. Several factors must be considered when creating a high tide roost including predation risk (distance to tall vegetation, separation from the mainland, visibility), energetics (energetic cost travelling to and from site), disturbance risk and proximity to nearby feeding sites (Rogers, 2003). It is important that undisturbed roosts are close to the birds' main feeding areas, particularly in winter. A study carried out by Zharikov and Milton (2009) found that abundance of certain species, such as bar-tailed godwit and curlew, depended on distance to the nearest large foraging area or the size of the roost. A detailed survey on the provision of refuges for roosting waders was undertaken by Rehfish et al. (1993) and was considered during this assessment. The compensation areas should involve creation of areas of ground of a suitable substrate, level, extent and position to attract roosting birds during the high tide period.

8.2.1 Compensation Site Selection Rationale

The rationale behind identification of suitable compensation sites is based on making provision for at least the losses incurred due to the Scheme. The breakwater roost is located west of the Port of Grangemouth. It is a linear feature comprised primarily of rock substrate, which channels the flow of the River Carron through the intertidal area of the Firth of Forth. The breakwater spans an area of approximately 0.9ha, some of which will be submerged at high tide. The sheltered bay roost is located in a corner of the intertidal area where a trapezoidal section of reclaimed land meets the perimeter of the petrochemical plant. This area is largely comprised of mudflat habitat with some fringing drier substrates backed by small areas of saltmarsh habitat.

Roosting birds could be disturbed from any location within the Zol of the Scheme during construction works and operational maintenance activities, the most sensitive locations being at the breakwater and sheltered bay areas, as described. Phasing of construction works controls the potential for disturbance of roosting birds to occur at multiple locations simultaneously. In the event of a disturbance, roosting birds from one location/stretch of works could be affected and possibly displaced, not multiple groups of birds from several locations. Displaced roosting birds are anticipated to seek a nearby suitable alternative location at which to land and resume roosting behaviour, minimising the energetic cost involved.

The overriding consideration when identifying suitable compensatory roosting habitat location(s) is consequently proximity to the location at which the original disturbance is thought most likely to occur, whilst being sufficiently far from the source of disturbance for it to no longer be an effect. In order to minimise the distance through which displaced birds might need to travel, two locations have been identified for the implementation of compensation measures for the Scheme – Kinneil Lagoons to the east and Bothkennar Pools to the west. Provision of multiple compensation site locations also offers displaced birds options as opposed to reliance on the effectiveness of only one location, thereby providing a robust solution with embedded resilience.

Consideration was given to identifying possible compensation site locations elsewhere in the catchment, outside of the boundary of the Firth of Forth SPA (and beyond the Zol of the Scheme), however the greater distances involved (compared to Kinneil Lagoons and Bothkennar Pools) was considered to significantly decrease the likelihood of displaced birds selecting these locations.

Avoidance of provision of compensatory measures within an SPA is typically adopted where functionally supporting habitats could be adversely affected, however the proposed works are either in areas which are currently non-functional for the qualifying features involved, or will significantly enhance the quality of existing habitat. Compensatory measures have been developed in close consultation with NatureScot experts.

At Kinneil Lagoons, four islands will be created within the lagoon and there will be some targeted tree and scrub removal on the area of land closest to the islands. At Bothkennar Pools, an area of land between two lagoons will be made more suitable for roosting birds at high tide by altering the shape of the land between the two lagoons and managing the vegetation. Detailed information on the compensation measures at Kinneil Lagoons and Bothkennar Pools is available in Section 8.3 and provided on Figure 34.

Table 8.1 identifies the suitability of the proposed compensation measures for the qualifying species of the Firth of Forth SPA.

This HRA considers that a 300m Zol is suitable for noise disturbance for all qualifying species of the SPA and for visual disturbance for 18 of the 27 qualifying species. Additionally, a 650m Zol for visual disturbance was implemented for nine species (common scoter, curlew, eider, golden plover, pink-footed goose, red-throated diver, scaup, shelduck and wigeon). To avoid implementing several Zol, for the purposes of this assessment, the recommended visual disturbance buffer of the most sensitive species (650m for curlew) has been applied to all species with a recommended buffer of more than 300m. Therefore, the 650m Zol is very precautionary for some of the nine species (e.g. eider and scaup) based on a review of the literature.

The compensation sites are located outwith the 300m Zol but fall within the 650m Zol for visual disturbance for the nine species previously identified. However, both sites are fully screened from construction works by existing vegetation and topography. More information is provided within Sections 8.3.1 Kinneil Lagoons and 8.3.2 Bothkennar Pools.

Table 8.1 Qualifying interest species requirements

Qualifying Interest	High Tide Roost Requirements	Suitable Compensation Provision	References
Bar-tailed godwit	Bar-tailed godwit often roost on sandy beaches, sandbars, spits and also in habitats in proximity to coastal saltmarsh. Birds have also been recorded roosting in wet grasslands and farmlands on occasion. Bar-tailed godwit typically roost on higher level sites, before the water level reaches the ankles of the birds.	The proposed compensation sites will provide suitable roosting habitat for bar-tailed godwit. At Kinneil Lagoons, four islands will be created which will be topped with gravel/crushed aggregate to mimic a shingle beach. The dome shape of the islands and gradual, sloped sides will enable bar-tailed godwit to roost at any time without leaving the area due to water level. At Bothkennar Pools, the sloping edges of the pools, reprofiling of the eastern embankment, and creation of a short sward will also provide suitable roosting habitat. Vegetation removal will occur at both locations to remove potential predator perches and cover.	McCaffery and Gill (2020) Gill and Handel (1990)
Curlew	Curlew roost in fields close to coastal habitats and will tolerate taller vegetation as they are relatively large wading birds, allowing for maintained predator vigilance.	The proposed compensation sites will provide suitable roosting habitat for curlew. At Kinneil Lagoons, four islands will be created which will have a mimic shingle beach sloping to the water's edge. At Bothkennar Pools, the sloping edges of the pools, reprofiling of the eastern embankment, and creation of a short sward will also provide suitable roosting habitat. Vegetation removal will occur at both locations to remove potential predator perches and cover.	Rogers (2003) Zharikov and Milton (2009) Van Gils et al. (2020)
Dunlin	Dunlin roost above or slightly below the high tide line with preference for relatively smooth/level surfaces of mud/sand/gravels. Roosting areas are generally open spaces to avoid predation risk. Dunlin roost in areas including sandbars, islands and coastal beaches.	The proposed compensation sites will provide suitable roosting habitat for dunlin. At Kinneil Lagoons, four islands will be created which will have a mimic shingle beach sloping to the water's edge. At Bothkennar Pools, the sloping edges of the pools, reprofiling of the eastern embankment, and creation of a short sward will also provide suitable roosting habitat. Vegetation removal will occur at both locations to remove potential predator perches and cover. As noted in this HRA , the roving flock of dunlin around Grangemouth are not site faithful and have several high tide roost locations.	Handel and Gill (1992) Rogers (2003) Zharikov and Milton (2009) Rehfish (1993) Warnock and Gill (2020)
Golden plover	Golden plover are largely dependent on low-lying cultivated land, coastal mudflat, saltmarsh and rocky foreshore roosting in tight, compact assemblages.	The proposed compensation of four islands at Kinneil Lagoons and managed short sward habitat at Bothkennar Pools will provide suitable roosting habitat for golden plover, in addition to the vast expanse of tidal flats and arable land in the vicinity.	Wiersma et al. (2020)
Knot	Knot roost above or slightly just below the high tide line, with preference for sandy coastal habitats. They form dense aggregations on shorelines at high tide, often with dunlin.	The proposed compensation sites will provide suitable roosting habitat for knot. At Kinneil Lagoons, four islands will be created which will have a mimic shingle beach sloping to the water's edge. At Bothkennar Pools, the sloping edges of the pools, reprofiling of the eastern embankment, and creation of a short sward will also provide suitable roosting habitat. Vegetation removal will occur at both locations to remove potential predator perches and cover.	Rogers (2003) Zharikov and Milton (2009) Rehfish (1993) Baker et al. (2020)
Lapwing	Roosting flocks of lapwing prefer spacious, old pastures as well as mudflats. They mainly roost on drier ground with clear viewsheds to avoid predation risks.	The proposed compensation of four islands at Kinneil Lagoons and managed short sward habitat at Bothkennar Pools will provide suitable roosting habitat for lapwing, in addition to the vast expanse of tidal flats and arable land in the vicinity.	Wiersma et al. (2020)

Qualifying Interest	High Tide Roost Requirements	Suitable Compensation Provision	References
Mallard	Mallard often roost on water or along vegetated fringes at high tide. They can roost above the high tide line, particularly to conserve energy when water temperatures drop significantly. They are less restricted in terms of vegetation state and specific roost site selection.	The proposed compensation sites will provide suitable roosting habitat at Kinneil Lagoons and Bothkennar Pools for mallard, both on water and vegetated fringing habitat during high tide, with expanses of water present at both sites and on the nearby Firth of Forth estuary.	Drilling et al. (2020)
Oystercatcher	Oystercatcher are communal roosters. They often roost on mud, sand, gravel or rocky coasts and estuaries. They also sometimes roost inland by lakes and rivers with low levels of disturbance and at a safe tide height.	The proposed compensation sites will provide suitable roosting habitat for oystercatcher at Kinneil Lagoons on the four islands that will be created, and along the pool edge and area of short sward at Bothkennar Pools.	Van der Kolk et al. (2021) Hockey et al. (2020)
Red-throated diver	Red-throated diver forage and roost on water close to shore in coastal estuaries over winter.	The proposed compensation sites will provide suitable roosting habitat at Kinneil Lagoons and Bothkennar Pools for red-throated diver, with expanses of water present at both sites and on the nearby Firth of Forth estuary.	Rizzolo et al. (2020)
Redshank	Redshank roost above the high tide line at secure roost sites. These tend to be open spaces to avoid predation, near to their feeding grounds, in sometimes dense aggregations. Redshank are often found as part of larger groups with dunlin.	The proposed compensation sites will provide suitable roosting habitat for redshank. At Kinneil Lagoons, four islands will be created which will have a mimic shingle beach sloping to the water's edge. At Bothkennar Pools, the sloping edges of the pools, reprofiling of the eastern embankment, and creation of a short sward will also provide suitable roosting habitat. Vegetation removal will occur at both locations to remove potential predator perches and cover.	Van Gils et al. (2020)
Ringed plover	Ringed plover choose shingle shores with stones of a specific size to allow some shelter without loss of visibility. Ringed plover roost near feeding areas, usually just above the high tide line.	The proposed compensation sites will provide suitable roosting habitat ringed plover. At Kinneil Lagoons, four islands will be created which will have a mimic shingle beach sloping to the water's edge.	Wiersma et al. (2020)
Wigeon	Wigeon forage and roost along the water's edge, together with teal and mallard, with some rafting taking place. They are often associated with roosting in brackish waters and near grass banks of lakes. Wigeon also roost close to feeding grounds, dabbling for shallow submerged vegetation and grazing on terrestrial grassland close to water.	There are suitable areas of open water available for this species to roost at both Kinneil Lagoons and Bothkennar Pools, with suitable pool edge created at Bothkennar Pools through the proposed habitat management.	Carboneras et al. (2020)

8.3 Compensation Proposals

8.3.1 Kinneil Lagoons

8.3.1.1 Background

Kinneil Lagoons is located between Grangemouth and Bo'ness (Figure 34) and is an important waterbird high tide roost within the inner Forth, attracting thousands of wintering birds such as knot, dunlin and black-tailed godwit each year. The site is part of the Firth of Forth SPA and Ramsar site and is owned by Falkirk Council. The lagoons were created when the intertidal zone was reclaimed in 1969, when a seawall was built along the seaward side as part of the Kinneil Kerse landfill site operation. The lagoons are linked to the Forth through a series of large pipes in the seawall, which allows sea water to come in and go out with each tidal cycle. The resulting saline lagoon/mud habitat is an uncommon habitat on the Forth (Inner Forth Landscape (IFL), 2019a).

The Scheme's data suggests that the lagoons are likely to be able to already support the numbers of roosting birds potentially displaced during construction from the sheltered bay (see Section 8.3.1.3 Kinneil Bird Numbers). However, to ensure that there is adequate high roosting habitat, compensation in the form of four islands will be created. Islands are known to be utilised by wading birds for roosting as they provide a protection from land-based predators and the edge habitat allows for birds to roost at different heights as required with the tidal cycles.

The proposed works outlined below would be separate, but complementary to, any site management plan which may be implemented by Falkirk Council prior to compensatory works commencing, and detailed design would be undertaken in consultation with Falkirk Council.

8.3.1.2 Compensatory Habitat

At Kinneil Lagoons, four islands will be created within the lagoons to provide new high tide roosting habitat for the qualifying species of the SPA (and any other roosting birds that may wish to utilise them). The largest island will be created from an existing 'spit' of land that extends from the southern side of the lagoons and the other three islands will be located to the north and east of this. Additionally, there will be some targeted tree and scrub removal close to the islands to provide good sight lines for roosting birds and remove potential predator perches (Figure 34).

Whilst the compensation site falls within the 650m ZoI for visual disturbance for the nine species previously identified, it is fully screened from construction works by existing vegetation and topography. At Kinneil, the lagoons are located in a basin, with higher ground surrounding it on all sides, and there is a bund that runs along the east and south perimeter (Photograph 8.1). To the southwest of the lagoons, woodland and scrub screens the site from the existing access road (Photograph 8.2).



Photograph 8.1: Looking northeast from a passing bay on the access road to Kinneil Kerse waste water treatment facility. The bund and higher ground with scattered trees are visible on the other side of the field, and the area of woodland is visible to the left.



Photograph 8.2: Looking southeast from a passing bay at the bend in the access road to Kinneil Kerse waste water treatment facility. The woodland edge is visible to the left and a bund is visible above the field.

There are no footpaths or easy means of access that would bring members of the public close to the spit at the southeast side of the lagoons. The spit currently comprises large pieces of concrete rubble and building debris, with scattered scrub and a thin layer of grass over the rubble and is not utilised by roosting birds (Photographs 8.3 to 8.5).



Photograph 8.3: Spit of land at Kinneil Lagoons which is has a perimeter of concrete blocks/rubble.



Photograph 8.4: The spit of land is composed of large pieces of concrete rubble.



Photograph 8.5: A thin layer of soil and grass covers the concrete rubble with some scattered scrub.

Creation of four islands would provide approximately 0.62ha of roosting habitat, although this would vary to a limited extent with the changing lagoon water levels. The approximate area of each island is as follows:

- Island 1: 0.33ha
- Island 2: 0.05ha
- Island 3: 0.14ha
- Island 4: 0.09ha

Construction of the islands will take place in the spring/summer months, outwith the most sensitive period for the qualifying species of the SPA (October to March inclusive). Works will be cognisant of the tide times at Kinneil Lagoons and will not take place at high tide. The existing spit will be used to create a haul road/causeway to enable the new islands to be created (islands 2 to 4).

All islands will have a domed surface, sloping to the water's edge in a 1:50 gradient, which will ensure no steep banks. The centre of the islands will be approximately 1.00m AoD, slightly higher than the edges, and will be designed so that the islands will inundate rarely during extreme flood events or the highest spring tides. The islands will have indented bays, to varying extents, which will increase edge length and is more attractive to roosting birds. Islands 2, 3 and 4 will be created from aggregate/crushed rubble and covered in a geotextile membrane to suppress vegetation growth. The membrane will be buried at least 200mm below the surface and firmly fixed in place. The islands will then be topped with aggregate/crushed rubble approximately c. 25mm-100mm in size, which will mimic a shingle beach. This smaller aggregate/crushed rubble will form a layer 10-15cm deep and will be spread evenly to avoid creating any depressions which may fill with water and become unusable for roosting.

Island 1 will be created from the existing spit and the island level will be lowered to approximately 1.00m AoD. The rubble which comprised the spit will be crushed to create the heart shape of island 1 and the topsoil of the

spit would be stripped. The geotextile membrane and smaller aggregate would then be laid in line with the process identified for all islands. If the crushed rubble is unsuitable or more is required than is crushed, suitable inert aggregate will be locally sourced and imported to site.

The final phase of creating island 1 will be to form a channel between the spit and the surrounding habitat. This will prevent terrestrial predators and dogs from accessing island 1 and then consequently the other islands. A deep channel will be excavated to 1.50m AOD to disconnect the island from Kinneil Lagoons boundary.

It is anticipated that all rubble and spoil excavated will be re-used to create the islands. Should any material need to be removed from site, the appropriate consents will be sought to do so.

The islands at Kinneil will be constructed and available for use by roosting birds at least one winter prior to construction works commencing adjacent to the Firth of Forth estuary. This is to ensure that compensatory habitat is in place before the commencement of potential disturbance impacts during construction.

8.3.1.3 Kinneil Bird Numbers

The Scheme compensation measures need to be large enough to support all roosting birds potentially disturbed by the works (SPA qualifying species and non-qualifying species), *in addition* to the number of birds which are already known to use the locations at which the compensation measures are proposed.

For Kinneil Lagoons, bird data from the survey period encompassing the winters of 2015/2016, 2016/2017 and 2022/23 was used to inform an assessment of how many birds may be displaced during construction and maintenance works. The working assumption adopted is that the worst-case scenario, in terms of numbers of roosting birds potentially displaced due to disturbance effects from works, would involve the large aggregations of birds in the sheltered bay area taking flight and moving to Kinneil Lagoons to roost, in addition to birds which might already be using the lagoon as a roost site. Birds displaced from the other main area holding large aggregations of roosting birds, namely along the breakwater, could similarly choose Kinneil Lagoons as their alternative roosting location, but works will not take place at both locations (breakwater and sheltered bay) simultaneously. Numbers of birds using the sheltered bay area are higher than at the breakwater, therefore we use the sheltered bay numbers in this analysis to represent the worst case for the purpose of sizing the compensatory habitat proposal in Kinneil Lagoons.

Typical roosting densities of birds were explored using available literature and evidence to determine if the proposed islands would provide adequate habitat spatially for displaced birds, additional to birds already using the lagoon as a roost site – details of which are described below.

Table 8.2 presents the summed peak counts of all qualifying and non-qualifying species recorded roosting within the sheltered bay and Kinneil Lagoons each month during the survey period. Certain species (common scoter, curlew, eider, golden plover, pink-footed goose, red-throated diver, scaup, shelduck and wigeon) are deemed to have a visual disturbance Zol of 650m from the Scheme, and as such records up to the 650m Zol boundary are included for these species, if present.

Table 8.2: Summed peak counts of all species (qualifying and non-qualifying species) recorded roosting at Kinneil Lagoons and the sheltered bay area each month. The highest counts recorded are demarcated by bold cell outlines.

	2015		2016		2017		2022		2023	
	Sheltered Bay	Kinneil Lagoons	Sheltered Bay	Kinneil Lagoons	Sheltered Bay	Kinneil Lagoons	Sheltered Bay	Kinneil Lagoons	Sheltered Bay	Kinneil Lagoons
January	n/a	n/a	2,496	7,522	17,217	10,500	n/a	n/a	1,122	2,560
February	n/a	n/a	1,030	5,930	2,387	2,057	n/a	n/a	966	436
March	n/a	n/a	198	7,874	727	5,420	n/a	n/a	720	1,392
August	404	1,780	n/a	1,409	n/a	n/a	1,606	1,986	n/a	n/a
September	1,073	1,779	1,581	2,232	n/a	n/a	2,547	2,337	n/a	n/a
October	1,182	1,225	2,601	5,574	n/a	n/a	2,049	527	n/a	n/a
November	947	4,663	6,375	428	n/a	n/a	1,311	2,344	n/a	n/a
December	717	7,998	7,381	9,924	n/a	n/a	1,797	1,686	n/a	n/a

Dunlin was the most abundant species recorded during the surveys at each site. Dunlin made up over 50% of the total species count on several occasions within Kinneil Lagoons. A maximum flock size of 11,000 birds was recorded in January 2017 roosting at high tide in the sheltered bay (survey Sector 9) (Appendix B: Ornithological Information). Dunlin tend to move between several roost sites frequently in large numbers (Conklin and Colwell, 2007) and it is likely that the peak number of birds recorded in the sheltered bay in January 2017 contains birds which were also recorded in Kinneil Lagoons in the same month (on different days).

Adopting a highly precautionary approach however, the worst-case scenario for birds potentially needing to use Kinneil Lagoon as a roost site (if displaced by works) could at times be as high as the combined numbers observed in January 2017, i.e. $17,217 + 10,500 = 27,717$ birds. The compensatory measures therefore need to accommodate at least that number, plus a contingency to allow for years when numbers of birds using these areas could be even higher than those recorded during the study period.

Dunlin and knot are known to form densely packed roosts (Baker et. al, 2020; Warnock and Gill, 2020). Literature on roosting densities of waders is limited; however, Cramp and Simmons (1983) studied the high tide roosting behaviour of dunlin on saltmarsh and noted a maximum density of 20 birds per m². Knot are known to roost in denser aggregations than dunlin. However, other larger wader species, such as redshank and bar-tailed godwit present within the sheltered bay, roost less densely.

Published literature regarding roosting densities of the majority of species present within the sheltered bay/Zol of the Scheme is extremely limited. A figure of 5 roosting bar-tailed godwit per m² is noted in McCaffrey and Gill (2020). However, using professional judgement and experience of observations of roosting birds at multiple schemes, an understanding of the other species' roosting densities can be achieved. In general, all other terrestrial roosting species roost at lower densities in comparison to knot and dunlin, with some species more frequently found to roost on water i.e. shelduck, mallard and teal (Toomer and Clark, 1992) and therefore more likely to use the main lagoon waterbody. Although the majority of potentially displaced birds are dunlin and knot which form dense roost aggregations (circa 20 birds per m²), a precautionary density figure of 10 birds per m² for small – medium wader species and 5 birds per m² for larger wader and duck species based on professional experience would suitably account for all potentially displaced species roost densities. Seven small to medium sized wader species (dunlin, golden plover, knot, redshank, lapwing, oystercatcher and ringed plover) and seven large wader and duck species (bar-tailed godwit, black-tailed godwit, curlew, mallard, shelduck, teal and wigeon) were recorded in large aggregations within the sheltered bay area during the bird surveys. Using the precautionary 5 birds per m² and 10 birds per m² roost density figures this results in an overall average roost density figure of 7.5

birds per m². This figure is considered sufficient to accommodate all species displaced however it is expected that dunlin and knot will comprise the majority of the potentially displaced flock.

The total area of the proposed islands once created would be approximately 6,184m² (0.62ha). Using the precautionary roosting density figure of 7.5 birds per m², the Kinneil islands group could therefore provide an additional theoretical capacity to accommodate 46,380 roosting birds, which is comfortably above the estimated maximum number of 27,717 birds described above, providing a buffer sufficient to give confidence that the proposed compensatory measures are proportionate to the effect and will secure the long-term integrity of the European Sites Network.

8.3.1.4 Site Investigations

Investigation undertaken at the Kinneil Lagoons consisted of surface water sampling which was undertaken on 21st October 2020 at two separate locations and on 10th November 2020 at three locations (including the initial two). The purpose of this was to review the chemical properties of the lagoon, as well as the potential for groundwater discharges from the Kinneil Kerse landfill into the lagoon, which could impact on the lagoon's surface water quality.

The samples were tested for a range of metals, inorganics and organics. The results were screened against both the freshwater and marine Environmental Quality Standard (EQS). There were elevated concentrations of chloride and sulphate, which are likely to be attributed to the salinity of the surface water present due to the site's proximity to the Firth of Forth.

There is a possibility of the leaching of onsite anthropogenic materials and natural sediments into the surrounding tidal lagoon surface water, and subsequently underlying groundwater. However, there is likely to be substantial dilution and dispersion.

8.3.1.5 Consents

The proposal has been agreed with Falkirk Council, who own the land at Kinneil Lagoons.

SEPA confirmed on 20 December 2021 that a waste management licence will not be required as material will not leave the site.

As works will take place below the tidal level of Mean High Water Springs (MHWS), a marine licence will be required. This will be applied for prior to construction of the island at Kinneil Lagoon. Creation of the compensatory habitat will be assessed as part of the Scheme marine licence application.

8.3.1.6 Maintenance and Monitoring

Longer term management of the islands will be required during construction and operation of the Scheme to ensure the island remains a shingle surface to encourage roosting birds. If the islands become heavily vegetated with dense vegetation this will discourage some birds, particularly waders, from roosting. As a geotextile membrane to suppress vegetation growth will be laid, maintenance of the compensatory habitat to keep vegetation levels low should be minimal. On completion of the Scheme, the compensatory habitat will be managed by Falkirk Council or in agreement with another appropriate stakeholder.

The employer's ecologists will monitor bird use of the site for an appropriate number of winters following completion of the compensation measures and throughout construction of main works adjacent to the Firth of Forth SPA/Ramsar site.

8.3.2 Bothkennar Pools

8.3.2.1 Background

Bothkennar Pools lie between Skinflats Village to the east and the River Carron to the south (Figure 34). The site is part of the Firth of Forth SPA and Ramsar and is noted within the Falkirk Area Biodiversity Action Plan. The land is owned by Falkirk Council and the site has benefitted from some management by Falkirk Council Biodiversity

Officers, such as tree planting at targeted areas around the perimeter and the installation of tern rafts on the northern pool. Bothkennar Pools features both saline and freshwater lagoons which formed due to subsidence caused by past undermining of the land. The saline lagoon (the southern pool, closest to the River Carron) and reed beds are slowly increasing in size due to this subsidence (IFL, 2019b).

This site could support displaced birds during construction and maintenance works from the high tide roost along the breakwater given its close proximity and suitable habitat. The site is known to already contain high tide roosts which are currently infrequently used by most species recorded or used in low numbers. It is likely that the current vegetation (including scrub, rushes, and a line of trees) makes the site less attractive to birds as it hinders sight lines. The proposed works outlined below would be separate, but complementary to, any site management plan which may be implemented by Falkirk Council prior to compensatory works commencing, and detailed design would be undertaken in consultation with Falkirk Council.

8.3.2.2 Compensatory Habitat

At Bothkennar Pools, the site is fully screened from works on the right bank of the River Carron by a large bund (approximately 3-4m in height from the existing access track) on the left bank of the River Carron, which is lined with scattered trees (Photographs 8.6 and 8.7).



Photograph 8.6: Photograph is looking southeast from field edge, adjacent to public footpath. The bund (approximately 3-4m high) on the left bank of the River Carron is lined with scattered trees and scrub.



Photograph 8.7: Photograph is looking southeast from the field, between the two pools. The bund and line of trees is visible in the background.

Public core paths surround Bothkennar Pools but are not present through the area of land between the two pools. Core paths are screened from the pools; the core path along the west side of the pools is screened by vegetation (IFL, 2018) and the path to the east is behind a bund approximately 1m high. The pools are fenced off from the public, including the area proposed for compensation, and fencing will be retained to restrict public access. The area currently comprises poor semi-improved grassland, rushes, reeds and scattered scrub.



Photograph 8.8: Location of compensatory habitat between the two pools at Bothkennar. Photograph is looking southwest from the east of the land between the pools.

At Bothkennar Pools the area of land between the two pools (Photograph 8.8 and Figure 34) will be managed to become more appealing to roosting birds. Approximately 2.90ha of roosting habitat will be available to fully compensate for birds displaced from the breakwater, which has an area of 0.9ha.

Evidence of birds roosting in similar habitat has been observed at the Musselburgh lagoons in East Lothian, which are also part of the Firth of Forth SPA and Ramsar site. Photograph 8.9 shows qualifying species of the sites roosting on an area of grassland in between two pools at Musselburgh lagoons.



Photograph 8.9: Birds roosting on land in between the Musselburgh lagoons. Photograph taken on 23 April 2019.

At Bothkennar Pools, the shape of the land between the two lagoons will be altered to create more edge habitat for roosting birds. An area on each side of the lagoon will be excavated and this material will be used to create spits of land that encroach into the pools. The topsoil removed from the excavated areas will be laid on the new areas created.

The existing habitat will be made more suitable for high tide roosting by removing the scrub vegetation and maintaining a short sward length (c. 50mm) through the winter months (September-March). Rushes, which have become dominant in this area, will be cut and maintained to provide a more open area of grassland for roosting birds. Grazing of this area currently takes place between April and September (inclusive) by a small herd of cattle (maximum 13 livestock) as permitted by Falkirk Council and NatureScot. Grazing throughout these months helps to maintain a short sward grassland, which is attractive to roosting birds as it provides an open area from which the birds' view of the surrounding area is unobstructed, thereby enabling early detection of predators. Cattle are not permitted within approximately 5m of the edge of the northern pool to prevent cattle damage and over grazing in this area. This area will be managed manually.

Reed growth, particularly within the southern pool, has reduced the area available for feeding and increased cover for predators, which may be inhibiting birds from using the pool. Cutting and removal of reeds from both pools will also be undertaken to make the area more attractive to feeding and roosting birds. With the current grazing regime continuing, and management of scrub, rushes and reeds, it is considered that the area would become attractive and suitable for roosting birds.

The habitat management at Bothkennar will be completed and available for use by roosting birds at least one winter prior to construction works commencing adjacent to the Firth of Forth estuary. This is to ensure that compensatory habitat is in place before the commencement of potential disturbance impacts during construction.

8.3.2.3 Site Investigations

Ground investigations consisting of six hand dug pits (to a maximum depth of 1.2 m below ground level) were undertaken on 30th September 2020 in order to assess ground conditions and confirm the presence of any made ground and the nature of any potential contamination within the site. Environmental soil samples were taken from all hand pits. The ground conditions encountered generally comprised a layer of shallow topsoil between 0.1m and 0.4m in thickness above either slightly sandy slightly gravelly clay or silt. One location comprised silty clay above fine to coarse gravel containing slag like material (made ground) which was first encountered at 0.9 m below ground level.

Seven soil samples were tested for a range of metals, inorganics, pesticides and organics. The samples were screened against generic assessment criteria (GAC) including S4UL, EIC and C4SL to assess the potential risks to human health. No exceedances were recorded for any of the samples.

Two rounds of surface water sampling were undertaken on 21st October 2020 and 19th November 2020, with samples taken from three locations. The purpose of this was to review the chemical properties of the pools and the associated water quality. The samples were tested for a range of metals, inorganics and organics. The results were screened against the freshwater and marine Environmental Quality Standard (EQS).

There is a possibility of the leaching of onsite anthropogenic materials and natural sediments into the surrounding pools and subsequently underlying groundwater. However, whilst there is reclaimed land beneath the pools, there is no evidence to suggest that this is significantly contaminated and there is likely to be substantial dilution and dispersion.

8.3.2.4 Consents

The compensation proposal will be agreed with Falkirk Council and permission obtained prior to creation. The Scheme has liaised with Falkirk Council to ensure that the compensation measures are complimentary to the current site management activities.

8.3.2.5 Maintenance and Monitoring

The scrub, rushes and reeds will be maintained, at least annually, to keep growth to a minimum and provide an open area of grassland. If required on top of the current grazing regime, maintenance to keep the grass to a suitable height will take place annually as a minimum, for example the area will be mown in autumn to create suitable roosting habitat ahead of the overwintering period. On completion of the Scheme, maintenance as described will be co-ordinated by Falkirk Council.

The employer's ecologists will monitor bird use of the site for an appropriate number of winters following completion of the compensation measures and throughout construction of main works adjacent to the Firth of Forth SPA/Ramsar site.

8.4 Compensation Conclusion

As it may not be possible to demonstrate beyond reasonable scientific doubt that the project will not adversely affect the integrity of the Firth of Forth SPA and Ramsar as a result of disturbance to birds roosting at high tide during construction and maintenance works, compensatory measures have been identified to support displaced birds.

Kinneil Lagoons are currently very popular with roosting birds. It is considered that the proposed compensation would enhance the site by enabling it to support even higher numbers of birds, which may be displaced from nearby high tide roost(s).

Bothkennar Pools, although used by birds, are infrequently used by most species for roosting. The proposed compensation would enhance the habitat already designated as part of the SPA and provide suitable roosting opportunities to compensate for the displacement of birds from the high tide roost(s).

In summary, the compensatory measures ensure the overall coherence of the European Sites Network by achieving the following:

Effectiveness

- The compensatory measures proposed involve creation of new islands at Kinneil lagoon and improvement of roosting habitat at Bothkennar Pools. Waterbirds are a well-researched and understood species group, whose habitat requirements are well documented. The best roost sites are undisturbed, close to feeding grounds, protected from prevailing winds, offer easy access to water at the edge of the roost, and have limited or no vegetative cover – all of these features are provided in the designs of the proposed measures. Further, islands

are known to be especially attractive to waterbirds as they reduce the risk of predation of roosting birds from land predators and typically offer good all-round views, again allowing birds to spot predators at distance. The chosen locations are already utilised by roosting birds – the proposals add to the capacity of each location and enable these areas to support greater numbers. The compensatory measures will therefore be effective in their purpose of attracting and supporting roosting birds.

Feasibility

- The proposed measures are designed to be easily constructed. Creation of new islands at Kinneil and reprofiling of land/water edges at Bothkennar Pools involve relatively simple earthworks, placing of material and profiling, with no complex construction methods required. There will be no requirement for export of materials during the works, making use of existing on-site materials where possible. Vegetation management at Bothkennar is a basic land management task, involving simple, tried and tested methods. The site investigation works did not identify the presence of any contaminants at unsafe levels. Both compensation sites are located on Falkirk Council land, who are content for the proposed measures to be implemented as part of the Scheme. Liaison with other relevant stakeholders will continue as required.

Best practice

- A key aspect of the selection of the location of the measures, both at Kinneil and at Bothkennar, is that they are close to the source of potential disturbance and close to the birds' foraging areas. Best practice design is to provide sufficient suitable roosting habitat matching these criteria. Displaced birds will not have to fly far to find the alternative roosting habitat, and the roost locations are close to existing known foraging areas. Data gathered on numbers of birds using the Scheme area have been used to calculate the required area/extent of roosting habitat required to accommodate the potential number of displaced birds.

Proportionate

- Following the precautionary principle, the HRA identifies a potential adverse effect on site integrity arising from temporary disturbance of roosting birds. The proposed measures are designed to attract and support roosting birds, using best practice methods and scientific knowledge. Each location on its own could theoretically support the number of potentially displaced birds during works (as identified in Section 8.3.1 Kinneil Lagoons), but a 'belt-and-braces' approach has been adopted in proposing compensatory measures at two separate locations. The proposals are therefore robustly proportionate to the identified effect.

Delivery timing of Compensation Measures

- The proposed measures will be in place at least one winter prior to the commencement of works adjacent to the estuary.

Safeguard the overall coherence of the European Sites Network

- Waterbirds breeding in Arctic areas use UK estuaries during passage and winter periods. UK estuaries are globally important in this respect. Birds can move around/between estuaries through the winter period, depending mainly on cold weather conditions, food availability and levels of disturbance. Therefore, it is essential to maintain a network of suitable sites, offering sufficient foraging resource and roosting habitat which is not excessively disturbed. The proposed compensatory measures, by providing increased habitat for roosting birds in perpetuity, will therefore help to safeguard the overall coherence of the European Sites Network.

References

- Antill, R., Buisson, R. and Pérez-Domínguez, R. (2016). Review of potential impact to ecological receptors of the Stour Estuary Several Order Application. APEM Scientific Report for Wash Mussels Ltd. Ref. 414003., May 2016, Final, 45 pp.
- Baker, A., Gonzalez, P., Morrison, R.I.G. and Harrington, B.A. (2020). Red Knot (*Calidris canutus*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.redkno.01>
- Bennet, T.L. and McLeod, C.R. (1998). East Scotland: (Dunscaby Head to Dunbar) (MNCR Sector 4). In: Marine Nature Conservation Review. Benthic marine ecosystems of Great Britain and the north-east Atlantic, ed. by K. Hiscock, 123-154. Peterborough, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom, MNCR series).
- Berg, Å. (1993). Food resources and foraging success of Curlews *Numenius arquata* in different farmland habitats. *Ornis Fennica*. 70. 22-31.
- Borgmann, K.L. (2011). A Review of Human Disturbance Impacts on Waterbirds. Audubon California 376.
- Bregnballe, T., Aaen, K. and Fox, A.D. (2009). Escape distances from human pedestrians by staging waterbirds in a Danish wetland. *Wildfowl Sp Iss* 2: 115-130.
- Brett, J. (2012). Disturbance to Wading birds Charadriiformes on their winter feeding grounds: Factors affecting behavioural response. A research paper as part of the requirement for the BSc (Hons) Ecology and Wildlife Conservation University of Bournemouth.
- Bright, J.A., Langston, R.H.W., Bullman, R., Evans, R.J., Gardner, S., Pearce-Higgins, J. and Wilson, E. (2006). Bird Sensitivity Map to provide locational guidance for onshore wind farms in Scotland. RSPB Research Report No 20.
- British Standards Institution (1994). BS EN 60651:1994: Specification for sound level meters. BSI.
- British Standards Institution (2001). BS EN 60804: 2001 (IEC 60804: 2001): Integrating-averaging sound level meters. BSI.
- British Standards Institution (2014). BS 5228-1:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites. BSI.
- Brown, A. and Grice, P. (2005). Birds in England. T and AD Poyser, London.
- Bryant, D. M. (1987). Wading birds and wildfowl of the estuary and Firth of Forth, Scotland. Volume 93, Issue 3-4 (The Natural Environment of the Estuary and Firth of Forth) 1987, pp. 509-520.
- Burton, N. H. K., Armitage, M. J. S., Musgrove, A. J. and Rehfisch, M. M. (2002). Impacts of man-made landscape features on numbers of estuarine waterbirds at low tide. *Environmental Management* 30: 857-864.
- Byrkjedal, I. (1987). Antipredator behavior and breeding success in greater golden-plover and Eurasian dotterel. *The Condor* 89:40-47.
- Campbell, L.H. (1984). The impact of changes in sewage treatment on seaducks wintering in the Firth of Forth, Scotland. *Biological Conservation* 28: 173-180.
- Carboneras, C., D.A. Christie, and G.M. Kirwan (2020). Eurasian Wigeon (*Mareca 147enelope*), version 1.0. In Birds of the World (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.eurwig.01>

Catry, T., Alves, J.A., Andrade, J., Costa, H., Dias, M.P., Fernandes, P., Leal, A., Lourenco, P.M., Martins, R.C., Muniz, F., Pardal, S., Rocha, A., Santos, C.D., Encarnacao, V. and Granadeiro, J.P. (2011). Long-term declines of wader populations at the Tagus estuary, Portugal: a response to global or local factors? *Bird Conservation International*, 21, 438–453.

CH2MHill (2015). Grangemouth Flood Alleviation Scheme: Ornithology Survey Desk Study and Proposed Scope. On behalf of Falkirk Council.

Collop, C., Stillman, R.A., Garbutt, A., Yates, M.G., Rispin, E. and Yates, T. (2016). Variability in the area, energy and time costs of wintering waders responding to disturbance. *Ibis* 158: 711–725.

Conklin, J.R. and Colwell, M.A. (2007). Diurnal and nocturnal roost site fidelity of dunlin (*Calidris alpina pacifica*) at Humboldt Bay, California. Available at: https://www2.humboldt.edu/wildlife/faculty/colwell/pdf/Conklin_&_Colwell_2007a.pdf [Accessed December 2019]

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. and Reker, J.B. (2004). The Marine Habitat Classification for Britain and Ireland Version 04.05 ISBN 1 861 07561 8. In: JNCC (2015). The Marine Habitat Classification for Britain and Ireland Version 15.03.

Cook, A.S.C.P., Barimore, C., Holt, C.A., Read, W.J. and Austin, G.E. (2013). Wetland Bird Survey Alerts 2009/2010: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs). BTO Research Report 641. BTO, Thetford.

Cooke, A.S. (1987). Disturbance by anglers of birds at Grafham Water. Pp 15–22 in: Maitland & Turner (Eds) 1987 *Angling and Wildlife in Fresh Waters*. ITE Symposium No. 9. ITE, Merlewood.

Currie, F. & Elliott, G. (1997). *Forests and Birds: A Guide to Managing Forests for Rare Birds*. Forestry Authority, Cambridge and Royal Society for the Protection of Birds, Sandy, UK.

Cutts, N. and J. Allen. (1999). Avifaunal Disturbance Assessment, Flood Defence Work, Saltend. Report to the Environment Agency.

Cutts, N., Hemingway, K. and Spencer, J. (2013). Waterbird disturbance mitigation toolkit. Institute of Estuarine and Coastal Studies, University of Hull.

Cutts, N., Phelps, A. and Burdon, D. (2009). Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance. Available from: <https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010001/EN010001-005116-HPC-NNBPEA-XX-000-RET-000089%201.pdf>.

David Tyldesley and Associates (2015). *Habitats Regulations Appraisal of Plans: Guidance for Plan-making Bodies in Scotland*. Version 3.0. January 2015.

Davis, H. (2001). A study of an estuarine benthic community subjected to petrochemical effluents. University of Stirling PhD Thesis.

Dehnhard, N., Skei, J., Christensen Dalsgaard, S., May, R., Halley, D., Ringsby, T.H., and Lorentsen, S-H. (2020). Boat disturbance effects on moulting common eiders *Somateria mollissima*. *Marine Biology* 167:12

Del Hoyo, J., Elliot, A. and Sargatal, J. (1992). *Handbook of the Birds of the World, Vol. 1: Ostrich to Ducks*. Lynx Edicions, Barcelona, Spain.

Dias, M., Granadeiro, J., Lecoq, M., Santos, C. and Palmeirim, J. (2006). Distance to high-tide roosts constrains the use of foraging areas by dunlins: Implications for the management of estuarine wetlands. *Biological Conservation*. 131. 446–452. 10.1016/j.biocon.2006.02.020.

Díaz, M., Grim, T., Markó, G., Morelli, F., Ibáñez-Alamo, J.D., Jokimäki, J., Kaisanlahti-Jokimäki, M.L., Tätté, K., Tryjanowski, P. and Møller, A.P. (2021). Effects of climate variation on bird escape distances modulate community responses to global change. *Scientific Reports* 11: 12826.

Dierschke, V., Furness, R. and Garthe, S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. *Biological Conservation*. 202. 59-68. 10.1016/j.biocon.2016.08.016.

Drewitt, A., Hawthorne, E., Saunders, R. and Anthony, S. (2018). A review of the effects of noise on birds. Version 1. Natural England, October 2018.

Drilling, N., Titman, R.D., and McKinney, F. (2020). Mallard (*Anas platyrhynchos*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.mallar3.01>

Dwyer, R.G. (2010). Ecological and anthropogenic constraints on waterbirds of the Forth Estuary: population and behavioural responses to disturbance. Centre for Ecology and Conservation, University of Exeter.

East Lothian Council and Jacobs (2024). Musselburgh Flood Protection Scheme. Available at: <https://www.musselburghfloodprotection.com/proposed-scheme/> [Accessed October 2024]

Natura 2000 Sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. Office for Official Publications of the European Communities, Luxembourg.

European Commission (2000b). Communication from the Commission on the Precautionary Principle.

European Commission (2001). Assessment of plans and projects significantly affecting Natura 2000 sites Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC.

European Commission (2007). Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EEC. Clarification of the Concepts of: Alternative Solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall Coherence, Opinion of the Commission. January 2007.

European Commission (2011). Guidelines on the Implementation of the Birds and Habitats Directives in Estuaries and Coastal Zones: With particular attention to port development and dredging. January 2011.

European Commission (2018). Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. Office for Official Publications of the European Communities, Luxembourg.

Falkirk Council (2018). Falkirk Local Development Plan 2. Proposed Plan September 2018.

Falkirk Council (2023). Local Flood Risk Management Plan Cycle 2 2022-2028. Forth Estuary Local Plan District. Available at: <https://www.falkirk.gov.uk/policies-and-strategies/resilience-planning/flooding> [Accessed February 2024]

Falkirk Council and Jacobs (2023a). Grangemouth Flood Protection Scheme. Available at: <https://www.grangemouthfloodscheme.com/> [Accessed January 2023]

Falkirk Council and Jacobs (2023b). Grangemouth Flood Protection Scheme. Available at: <http://www.grangemouthfloodscheme.com/pobjectives/> [Accessed January 2023]

Forrester, R.W., Andrews, I.J., McNerny, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. and Grundy, D.S. (eds) (2007). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Forth Ports Group (2023). Grangemouth. Available at: <https://www.forthports.co.uk/our-ports/grangemouth/> [Accessed January 2023]

- Fox, A.D. and Madsen, J. (1997). Behavioural and distributional effects of hunting disturbance on waterbirds in Europe: Implications for refuge design. *Journal of Applied Ecology* 34: 1-13.
- Frost, T.M., Calbrade, N.A., Birtles, G.A., Mellan, H.J., Hall, C., Robinson, A.E., Wotton, S.R., Balmer, D.E. and Austin, G.E. (2020). Waterbirds in the UK 2018/19: The Wetland Bird Survey. BTO/RSPB/JNCC. Thetford.
- Furness, R.W. (1973). Roost selection by waders. *Scottish Birds* 7: 281-287.
- Gillings, S. and Fuller, R.J. (1999). Winter ecology of golden plovers and lapwings: a review and consideration of extensive survey methods. A report by the British Trust for Ornithology. July 1999.
- Gillingwater, L. (2018). East Lothian Local Development Plan 2018: Update on Habitats Regulations Appraisal.
- Gittings, T. and O'Donoghue, P. (2016). Disturbance response of Red-breasted Mergansers *Mergus serrator* to boat traffic in Wexford Harbour. *Irish Birds*. 10: 329-334.
- Glover, H.K., Weston, M.A., Maguire, G.S., Miller, K.K. and Christie, B.A. (2011). Towards ecologically meaningful and socially acceptable buffers: response distances of shorebirds in Victoria, Australia, to human disturbance. *Landsc Urban Plan.* 2011; 103:326-34.
- Goodship, N. and Furness, R.W. (2019). Seaweed hand-harvesting: literature review of disturbance distances and vulnerabilities of marine and coastal birds. *Scottish Natural Heritage Research Report No. 1096.*
- Goodship, N.M. and Furness, R.W. (2022). Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. *NatureScot Research Report 1283.*
- Gray, C.E., Dierschke, V., Furness, R.W., Petersen, I.K., Schmutz, J., Zydels, R. and Daunt, F. (2017). Possible Behavioural, Energetic and Demographic Effects of Displacement of Red-throated Divers (Revised December 2017). JNCC Report No. 605. JNCC, Peterborough. ISSN 0963-8091.
- Green, R.M.W., Burton, N.H.K. and Cook, A.S.C.P. (2019). Review of the migratory movements of shelduck to inform understanding of potential interactions with offshore wind farms in the southern North Sea. BTO Research Report 718.
- Havera, S.P., Boens, L.R., Georgi, M.M. and Shealy, R.T. (1992). Human disturbance of waterfowl on Cacique Pool, Mississippi River. *Wildlife Society Bulletin* 20: 290-298.
- Hearn, R.D. (2004). Bean Goose *Anser fabalis* in Britain and Ireland 1960/61 – 1999/2000. Waterbird Review Series, The Wildfowl & Wetlands Trust/Joint Nature Conservation Committee, Slimbridge.
- Hockey, P., Kirwan, G.M. and Boesman, P.F.D. (2020). Eurasian Oystercatcher (*Haematopus ostralegus*), version 1.0. In *Birds of the World* (S. M. Billerman, B. K. Keeney, P. G. Rodewald, and T. S. Schulenberg, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Hötter, H., Thomsen, K-M., and Jeromin, H. (2006). Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats—facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation. *NABU*: 1-65.
- Hume, R.A. (1976). Reactions of goldeneyes to boating. *British Birds* 69:178-179.
- INEOS (2023). INEOS Grangemouth. Available at: <https://www.ineos.com/sites/grangemouth/about/> [Accessed October 2023]
- Inner Forth Landscape (2018). Initiative End of Year Report: A3.2 Bothkennar Pools. Available at: https://www.innerforthlandscape.co.uk/files/A3_2_End_of_project_report_for_website.pdf [Accessed November 2019]

Inner Forth Landscape (2019a). Kinneil Lagoons – Boost the Roost. Available at: <https://www.innerforthlandscape.co.uk/projects/conserving-restoring/kinneil-lagoons-boost-the-roost> [Accessed November 2019]

Inner Forth Landscape (2019b). Bothkennar Pools. Available at: <https://www.innerforthlandscape.co.uk/projects/conserving-restoring/bothkennar-pools> [Accessed November 2019]

Jacobs (2018) (on behalf of Falkirk Council). Grangemouth Flood Protection Scheme Environmental Impact Assessment: Screening / Scoping Report.

Jacobs (2023). Hydraulic Modelling Report.

Jacobs (2019). Grangemouth FPS Phase 5 Ground Investigation Works – Habitats Regulations Appraisal.

Jacobs (2024). Grangemouth Flood Protection Scheme Environmental Impact Assessment Report.

Jarret, D., Cook, A.S.C.P., Woodward, I., Ross, K., Horswill, C., Dadam, D. and Humphreys, E.M. (2018). Short-Term Behavioural Responses of Wintering Waterbirds to Marine Activity. Scottish Marine and Freshwater Science Vol 9 No 7.

JBA (2005). Scoping Study into the Cost of Flooding: Using the August 2004 Event as a Case Study.

Jiang, Y. and Møller, A.P. (2017). Antipredator escape distances of common and threatened birds. Behavioral Ecology 28: 1498–1503.

JNCC (2001). Firth of Forth SPA Description. Available at: <http://archive.jncc.gov.uk/default.aspx?page=1979> [Accessed November 2019]

JNCC (2008a). Information Sheet on Ramsar Wetlands: Loch Leven. Available at: <https://jncc.gov.uk/jncc-assets/RIS/UK13033.pdf> [Accessed November 2023]

JNCC (2018). Favourable Conservation Status: UK Statutory Nature Conservation Bodies Common Statement.

JNCC (2019). Isle of May. Available at: <https://sac.jncc.gov.uk/site/UK0030172> [Accessed September 2019]

Johnston, A., Ausden, M., Dodd, A.M., Bradbury, R.B., Chamberlain, D.E., Jiguet, F. and Pearce-Higgins, J.W. (2013). Observed and predicted effects of climate change on species abundance in protected areas. Nature Climate Change, 3, 1055– 1061.

Kaiser, M.J., Galanidi, M., Showler, D.A., Elliott, A.J., Caldow, R.W.G., Rees, E.I.S., Stillman, R.A. and Sutherland, W.J. (2006). Distribution and behaviour of common scoter relative to prey resources and environmental parameters. In Wind, Fire and Water: Renewable Energy and Birds. Ibis 148 (Suppl. 1): 110–128.

Lack, P. (1986). The Atlas of Wintering Birds in Britain and Ireland. T. & A.D. Poyser.

Larsen, J.K. and Laubek, B. (2005). Disturbance effects of high-speed ferries on wintering sea ducks. Wildfowl 55: 99–116.

Laursen, K., Kahlert, J. and Frikke, J. (2005). Factors affecting escape distances of staging waterbirds. - Wildl. Biol. 11: 13–19.

Laursen, K., Bregnballe, T., Therkildsen, O.R., Holm, T.E. and Nielsen, R.D. (2017). Disturbance of waterbirds by water-based recreational activities – a review (in Danish with English summary). Dansk Ornitologisk Forenings Tidsskrift 111: 96–112.

- Lewis, L.J., Davenport, J. and Kelly, T.C. (2002). A study of the impact of a pipeline construction on estuarine benthic invertebrate communities. *Estuarine, Coastal and Shelf Science* 55: 213-221.
- Liley, D. and Sutherland, W.J. (2007). Predicting the population consequences of human disturbance for ringed plovers *Charadrius hiaticula*: a game theory approach. *Ibis* 149 (Suppl. 1): 82-94.
- Liley, D., Stillman, R. and Fearnley, H. (2010). The Solent Disturbance and Mitigation Project Phase 2: Results of Bird Disturbance Fieldwork 2009/10. *Footprint Ecology / Solent Forum*.
- Liley, D., Cruickshanks, K., Waldon, J. and Fearnley, H. (2011). Exe Estuary Disturbance Study. *Footprint Ecology, Wareham. Ibis* (2006), 148, 110-128.
- Linssen, H., van de Pol, M., Allen, A.M., Jans, M., Ens, B.J., Krijgsveld, K. L., Frauendorf, M. and van der Kolk, H. (2019). Disturbance increases high tide travel distance of a roosting shorebird but only marginally affects daily energy expenditure. *Avian Res* 10, 31 (2019) doi:10.1186/s40657-019-0171-8.
- MacArthur Green, (2017). Grangemouth Flood Alleviation Scheme - Ornithology Survey Report 2015-2017.
- Madsen, J. (1985). Impact of disturbance on field utilization of pink-footed geese in West Jutland, Denmark. *Biological Conservation* 33: 53-63
- Madsen, J., Tombre, I. and Eide, N.E. (2009). Effects of disturbance on geese in Svalbard: implications for regulating increasing tourism. *Polar Research* 28: 376-389.
- Mallory, M.L. (2016). Reactions of ground-nesting marine birds to human disturbance in the Canadian Arctic. *Arctic Science* 2: 67-77.
- Marine Scotland (undated). PROFORMA FOR RECORDING MARINE SCOTLAND'S CONSIDERATION OF A PROPOSAL AFFECTING A POTENTIAL/DESIGNATED SAC OR SPA.
- Marine Scotland (2020). National Marine Plan Interactive. Available at: <https://marinescotland.atkinsgeospatial.com/nmpi/> [Accessed February 2020]
- Mathers, R.G., Watson, S., Stone, R. and Montgomery, I. (2000). A study of the impact of human disturbance on Wigeon *Anas 152*enelope and Brent Geese *Branta bernicla hrota* on an Irish sea loch. *Wildfowl* 51:67-81.
- McCaffery, B.J. and Gill, R.E. (2020). Bar-tailed Godwit (*Limosa lapponica*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.batgod.01>
- McKay, H., Furness, R., Russell, L.I., Parrott, D., Rehfish, M., Watola, G., Packer, J., Armitage, M., Gill, E. and Robertson, P. (1999). The assessment of the effectiveness of management measures to control change by fish-eating birds to inland fisheries in England and Wales. York: MAFF.
- McLeod, E.M., Guay, P.J., Taysom, A.J., Robinson, R.W. and Weston, M.A. (2013). Buses, cars, bicycles and walkers: the Influence of the type of human transport on the flight responses of waterbirds. *PLoS ONE*, 8(12): e82008.
- McLusky, D.S., Hull, S.C. and Elliot, M. (1993). Variations in the intertidal and subtidal macrofauna and sediments along a salinity gradient in the upper Forth Estuary. *Netherlands Journal of Aquatic Ecology* 27(2-4): 101-109.
- Medonca, V.M., Raffaelli, D.G. and Boyle, P.R. (2007). Interactions between shorebirds and benthic invertebrates at Culbin Sands lagoon, NE Scotland: Effects of avian predation on their prey community density and structure. *Scientia Marina* 71(3): 579-591.

Mendel, B., Sonntag, N., Wahl, J., Schwemmer, P., Dries, H., Guse, N., Müller, S. and Garthe, S. (2008). Profiles of seabirds and waterbirds of the German North and Baltic Seas. Distribution, ecology and sensitivities to human activities within the marine environment. Naturschutz und Biologische Vielfalt 61. Bundesamt für Naturschutz. Bonn–Bad Godesberg, Germany.

Mikula, P., Díaz, M., Møller, A.P., Albrecht, T., Tryjanowski, P. and Hromada, M. (2018). Migratory and resident waders differ in risk taking on the wintering grounds. Behavioural Processes 157: 309–314.

Mitchell, C. (2012). Mapping the distribution of feeding Pink-footed and Iceland Grey Lag Geese in Scotland. Wildfowl & Wetlands Trust / Scottish Natural Heritage Report, Slimbridge: 108pp.

Møller, A.P. and Erritzøe, J. (2010). Flight distance and eye size in birds. Ethology 116: 458–465.

National Parks and Wildlife Service (2014). Clonakilty Bay SPA: Conservation Objectives Supporting Document. Available at: <https://www.npws.ie/maps-and-data/designated-site-data> [Accessed November 2019]

NatureScot (undated). Habitats Regulations Appraisal (HRA). Available at: <https://www.nature.scot/professional-advice/planning-and-development/environmental-assessment/habitats-regulations-appraisal-hra> [Accessed July 2019]

NatureScot (2020). Seals. Available at: <https://www.nature.scot/plants-animals-and-fungi/mammals/marine-mammals/seals> [Accessed January 2020]

NatureScot (2022). Conservation and Management Advice Outer Firth of Forth and St Andrews Bay Complex SPA UK Site: 9020316. June 2022.

NatureScot (2023a). Ramsar sites. Available at: <https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/protected-areas/international-designations/ramsar-sites> [Accessed July 2023]

NatureScot (2023b). EU Exit information. Available at: <https://www.nature.scot/professional-advice/protected-areas-and-species/protected-areas/international-designations/european-sites> [Accessed November 2023]

NatureScot (2023c). Firth of Forth SPA. Available at: <https://sitelink.nature.scot/site/8499> [Accessed September 2023]

NatureScot (2023d). Firth of Forth Ramsar. Available at: <https://sitelink.nature.scot/site/8424> [Accessed September 2023]

NatureScot (2023e). River Teith SAC. Available at: <https://sitelink.nature.scot/site/8367> [Accessed September 2023]

NatureScot (2023f). Forth Islands SPA. Available at: <https://sitelink.nature.scot/site/8500> [Accessed September 2023]

NatureScot (2023g). Imperial Dock Lock, Leith SPA. Available at: <https://sitelink.nature.scot/site/8668> [Accessed September 2023]

NatureScot (2023h). Isle of May SAC. Available at: <https://sitelink.nature.scot/site/8278> [Accessed September 2023]

NatureScot (2023i). Outer Firth of Forth and St Andrews Bay Complex SPA. Available at: <https://sitelink.nature.scot/site/10478> [Accessed September 2023]

NatureScot (2023j). Slamannan Plateau SPA. Available at: <https://sitelink.nature.scot/site/9184> [Accessed September 2023]

NatureScot (2023k). Loch Leven SPA. Available at: <https://sitelink.nature.scot/site/8530> [Accessed September 2023]

NatureScot (2023l). Loch Leven Ramsar. Available at: <https://sitelink.nature.scot/site/8436> [Accessed September 2023]

NatureScot (2023m). Guidance Note 4: Guidance to support offshore wind applications: ornithology – determining connectivity of marine birds with marine Special Protection Areas and breeding seabirds for colony SPAs in the non-breeding season. Available at: <https://www.nature.scot/doc/guidance-note-4-guidance-support-offshore-wind-applications-ornithology-determining-connectivity> [Accessed August 2024]

Nilsson, L. and Persson, H. (1991). Selection and exploitation of feeding areas by staging and wintering geese in southernmost Sweden. *Ornis Svecica* 1:81- 92.

Owen, M. and Thomas, G. (1979). The Feeding Ecology and Conservation of Wigeon Wintering at the Ouse Washes, England. *Journal of Applied Ecology*, 16(3), 795-809. doi:10.2307/2402854.

Pearce-Higgins, J.W., Finney, S. K., Yalden, D.W. and Langston, R.H.W. (2007). Testing the effects of recreational disturbance on two upland breeding waders. *Ibis* 2007, 149 (Suppl. 1): 45–55.

Penning-Rowsell, E., Priest, S., Parker, D., Morris, J., Tunstall, S., Viavattene, C., Chatterton, J. and Owen, D. (2013). *Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal*. Routledge Press.

Pienkowski, M.W. and Clark, H.A. (1979). Preliminary results of winter dye-marking on the Firth of Forth, Scotland. *Wader Study Group Bulletin* 27: 16–18.

Rehfish, M.M., Clark, N.A., Langston, R.H.W. and Forrest, C. (1993). A guide to the provision of refuges for waders. BTO Research Report No. 120.

Rizzolo, D.J., Gray, C.E., Schmutz, J.A., Barr, J.F., Eberl, C., and McIntyre, J.W. (2020). Red-throated Loon (*Gavia stellata*), version 2.0. In *Birds of the World* (P. G. Rodewald and B. K. Keeney, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.retloo.02>

Rogers, D.I. (2003). High-tide roost choice by coastal waders. *Wader Study Group Bull.* 100: 73-79.

Ruddock, M. and Whitfield, D.P. (2007). A Review of Disturbance Distances in Selected Bird Species. Natural Research Ltd – Scottish Natural Heritage.

Salomonsen, F. (1968). The moult migration. *Wildfowl*, 19, 5–24.

Scarton, F. (2018). Disturbance of non-breeding waders by pedestrians and boats in a Mediterranean lagoon. *Ardeola* 65: 209-220.

Schwemmer, P., Mendel, B., Sonntag, N., Dierschke, V. and Garthe, S. (2011). Effects of ship traffic on seabirds in offshore waters: Implications for marine conservation and spatial planning. *Ecological applications: a publication of the Ecological Society of America*. 21. 1851-60. 10.2307/23023122.

Scottish Enterprise and Chemical Sciences Scotland (2017). *Future Grangemouth Vision 2025 Evaluation of Economic Effects*.

Scotland's Environment (2019). Protected Nature Sites. Available at: <https://www.environment.gov.scot/data/data-analysis/protected-nature-sites/> [Accessed August 2019]

Scottish Executive Social Research (2007). Exploring the Social Impacts of Flood Risk and Flooding in Scotland. Available at:

<https://www.webarchive.org.uk/wayback/archive/20170114093343/http://www.gov.scot/Publications/2007/04/02121350/16> [Accessed November 2019]

Scottish Government (2010). The Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Regulations 2010. Available at:

<https://www.legislation.gov.uk/ssi/2010/426/contents/made> [Accessed August 2023]

Scottish Government (2014). Scotland's Third National Planning Framework. The Scottish Government, Edinburgh.

Scottish Government (2017). The Flood Risk Management (Flood Protection Schemes, Potentially Vulnerable Areas and Local Plan Districts) (Scotland) Amendment Regulations 2017. Available at:

<https://www.legislation.gov.uk/ssi/2017/112/made> [Accessed August 2023]

Scottish Government (2021). Electoral Ward: Grangemouth. Available at:

<https://statistics.gov.scot/atlas/resource?uri=http%3A%2F%2Fstatistics.gov.scot%2Fid%2Fstatistical-geography%2FS13002937> [Accessed November 2023]

Scottish Government (2019). Implementation of Scottish Government policy on protecting Ramsar sites.

Available at: <https://www.gov.scot/publications/implementation-of-scottish-government-policy-on-protecting-ramsar-sites/> [Accessed November 2023]

Scottish Wildlife Trust (2019). Pink-footed goose *Anser brachyrhynchus*. Available at:

<https://scottishwildlifetrust.org.uk/species/pink-footed-goose/> [Accessed September 2019]

SEPA (2015). Flood Risk Management Strategy, Forth Estuary. Available at:

<https://www2.sepa.org.uk/frmstrategies/forth-estuary.html> [Accessed November 2023]

Skov, H., Heinänen, S., Žydelis, R., Bellebaum, J., Bzoma, S., Dagys, M., Durinck, J., Garthe, S., Grishanov, G., Hario, M., Kieckbusch, J.J., Kube, J., Kuresoo, A., Lasson, K., Luigujoe, L., Meissner, W., Nehls, H.W., Nilsson, L., Petersen, I.K., Roos, M.M., Pihl, S., Sonntag, N., Stock, A., Stipniece, A. and Wahl, J. (2011). Waterbird populations and pressures in the Baltic Sea. Copenhagen: Nordic Council of Ministers.

Smit, C.J. and Visser, G.J.M. (1993). Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area. Wader Study Group Bulletin, 68, 6–19.

SNH (2000). Firth of Forth Site of Scientific Interest Citation.

SNH (2014). Natura Casework Guidance: How to consider plans and projects affecting Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

SNH (2016a). Guidance: Assessing Connectivity with Special Protection Areas (SPAs). Version 3 - June 2016.

SNH (2016b). Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators. SNH, Inverness.

SNH (2018a). Planning e-bulletin - Scottish Government policy on protection of Ramsar sites. SNH (2018b). Letter to Fife Council 3 August 2018 Reference CDM151211/ A2680669.

Summers, R., Mavor, R. and Hogg, S. (1994). Factors affecting loch selection and breeding success of Slavonian grebes in Scotland. Report to Scottish Natural Heritage

Symonds, F. L., Langslow, D. R. and Pienkowski, M. W. (1984). Geographical origins and movements of shorebirds using the Firth of Forth. Ringing and Migration 5: 145–152.

The City of Edinburgh Council (2016). Local Flood Risk Management Plan: Forth Estuary Local Plan District. Available at: <https://www.edinburgh.gov.uk/downloads/file/32870/local-flood-risk-management-plan> [Accessed November 2023]

Tillin, H.M. and Rayment, W. (2016). [Hediste diversicolor] and [Limecola balthica] in littoral sandy mud. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available at: <https://www.marlin.ac.uk/habitat/detail/209> [Accessed January 2020]

Transport Scotland (2009). Forth Replacement Crossing: Environmental Statement. Available at: <https://www.transport.gov.scot/publication/forth-replacement-crossing-environmental-statement/> [Accessed January 2020]

Triplet, P., Bacquet, S., Morand, M.E. and Lahilaire, L. (1998). La distance d'envol, un indicateur de dérangements: l'exemple de quelques espèces d'oiseaux en milieu estuarien. *Alauda* 66: 199–206.

Trulio, L.A. and White, H.R. (2017). Wintering waterfowl avoidance and tolerance of recreational trail use. *Waterbirds* 40: 252–262.

Van der Kolk, H.J., Ens, B.J., Oosterbeek, K., Jongejans, E., and Van de Pol, M. (2021) The hidden cost of disturbance: Eurasian Oystercatchers (*Haematopus ostralegus*) avoid a disturbed roost site during the tourist season. *Ibis*. doi: 10.1111/ibi.13035. Available at: <https://onlinelibrary.wiley.com/doi/10.1111/ibi.13035>

Van Gils, J., Wiersma, P., Kirwan, G.M., and Sharpe, C.J. (2020). Eurasian Curlew (*Numenius arquata*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

Versluijs, M. (2011). Afro-Siberian bar-tailed godwits on inland coastal meadows during spring migration. Professional bachelor thesis: Department of Marine Ecology. NIOZ Royal Netherlands Institute for Sea Research.

Warnock, N.D. and Gill, R.E. (2020). Dunlin (*Calidris alpina*), version 1.0. In *Birds of the World* (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.dunlin.01>

Weston, M.A., McLeod, E.M., Blumstein, D.T. and Guay, P.-J. (2012). A review of flight-initiation distances and their application to managing disturbance to Australian birds. *Emu* 112: 269–286.

Whitfield, D.P., Ruddock, M. and Bullman, R. (2008). Expert opinion as a tool for quantifying bird tolerance to human disturbance. *Biological Conservation*, 141, 2708–2717.

Wiersma, P., Kirwan, G.M. and Boesman, P.F.D. (2020). European Golden-Plover (*Pluvialis apricaria*), version 1.0. In *Birds of the World* (J. del Hoyo, A. Elliott, J. Sargatal, D. A. Christie, and E. de Juana, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. Available at: <https://doi.org/10.2173/bow.eugplo.01>

Woodward, I., Bray, J., Marchant, J., Austin, J. and Calladine, J. (2015). A review of literature on the qualifying interest species of Special Protection Areas (SPAs) in the Firth of Forth and development related influences. Scottish Natural Heritage Commissioned Report No. 804.

Wright, G.A. (2003). Impact of cormorants on the Loch Leven trout fishery and the effectiveness of shooting as mitigation. In: I.G. Cowx (editor) *Interactions between Fish and Birds: Implications for Management*. Oxford: Fishing News Books, Blackwell Science.

Yalden, D.W. and Yalden, P.E. (1989). The sensitivity of breeding golden plovers *Pluvialis apricaria* to human intruders. *Bird Study* 36: 49–55.

Yalden, P.E. and Yalden, D.W. (1990). Recreational disturbances of breeding golden plovers *Pluvialis apricarius*. *Biological Conservation* 51: 243–262.

Zharikov, Y. and Milton, D. (2009). Valuing coastal habitats: Predicting high-tide roosts of non-breeding migratory shorebirds from landscape composition. *Emu*. 109. 10.1071/MU08017.

Zoutenbier, R., Barrett, C. and Lyndon, A.R. (2016). Distribution and Status of Seagrass (*Zostera* spp.) in the Estuary and Firth of Forth. International Seagrass Biology Workshop.

Appendix A: European and Ramsar Site Details

This appendix contains information documents for the following European and Ramsar sites:

- Firth of Forth SPA;
- Firth of Forth Ramsar site;
- River Teith SAC;
- Forth Islands SPA;
- Imperial Dock Lock, Leith SPA;
- Isle of May SAC;
- Outer Firth of Forth and St Andrews Bay Complex SPA;
- Slamannan Plateau SPA;
- Loch Leven SPA; and,
- Loch Leven Ramsar site.

Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (this is the codified version of Directive 79/409/EEC as amended)

CITATION FOR SPECIAL PROTECTION AREA (SPA)

FIRTH OF FORTH (UK9004411)

Site Description:

The Firth of Forth SPA is a complex of estuarine and coastal habitats in south east Scotland stretching from Alloa to the coasts of Fife and East Lothian. The site includes extensive invertebrate-rich intertidal flats and rocky shores, areas of saltmarsh, lagoons and sand dune.

The boundary of the SPA mostly follows that of the Firth of Forth Site of Special Scientific Interest and slightly overlaps with Forth Islands SPA.

Qualifying Interest N.B All figures relate to numbers at the time of classification:

The Firth of Forth SPA qualifies under **Article 4.1** by regularly supporting populations of European importance of the **Annex 1** species (1993/94 to 1997/98 winter peak means): **red-throated diver** *Gavia stellata* (90 individuals, 2% of the GB population), **Slavonian grebe** *Podiceps auritus* (84 individuals, 21% of the GB population), **golden plover** *Pluvialis apricaria* (2,949 individuals, 1% of the GB population) and **bar-tailed godwit** *Limosa lapponica* (1,974 individuals, 4% of the GB population).

The Firth of Forth SPA qualifies under **Article 4.1** by regularly supporting a population of European importance of the **Annex 1** species: **sandwich tern** *Sterna sandvicensis* during the passage period (a winter peak mean during the five year period 1993/94 to 1997/98 of 1,617 individuals, 6% of the GB population).

The Firth of Forth SPA further qualifies under **Article 4.2** by regularly supporting populations of European importance of the **migratory** species (1993/94 to 1997/98 winter peak means): **pink-footed goose** *Anser brachyrhynchus* (10,852 individuals, 6% of the Eastern Greenland/Iceland/UK biogeographic population); **shelduck** *Tadorna tadorna* (4,509 individuals, 2% of the North-western Europe biogeographic population); **knot** *Calidris canutus* (9,258 individuals, 3% of the North-eastern Canada/Greenland/Iceland/North-western Europe biogeographic population); **redshank** *Tringa totanus* (4,341 individuals, 3% of the Eastern Atlantic biogeographic population) and **turnstone** *Arenaria interpres* (860 individuals, 1% of the Western Palearctic biogeographic population).

The Firth of Forth SPA also qualifies under **Article 4.2** by regularly supporting **in excess of 20,000 individual waterfowl**. In the five year period 1992/93 to 1996/97 a winter peak mean of 95,000 individual waterfowl was recorded, comprising 45,000 wildfowl and 50,000 waders including nationally important populations of the following species: **scaup** *Aythya marila* (437 individuals, 4% of the GB population);

Slavonian grebe (84 individuals); **golden plover** (2,949 individuals); **bar-tailed godwit** (1974 individuals); **pink-footed goose** (10,852 individuals, 6% of the GB population); **shelduck** (4,509 individuals, 6% of the GB population); **knot** (9258 individuals, 3% of the GB population); **redshank** (4,341 individuals, 4% of the GB population); **turnstone** (860 individuals, 1% of the GB population); **great crested grebe** *Podiceps cristatus* (720 individuals, 7% of the GB population); **cormorant** *Phalacrocorax carbo* (682 individuals, 5% of the GB population); **red-throated diver** (90 individuals); **curlew** *Numenius arquata* (1,928 individuals, 2% of the GB population); **eider** *Somateria mollissima* (9,400 individuals, 13% of the GB population); **long-tailed duck** *Clangula hyemalis* (1,045 individuals, 4% of the GB population); **common scoter** *Melanitta nigra* (2,880 individuals, 8% of the GB population); **velvet scoter** *Melanitta fusca* (635 individuals, 21% of the GB population); **goldeneye** *Bucephala clangula* (3,004 individuals, 18% of the GB population); **red-breasted merganser** *Mergus serrator* (670 individuals, 7% of the GB population); **oystercatcher** *Haematopus ostralegus* (7,846 individuals, 2% of the GB population); **ringed plover** *Charadrius hiaticula* (328 individuals, 1% of the GB population); **grey plover** *Pluvialis squatarola* (724 individuals, 2% of the GB population); **dunlin** *Calidris alpina alpina* (9,514 individuals, 2% of the GB population). In the five year winter period 1991/92 to 1995/96 the **assemblage additionally included** nationally important populations greater than 2,000 individuals of: **mallard** *Anas platyrhynchos* (2,564 individuals, 0.5% of the GB population); **lapwing** *Vanellus vanellus* (4,148 individuals, 0.3% of the GB population), and **wigeon** *Anas penelope* (2,139 individuals, 0.78% of the GB population).

Area: 6317.93 ha

National Grid Reference: NT594853

OS Sheets 1:50 000 – 58, 59, 65, 66, 67

Classified on 30 October 2001

This (amended) citation adopted on 25 April 2018.

Conservation Objectives for Firth of Forth Special Protection Area

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site
- Distribution of the species within site
- Distribution and extent of habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

Qualifying Species:

- Bar-tailed godwit (*Limosa lapponica*)
- Common scoter (*Melanitta nigra*)*
- Cormorant (*Phalacrocorax carbo*)*
- Curlew (*Numenius arquata*)*
- Dunlin (*Calidris alpina alpina*)*
- Eider (*Somateria mollissima*)*
- Golden plover (*Pluvialis apricaria*)
- Goldeneye (*Bucephala clangula*)*
- Great crested grebe (*Podiceps cristatus*)*
- Grey plover (*Pluvialis squatarola*)*
- Knot (*Calidris canutus*)
- Lapwing (*Vanellus vanellus*)*
- Long-tailed duck (*Clangula hyemalis*) *
- Mallard (*Anas platyrhynchos*)*
- Oystercatcher (*Haematopus ostralegus*)*
- Pink-footed goose (*Anser brachyrhynchus*)
- Red-breasted merganser (*Mergus serrator*)*
- Redshank (*Tringa totanus*)
- Red-throated diver (*Gavia stellata*)
- Ringed plover (*Charadrius hiaticula*) *
- Sandwich tern (*Sterna sandvicensis*)
- Scaup (*Aythya marila*) *
- Shelduck (*Tadorna tadorna*)
- Slavonian grebe (*Podiceps auritus*)
- Turnstone (*Arenaria interpres*)
- Velvet scoter (*Melanitta fusca*)*
- Wigeon (*Anas penelope*)*

- Waterfowl assemblage

* indicates assemblage qualifier only

The site overlaps with Forth Islands Special Protection Area

Ramsar Convention on Wetlands of International Importance Especially as
Waterfowl Habitat

CITATION FOR RAMSAR SITE

(Kampala criteria, 2005)

FIRTH OF FORTH (UK13017)

Site Description:

Firth of Forth Ramsar site is a complex of estuarine and coastal habitats in south east Scotland stretching east from Alloa to the coasts of Fife and East Lothian. The site includes extensive invertebrate-rich intertidal flats and rocky shores, areas of saltmarsh, lagoons and sand dune.

Interest Features (marked in bold): N.B All bird figures relate to numbers at the time of designation:

Firth of Forth Ramsar site qualifies under Ramsar Criterion 2 by supporting: (1993/94 to 1997/98 winter peak means):

- **Red-throated diver** *Gavia stellata* (90 individuals, 2% of the GB population), and
- **Golden plover** *Pluvialis apricaria* (2,949 individuals, 1% of the GB population).

Firth of Forth Ramsar site further qualifies under Ramsar Criterion 5 by regularly supporting waterbirds in numbers of 20,000 individuals or more. In the five-year period 1992/93 to 1996/97, a winter peak mean of 95,000 individual waterbirds was recorded, comprising 45,000 wildfowl and 50,000 waders. The site also qualifies under Ramsar Criterion 4 by supporting the following waterbird species at a critical stage in their life cycles (data 1992/93 to 1996/97 except where stated):

- **Scaup** *Aythya marila* (437 individuals, 4% of the GB population).
- **Great crested grebe** *Podiceps cristatus* (720 individuals, 7% of the GB population).
- **Cormorant** *Phalacrocorax carbo* (682 individuals, 5% of the GB population).
- **Curlew** *Numenius arquata* (1,928 individuals, 2% of the GB population).
- **Eider** *Somateria mollissima* (9,400 individuals, 13% of the GB population).
- **Long-tailed duck** *Clangula hyemalis* (1,045 individuals, 4% of the GB population).
- **Common scoter** *Melanitta nigra* (2,880 individuals, 8% of the GB population).
- **Velvet scoter** *Melanitta fusca* (635 individuals, 21% of the GB population).
- **Red-breasted merganser** *Mergus serrator* (670 individuals, 7% of the GB population).
- **Oystercatcher** *Haematopus ostralegus* (7,846 individuals, 2% of the GB population).
- **Ringed plover** *Charadrius hiaticula* (328 individuals, 1% of the GB population).

- **Grey plover** *Pluvialis squatarola* (724 individuals, 2% of the GB population), and
- **Dunlin** *Calidris alpina alpina* (9,514 individuals, 2% of the GB population).

In the five year winter period 1991/92 to 1995/96 the assemblage additionally included nationally important populations greater than 2,000 individuals of:

- **Mallard** *Anas platyrhynchos* (2,564 individuals, 0.5% of the GB population).
- **Lapwing** *Vanellus vanellus* (4,148 individuals, 0.3% of the GB population), and
- **Wigeon** *Anas penelope* (2,139 individuals, 0.78% of the GB population).

Red-throated diver, golden plover, Slavonian grebe, pink-footed goose, shelduck, knot, redshank, turnstone, goldeneye and bar-tailed godwit are also components of the waterbird assemblage.

Firth of Forth Ramsar site also qualifies under Ramsar Criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbirds (1993/94 to 1997/98 winter peak means):

- **Slavonian grebe** *Podiceps auritus* (84 individuals, 2% of the Northwest Europe biogeographic population).
- **Pink-footed goose** *Anser brachyrhynchus* (10,852 individuals, 6% of the Eastern Greenland/Iceland/UK biogeographic population).
- **Shelduck** *Tadorna tadorna* (4,509 individuals, 2% of the North-western Europe biogeographic population).
- **Knot** *Calidris canutus* (9,258 individuals, 3% of the NE Canada & Greenland/W Europe biogeographic population).
- **Redshank** *Tringa totanus* (4,341 individuals, 3% of the Eastern Atlantic biogeographic population).
- **Turnstone** *Arenaria interpres* (860 individuals, 1% of the NE Canada & Greenland/W Europe & NW Africa biogeographic population).
- **Goldeneye** *Bucephala clangula* (3,004 individuals, 1% of the NW & C Europe biogeographic population).
- **Bar-tailed godwit** *Limosa lapponica* (1,974 individuals, 2% of the Western European biogeographic population), and
- **Sandwich tern** *Sterna sandvicensis* during the passage period (a winter peak mean of 1,617 individuals, 1% of the Europe and West Africa biogeographic population).

Area: 6317.93 ha

National Grid Ref: NT594853

OS Sheet 1:50,000 – 59, 65, 66, 67

Designated on 30 October 2001.

This (amended) citation adopted on 1 November 2021.

Measured site area corrected from 6313.72 ha

Other Designations that underpin the Ramsar Site:

These provide the statutory mechanisms for protection and management of the Ramsar site.

The boundary of the Ramsar site is coincident with the Firth of Forth Special Protection Area (SPA), which underpins all the bird features of the Ramsar site. It lies within the Firth of Forth Site of Special Scientific Interest (SSSI).

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX. 22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.
2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 7, 2nd edition, as amended by COP9 Resolution IX.1 Annex B). A 3rd edition of the Handbook, incorporating these amendments, is in preparation and will be available in 2006.
3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

1. Name and address of the compiler of this form:

Joint Nature Conservation Committee

Monkstone House

City Road

Peterborough

Cambridgeshire PE1 1JY

UK

Telephone/Fax: +44 (0)1733 – 562 626 / +44 (0)1733 – 555 948

Email: RIS@JNCC.gov.uk

FOR OFFICE USE ONLY.

DD MM YY

Designation date

Site Reference Number

2. Date this sheet was completed/updated:

Designated: 30 October 2001

3. Country:

UK (Scotland)

4. Name of the Ramsar site:

Firth of Forth

5. Designation of new Ramsar site or update of existing site:

This RIS is for: Updated information on an existing Ramsar site

6. **For RIS updates only,** changes to the site since its designation or earlier update:

a) Site boundary and area:

**** Important note:** If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site included:

Refer to Annex III of the *Explanatory Notes and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

- i) **hard copy** (required for inclusion of site in the Ramsar List): yes ✓ -or- no ☐;
- ii) **an electronic format** (e.g. a JPEG or ArcView image) Yes
- iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** yes ✓ -or- no ☐;

b) Describe briefly the type of boundary delineation applied:

e.g. the boundary is the same as an existing protected area (nature reserve, national park etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The site boundary is the same as, or falls within, an existing protected area.

For precise boundary details, please refer to paper map provided at designation

8. Geographical coordinates (latitude/longitude):

56 01 00 N 02 53 00 W

9. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

The site is on the east coast of Scotland

Administrative region: City of Edinburgh; Clackmannanshire; East Lothian; Falkirk; Fife; Stirling; West Lothian

10. Elevation (average and/or max. & min.) (metres): 11. Area (hectares): 6313.68

Min. -2
Max. 4
Mean 0

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

The Firth of Forth is a large coastal area comprising a complex of estuaries, mudflats, rocky shorelines, beaches and saltmarshes. It stretches from Alloa Inches in the River Forth to Fife Ness and Dunbar in the east. It is considered to act as a single ecological unit. Several large urban areas, including Edinburgh, are adjacent to the site and these include several areas of heavy industry. Furthermore the Forth is one of the most important shipping areas in Scotland. The site is important for a large number of wintering waders and wildfowl, many in nationally and internationally important numbers.

13. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

5, 6

14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Ramsar criterion 5

Assemblages of international importance:

Species with peak counts in winter:

72281 waterfowl (5 year peak mean 1998/99-2002/2003)

Ramsar criterion 6 – species/populations occurring at levels of international importance.

Qualifying Species/populations (as identified at designation):

Species with peak counts in spring/autumn:

Pink-footed goose , <i>Anser brachyrhynchus</i> , Greenland, Iceland/UK	7863 individuals, representing an average of 3.2% of the population (5 year peak mean 1998/9-2002/3)
Common shelduck , <i>Tadorna tadorna</i> , NW Europe	3596 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9-2002/3)
Common redshank , <i>Tringa totanus totanus</i> ,	5151 individuals, representing an average of 2% of the population (5 year peak mean 1998/9-2002/3)
Ruddy turnstone , <i>Arenaria interpres interpres</i> , NE Canada, Greenland/W Europe & NW Africa	936 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Slavonian grebe , <i>Podiceps auritus</i> , Northwest Europe	68 individuals, representing an average of 2% of the population (5 year peak mean 1998/9-2002/3)
Common goldeneye , <i>Bucephala clangula clangula</i> , NW & C Europe	1789 individuals, representing an average of 7.1% of the GB population (5 year peak mean 1998/9-2002/3)
Red knot , <i>Calidris canutus islandica</i> , W & Southern Africa (wintering)	7295 individuals, representing an average of 1.6% of the population (5 year peak mean 1998/9-2002/3)
Bar-tailed godwit , <i>Limosa lapponica lapponica</i> , W Palearctic	1737 individuals, representing an average of 1.4% of the population (5 year peak mean 1998/9-2002/3)

Species/populations identified subsequent to designation for possible future consideration under criterion 6.

Species regularly supported during the breeding season:

Common tern , <i>Sterna hirundo hirundo</i> , N & E Europe	889 apparently occupied nests, representing an average of 1.4% of the breeding population (Seabird 2000 Census)

Species with peak counts in spring/autumn:

Goosander , <i>Mergus merganser merganser</i> , NW & C Europe	191 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9-2002/3)

Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm.

Details of bird species occurring at levels of National importance are given in Section 22

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Atlantic

b) biogeographic regionalisation scheme (include reference citation):

Council Directive 92/43/EEC

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Soil & geology	shingle, sand, mud
Geomorphology and landscape	lowland, coastal, intertidal sediments (including sandflat/mudflat), open coast (including bay), enclosed coast (including embayment), estuary, lagoon, intertidal rock
Nutrient status	
pH	no information
Salinity	brackish / mixosaline, saline / euhaline
Soil	mainly mineral
Water permanence	usually permanent
Summary of main climatic features	Annual averages (Edinburgh, 1971–2000) (www.metoffice.com/climate/uk/averages/19712000/sites/edinburgh.html) Max. daily temperature: 12.2° C Min. daily temperature: 5.1° C Days of air frost: 54.5 Rainfall: 676.2 mm Hrs. of sunshine: 1405.8

General description of the Physical Features:

The Firth of Forth is a complex estuarine site, stretching for over 100 km from the River Forth at Stirling eastwards past Edinburgh and along the coasts of Fife and East Lothian to a wide estuary mouth. A wide range of coastal and intertidal habitats is found within the site, including saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle and brackish lagoons. Extensive mudflats occur particularly in the Inner Firth, notably at Kinneil Kerse and Skinflats on the south shore and Torry Bay on the north shore. Typically, the flats support a rich invertebrate fauna, with eelgrass *Zostera* spp. growing on the main mudflats. In the Outer Firth, the shoreline diversifies, with sandy shores, some rocky outcrops, mussel beds and some artificial sea-walls. The North Berwick coast includes cliffs and dune grassland, with extensive dune systems at Aberlady.

17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

The catchments of the River Forth and Firth of Forth Estuary cover a total area greater than 3600 km². The area can be split into two distinct sections; the River Forth drainage basin and those catchments that drain into the southern side of the Forth estuary.

The River Forth rises in the south-central Highlands. Glacial drift deposits are present in the middle and eastern parts of the catchment, and sands and gravels are found throughout the lowland valleys. The catchments along the southern side of the Forth Estuary include the major rivers Carron, Avon, Almond and Water of Leith. These areas are low-lying and are more urbanised and industrialised than the River Forth catchment itself. Consequently, dominant land uses are agriculture and built-up areas.

The Firth of Forth is a complex estuarine site, stretching for over 100 km from the River Forth at Stirling eastwards past Edinburgh and along the coasts of Fife and East Lothian to a wide estuary mouth. A wide range of coastal and intertidal habitats is found within the site, including saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle and brackish lagoons. Extensive mudflats occur particularly in the Inner Firth, notably at Kinneil Kerse and Skinflats on the south shore and Torry Bay on the north shore. Typically, the flats support a rich invertebrate fauna, with eelgrass *Zostera* spp. growing on the main mudflats. In the Outer Firth, the shoreline diversifies, with sandy shores, some rocky outcrops, mussel beds and some artificial sea-walls. The North Berwick coast includes cliffs and dune grassland, with extensive dune systems at Aberlady.

18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

Shoreline stabilisation and dissipation of erosive forces

19. Wetland types:

Marine/coastal wetland

Code	Name	% Area
G	Tidal flats	74
E	Sand / shingle shores (including dune systems)	11
D	Rocky shores	9.5
H	Salt marshes	4.5
J	Coastal brackish / saline lagoons	1

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

The site is mostly invertebrate-rich intertidal mud and sandflats. Fairly extensive areas of saltmarsh exist primarily on the south coast while at Alloa Inches there is a small *Phragmites* reedbed.

Ecosystem services

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

None reported

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Birds

Species currently occurring at levels of national importance:

Species regularly supported during the breeding season:

Great cormorant , <i>Phalacrocorax carbo carbo</i> , NW Europe	134 apparently occupied nests, representing an average of 1.6% of the GB population (Seabird 2000 Census)
Herring gull , <i>Larus argentatus argentatus</i> , NW Europe and Iceland/W Europe)	1777 apparently occupied nests, representing an average of 1.2% of the GB population (Seabird 2000 Census)
Roseate tern , <i>Sterna dougallii dougallii</i> , W Europe	11 apparently occupied nests, representing an average of 21.1% of the GB population (Seabird 2000 Census)

Species with peak counts in spring/autumn:

Black-throated diver , <i>Gavia arctica arctica</i> , N Europe & W Siberia	8 individuals, representing an average of 1.1% of the GB population (5 year peak mean 1998/9-2002/3 - spring peak)
Great crested grebe , <i>Podiceps cristatus cristatus</i> , NW Europe	298 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)
Great cormorant , <i>Phalacrocorax carbo carbo</i> , NW Europe	745 individuals, representing an average of 3.2% of the GB population (5 year peak mean 1998/9-2002/3)
Common eider , <i>Somateria mollissima mollissima</i> , NW Europe	6918 individuals, representing an average of 9.4% of the GB population (5 year peak mean 1998/9-2002/3)
Red-breasted merganser , <i>Mergus serrator</i> , NW & C Europe	569 individuals, representing an average of 5.7% of the GB population (5 year peak mean 1998/9-2002/3)
Eurasian oystercatcher , <i>Haematopus ostralegus ostralegus</i> , Europe & NW Africa -wintering	8596 individuals, representing an average of 2.7% of the GB population (5 year peak mean 1998/9-2002/3)
Ringed plover , <i>Charadrius hiaticula</i> , Europe/Northwest Africa	604 individuals, representing an average of 1.8% of the GB population (5 year peak mean 1998/9-2002/3)
Ruff , <i>Philomachus pugnax</i> , Europe/W Africa	28 individuals, representing an average of 4% of the GB population (5 year peak mean 1998/9-2002/3)
Eurasian curlew , <i>Numenius arquata arquata</i> , N. a. arquata Europe (breeding)	4007 individuals, representing an average of 2.7% of the GB population (5 year peak mean 1998/9-2002/3)
Spotted redshank , <i>Tringa erythropus</i> , Europe/W Africa	2 individuals, representing an average of 1.4% of the GB population (5 year peak mean 1998/9-2002/3)
Common greenshank , <i>Tringa nebularia</i> , Europe/W Africa	27 individuals, representing an average of 4.5% of the GB population (5 year peak mean 1998/9-2002/3)
Species with peak counts in winter:	
Red-throated diver , <i>Gavia stellata</i> , NW Europe	104 individuals, representing an average of 2.1% of the GB population (5 year peak mean 1998/9-2002/3)
Whooper swan , <i>Cygnus cygnus</i> , Iceland/UK/Ireland	77 individuals, representing an average of 1.3% of the GB population (5 year peak mean 1998/9-2002/3)

Greater scaup , <i>Aythya marila marila</i> , W Europe	211 individuals, representing an average of 2.7% of the GB population (5 year peak mean 1998/9-2002/3)
Long-tailed duck , <i>Clangula hyemalis</i> , W Siberia/N Europe	541 individuals, representing an average of 3.3% of the GB population (5 year peak mean 1998/9-2002/3)
Black (common) scoter , <i>Melanitta nigra nigra</i> ,	2125 individuals, representing an average of 4.2% of the GB population (5 year peak mean 1998/9-2002/3)
Velvet scoter , <i>Melanitta fusca fusca</i> , Baltic/W Europe	804 individuals, representing an average of 26.8% of the GB population (5 year peak mean 1998/9-2002/3)
European golden plover , <i>Pluvialis apricaria apricaria</i> , P. a. altifrons Iceland & Faroes/E Atlantic	2521 individuals, representing an average of 1% of the GB population (5 year peak mean 1998/9-2002/3)
Grey plover , <i>Pluvialis squatarola</i> , E Atlantic/W Africa -wintering	773 individuals, representing an average of 1.4% of the GB population (5 year peak mean 1998/9-2002/3)
Sanderling , <i>Calidris alba</i> , Eastern Atlantic	258 individuals, representing an average of 1.2% of the GB population (5 year peak mean 1998/9-2002/3)
Dunlin , <i>Calidris alpina alpina</i> , W Siberia/W Europe	12617 individuals, representing an average of 2.2% of the GB population (5 year peak mean 1998/9-2002/3)
Black-tailed godwit , <i>Limosa limosa islandica</i> , Iceland/W Europe	202 individuals, representing an average of 1.3% of the GB population (5 year peak mean 1998/9-2002/3)

Species Information

None reported

23. Social and cultural values:

Describe if the site has any general social and/or cultural values e.g. fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Aesthetic
 Archaeological/historical site
 Environmental education/ interpretation
 Non-consumptive recreation
 Scientific research
 Sport fishing
 Sport hunting
 Tourism
 Transportation/navigation

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? **No**

If Yes, describe this importance under one or more of the following categories:

- i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:

- ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:
- iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:
- iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

Ownership category	On-site	Off-site
Non-governmental organisation (NGO)	+	+
Local authority, municipality etc.	+	+
National/Crown Estate	+	
Private	+	+
Public/communal	+	+

25. Current land (including water) use:

Activity	On-site	Off-site
Nature conservation	+	
Tourism	+	+
Recreation	+	+
Current scientific research	+	
Commercial forestry		+
Fishing: commercial		+
Fishing: recreational/sport	+	
Gathering of shellfish	+	+
Bait collection	+	
Arable agriculture (unspecified)		+
Permanent arable agriculture		+
Hunting: recreational/sport	+	+
Industry		+
Sewage treatment/disposal	+	+
Harbour/port	+	+
Transport route	+	+
Urban development		+
Non-urbanised settlements		+
Military activities	+	+

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

Explanation of reporting category:

1. Those factors that are still operating, but it is unclear if they are under control, as there is a lag in showing the management or regulatory regime to be successful.
2. Those factors that are not currently being managed, or where the regulatory regime appears to have been ineffective so far.

NA = Not Applicable because no factors have been reported.

Adverse Factor Category	Reporting Category	Description of the problem (Newly reported Factors only)	On-Site	Off-Site	Major Impact?
No factors reported	NA				

For category 2 factors only.

What measures have been taken / are planned / regulatory processes invoked, to mitigate the effect of these factors?

Is the site subject to adverse ecological change? NO

27. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

Conservation measure	On-site	Off-site
Site/ Area of Special Scientific Interest (SSSI/ASSI)	+	
Special Protection Area (SPA)	+	
Land owned by a non-governmental organisation for nature conservation	+	
Management agreement	+	
Special Area of Conservation (SAC)		+

b) Describe any other current management practices:

The management of Ramsar sites in the UK is determined by either a formal management plan or through other management planning processes, and is overseen by the relevant statutory conservation agency. Details of the precise management practises are given in these documents.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

No information available

29. Current scientific research and facilities:

e.g. details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

WeBS counts are done between September and April each year.

An annual late summer bird count is also carried out.

Aberlady Bay is often used for undergraduate and postgraduate research projects

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitor centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

Aberlady Bay and Torry Bay Local Nature Reserves and the John Muir Country Park all have full-time rangers/wardens who lead some guided walks and other educational activities.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Many people use the areas adjoining the Firth for recreation. Walking, dog-walking, horse-riding and bathing are all common in many parts of the Forth. There is some evidence to suggest that the distribution of some bird species may be influenced by increased activity on the coast particularly in East Lothian. On the whole these activities are not considered detrimental to the site and visitor access is managed to minimise any negative effects. This includes specific locations and periods when public access may be restricted (e.g. the tern colony at Aberlady Bay).

The sea is also used for activities such as wind-surfing, canoeing and yachting. There is no evidence to suggest any of these are detrimental.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept. of Agriculture/Dept. of Environment, etc.

Scottish Executive, Environment and Rural Affairs Department

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Scottish Natural Heritage, 2 Anderson Place, Edinburgh, EH6 5NP

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

Site-relevant references

Anon. (ed.) (1972) *The Forth–Tay estuaries (an environmental assessment). Proceedings of the Royal Society of Edinburgh*, **71B**(2/4)

Barne, JH, Robson, CF, Kaznowska, SS, Doody, JP Davidson, NC & Buck, AL (eds.) (1997) *Coasts and Seas of the United Kingdom. Region 4. South-east Scotland: Montrose to Eyemouth*. Joint Nature Conservation Committee, Peterborough (Coastal Directories Series)

Baxter, EV & Rintoul, LJ (1953) *The birds of Scotland*. Oliver & Boyd, London

Bennett, TL & McLeod, CR (1998) Chapter 4. East Scotland (Duncansby Head to Dunbar) (MNCR Sector 4). In: *Benthic marine ecosystems of Great Britain and the north-east Atlantic*, ed. by K. Hiscock, 123-154. Joint Nature Conservation Committee, Peterborough. (Coasts and Seas of the United Kingdom. MNCR series)

Bentley, M (1998) The shore, the estuaries and the sea. In: *The nature of Fife. Wildlife and ecology*, ed. by GB Corbet, 52-69. Scottish Cultural Press, Edinburgh, for Scottish Wildlife Trust (Fife & Kinross Branch)

Brazier, DP, Davies, J, Holt, RHF & Murray, E (1998) *Marine Nature Conservation Review Sector 5. South-east Scotland and north-east England: area summaries*. Joint Nature Conservation Committee, Peterborough (Coasts and seas of the United Kingdom. MNCR series)

Bryant, DM (1978) Moulting shelducks on the Forth estuary. *Bird Study*, **25**, 103-108

Bryant, DM (1987) Wading birds and wildfowl of the estuary and Firth of Forth, Scotland. In: *The natural environment of the estuary and Firth of Forth*, ed. by DS McLusky, 509-520. *Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, **93**(3/4)

Buck, AL (ed.) (1993) *An inventory of UK estuaries. Volume 4. North and east Scotland*. Joint Nature Conservation Committee, Peterborough

Burd, F (1989) *The saltmarsh survey of Great Britain. An inventory of British saltmarshes*. Nature Conservancy Council, Peterborough (Research & Survey in Nature Conservation, No. 17)

- Covey, R, Fortune, F, Nichols, DM & Thorpe, K (1998) *Marine Nature Conservation Review Sectors 3, 4, 13 & 15. Lagoons in mainland Scotland and the Inner Hebrides: area summaries*. Joint Nature Conservation Committee, Peterborough (Coasts and seas of the United Kingdom. MNCR series)
- Cranswick, PA, Waters, RJ, Musgrove, AJ & Pollitt, MS (1997) *The Wetland Bird Survey 1995–96: wildfowl and wader counts*. British Trust for Ornithology, Wildfowl and Wetlands Trust, Royal Society for the Protection of Birds & Joint Nature Conservation Committee, Slimbridge
- Crawford, RMM (1998) The landward coast: dunes, saltmarsh, and cliffs. In: *The nature of Fife. Wildlife and ecology*, ed. by GB Corbet, 40-51. Scottish Cultural Press, Edinburgh, for Scottish Wildlife Trust (Fife & Kinross Branch)
- Davidson, NC, Laffoley, D d'A, Doody, JP, Way, LS, Gordon, J, Key, R, Pienkowski, MW, Mitchell, R & Duff, KL (1991) *Nature conservation and estuaries in Great Britain*. Nature Conservancy Council, Peterborough
- Dean, BJ, Webb, A, McSorley, CA & Reid, JB (2003) Aerial surveys of UK inshore areas for wintering seaduck, divers and grebes: 2000/01 and 2001/02. *JNCC Report*, No. **333**. www.jncc.gov.uk/page-2346
- Dean, BJ, Webb, A, McSorley, CA, Schofield, RA & Reid, JB (2004) Surveillance of wintering seaducks, divers and grebes in UK inshore areas: aerial surveys and shore-based counts 2003/04. *JNCC Report*, No. **357**
- Department for Environment, Food and Rural Affairs (2002) *National Report submitted to the 8th Meeting of the Conference of the Parties, Valencia, Spain, 2002*. Joint Nature Conservation Committee, Peterborough. www.jncc.gov.uk/idx/ramsar/cop8/Default.htm
- Doody, JP, Johnston, C & Smith, B (1993) *Directory of the North Sea coastal margin*. Joint Nature Conservation Committee, Peterborough
- Elkins, N, Reid, JB, Brown, AW, Robertson, DG & Smout, A-M (2003) *The Fife bird atlas*. Fife Ornithological Atlas Group
- Forth Estuary Forum (1999) *The Forth Integrated Management Strategy*. Forth Estuary Forum, Edinburgh
- Forth Estuary Forum [1995]. *File on Forth. The directory of the Forth Estuary Forum*. Forth Estuary Forum, [Perth]
- Goodman, KS, Ferbrache, J & Martin, DE (1984) *A review of BP sponsored environmental monitoring and research programmes carried out within the Forth Estuary 1973 – 1983*. (Contractor: BP International Ltd, Environmental Control Centre, London.) Unpublished report to Forth Colliery Joint Environmental Committee
- Howarth, D & Bryant, DM (1988) Spatial and temporal changes in bird populations on the estuary and Firth of Forth 1969–1986. *Nature Conservancy Council, CSD Report*, No. **841**
- Jenkins, DJ (1972) The status of shelducks in the Forth area. *Scottish Birds*, **87**, 183-201
- MacGregor, AR (1968) *Fife and Angus geology. An excursion guide*. Scottish Academic Press, Edinburgh, for University of St Andrews
- McLusky, DS (1978) Ecology of the Forth estuary. *Forth Naturalist and Historian*, **3**, 10-23
- McLusky, DS (ed.) (1987) *The natural environment of the estuary and Firth of Forth. Proceedings of the Royal Society of Edinburgh. Series B: Biological Sciences*, **93**(3/4)
- McLusky, DS (ed.) (1997) *The estuaries of central Scotland. A volume based on a local meeting of the Estuarine and Coastal Sciences Association, Edinburgh, UK, April 1995. Coastal Zone Topics: Process, Ecology & Management*, **3**
- McLusky, DS, Bryant, DM, Berry, AJ & Proctor, J [1991] *Forth estuary publications*. University of Stirling, Department of Biological and Molecular Sciences, Stirling
- McLusky, DS, Bryant, DM & Elliott, M (1992) The impact of land-claim on macrobenthos, fish and shorebirds on the Forth estuary, eastern Scotland. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **2**, 211-222
- Meire, P & Vincx, M (eds.) (1993) *Marine and estuarine gradients. Proceedings of the 21th (sic) symposium of the Estuarine and Coastal Sciences Association held in Gent, 9–14 September 1991. Netherlands Journal of Aquatic Ecology*, **27**(2–4)
- Morris, JM (2005) Firth of Forth National Vegetation Classification Survey 2003. *Scottish Natural Heritage Commissioned Report*, No. **092** (ROAME No. F03LH16)
- Musgrove, AJ, Langston, RHW, Baker, H & Ward, RM (eds.) (2003) *Estuarine waterbirds at low tide. The WeBS Low Tide Counts 1992–93 to 1998–99*. WSG/BTO/WWT/RSPB/JNCC, Thetford (International Wader Studies, No. 16)
- Musgrove, AJ, Pollitt, MS, Hall, C, Hearn, RD, Holloway, SJ, Marshall, PE, Robinson, JA & Cranswick, PA (2001) *The Wetland Bird Survey 1999–2000: wildfowl and wader counts*. British Trust for Ornithology, Wildfowl and Wetlands Trust, Royal Society for the Protection of Birds & Joint Nature Conservation Committee, Slimbridge. www.wwt.org.uk/publications/default.asp?PubID=14
- Pienkowski, MW & Evans, PR (1979) The origins of shelduck moulting in the Firth of Forth. *Bird Study*, **26**, 195-196
- Posford Haskoning (2002) Broad scale intertidal survey of the Firth of Forth. *Scottish Natural Heritage Commissioned Report*, No. F01AA407
- Pritchard, DE, Housden, SD, Mudge, GP, Galbraith, CA & Pienkowski, MW (eds.) (1992) *Important Bird Areas in the United Kingdom including the Channel Islands and the Isle of Man*. Royal Society for the Protection of Birds, Sandy

- Ramsay, DL & Brampton, AH (2000) Coastal cells in Scotland: Cell 1 – St Abb's Head to Fife Ness. *Scottish Natural Heritage Research Survey and Monitoring Report*, No. **143**
- Ratcliffe, DA (ed.) (1977) *A Nature Conservation Review. The selection of biological sites of national importance to nature conservation in Britain*. Cambridge University Press (for the Natural Environment Research Council and the Nature Conservancy Council), Cambridge (2 vols.)
- Read, P (1993) *Publications and theses relating to the estuary and Firth of Forth*. Unpublished, Napier University, Edinburgh
- Ritchie, W (1979) *The beaches of Fife*. University of Aberdeen, Department of Geography, Aberdeen (for the Countryside Commission for Scotland, Perth)
- Rose, PM & Scott, DA (1997) *Waterfowl population estimates*. 2nd edn. Wetlands International, Wageningen (Wetlands International Publication, No. 44) www.wetlands.org/IWC/wpe2/WPE2-toc.htm
- Royal Society for the Protection of Birds (1992) *The conservation of the Firth of Forth: Falkirk District*. Royal Society for the Protection of Birds, Edinburgh (Report to Falkirk District Council)
- Smout, A-M (1986) *The birds of Fife. An outline of their status and distribution*. John Donald, Edinburgh
- Stone, BH, Sears, J, Cranswick, PA, Gregory, RD, Gibbons, DW, Rehfish, MM, Aebischer, NJ & Reid, JB (1997) Population estimates of birds in Britain and in the United Kingdom. *British Birds*, **90**(1), 1-22
- Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H & Whitehead, S (eds.) (2001) *The UK SPA network: its scope and content. Volume 3: Site accounts*. Joint Nature Conservation Committee, Peterborough www.jncc.gov.uk/UKSPA/default.htm
- Stroud, DA, Mudge, GP & Pienkowski, MW (1990) *Protecting internationally important bird sites: a review of the EEC Special Protection Area network in Great Britain*. Nature Conservancy Council, Peterborough
- Stroud, JM, Turner, AK & Bryant, DM (1983) *Shorebirds on the Forth estuary: effects of pollution and reclamation at Kinneil*. (Contractor: University of Stirling.) Unpublished report to Nature Conservancy Council
- Symonds, FL, Langslow, DR & Pienkowski, MW (1984) Movements of wintering shorebirds within the Firth of Forth: species differences in usage of an intertidal complex. *Biological Conservation*, **28**, 187-215
- Thom, VM (1969) Wintering duck in Scotland, 1962–1968. *Scottish Birds*, **5**, 417-466
- Tynninghame Technical Working Party (1976) *John Muir Country Park: descriptive management plan*. East Lothian District Council, [Haddington]

Please return to: **Ramsar Secretariat, Rue Mauverney 28, CH-1196 Gland, Switzerland**
Telephone: +41 22 999 0170 • Fax: +41 22 999 0169 • email: ramsar@ramsar.org

NATURA 2000 – STANDARD DATA FORM

Special Areas of Conservation under the EC Habitats Directive (includes candidate SACs, Sites of Community Importance and designated SACs).

Each Natura 2000 site in the United Kingdom has its own Standard Data Form containing site-specific information. The data form for this site has been generated from the Natura 2000 Database submitted to the European Commission on the following date:

22/12/2015

The information provided here, follows the officially agreed site information format for Natura 2000 sites, as set out in the [Official Journal of the European Union recording the Commission Implementing Decision of 11 July 2011](#) (2011/484/EU).

The Standard Data Forms are generated automatically for all of the UK's Natura 2000 sites using the European Environment Agency's Natura 2000 software. The structure and format of these forms is exactly as produced by the EEA's Natura 2000 software (except for the addition of this coversheet and the end notes). The content matches exactly the data submitted to the European Commission.

Please note that these forms contain a number of codes, all of which are explained either within the data forms themselves or in the end notes.

Further technical documentation may be found here
http://bd.eionet.europa.eu/activities/Natura_2000/reference_portal

As part of the December 2015 submission, several sections of the UK's previously published Standard Data Forms have been updated. For details of the approach taken by the UK in this submission please refer to the following document:
http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

More general information on Special Areas of Conservation (SACs) in the United Kingdom is available from the [SAC home page on the JNCC website](#). This webpage also provides links to Standard Data Forms for all SACs in the UK.

Date form generated by the Joint Nature Conservation Committee
25 January 2016.



NATURA 2000 - STANDARD DATA FORM

For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)

SITE UK0030263

SITENAME River Teith

TABLE OF CONTENTS

- [1. SITE IDENTIFICATION](#)
- [2. SITE LOCATION](#)
- [3. ECOLOGICAL INFORMATION](#)
- [4. SITE DESCRIPTION](#)
- [5. SITE PROTECTION STATUS AND RELATION WITH CORINE BIOTOPES](#)
- [6. SITE MANAGEMENT](#)

1. SITE IDENTIFICATION

1.1 Type B	1.2 Site code UK0030263	Back to top

1.3 Site name

River Teith

1.4 First Compilation date 2001-03	1.5 Update date 2015-12

1.6 Respondent:

Name/Organisation: Joint Nature Conservation Committee
Address: Joint Nature Conservation Committee Monkstone House City Road Peterborough PE1 1JY
Email:

Date site proposed as SCI:	2001-03
Date site confirmed as SCI:	2004-12
Date site designated as SAC:	2005-03
National legal reference of SAC designation:	Regulations 8 and 11-15 of The Conservation (Natural Habitats, &c) Regulations 1994 (http://www.legislation.gov.uk/ukxi/1994/2716/contents/made).

2. SITE LOCATION

[Back to top](#)

2.1 Site-centre location [decimal degrees]:

Longitude

-4.2875

Latitude

56.28333333

2.2 Area [ha]:

1289.33

2.3 Marine area [%]

0.0

2.4 Sitelength [km]:

143.76

2.5 Administrative region code and name

NUTS level 2 code

Region Name

UKM2

Eastern Scotland

2.6 Biogeographical Region(s)

Atlantic (100.0
%)

3. ECOLOGICAL INFORMATION

3.1 Habitat types present on the site and assessment for them

[Back to top](#)

Annex I Habitat types						Site assessment			
Code	PF	NP	Cover [ha]	Cave [number]	Data quality	A B C D	A B C		
						Representativity	Relative Surface	Conservation	Global
3130 			520.5		G	D			
7140 			5.29		G	D			
91E0 	X		5.29		G	D			

- **PF:** for the habitat types that can have a non-priority as well as a priority form (6210, 7130, 9430) enter "X" in the column PF to indicate the priority form.
- **NP:** in case that a habitat type no longer exists in the site enter: x (optional)
- **Cover:** decimal values can be entered
- **Caves:** for habitat types 8310, 8330 (caves) enter the number of caves if estimated surface is not available.
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation)

3.2 Species referred to in Article 4 of Directive 2009/147/EC and listed in Annex II of Directive 92/43/EEC and site evaluation for them

Species					Population in the site						Site assessment			
G	Code	Scientific Name	S	NP	T	Size		Unit	Cat.	D.qual.	A B C D	A B C		
						Min	Max				Pop.	Con.	Iso.	Glo.
F	1099	Lampetra fluviatilis			p				P	DD	C	B	B	B
F	1096	Lampetra planeri			p				P	DD	C	B	B	B
M	1355	Lutra lutra			p				P	DD	D			
I	1029	Margaritifera margaritifera			p				P	DD	D			
F	1095	Petromyzon marinus			p				P	DD	C	B	B	B
F	1106	Salmo salar			p				P	DD	C	B	B	C

- **Group:** A = Amphibians, B = Birds, F = Fish, I = Invertebrates, M = Mammals, P = Plants, R = Reptiles
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Type:** p = permanent, r = reproducing, c = concentration, w = wintering (for plant and non-migratory species use permanent)
- **Unit:** i = individuals, p = pairs or other units according to the Standard list of population units and codes in accordance with Article 12 and 17 reporting (see [reference portal](#))
- **Abundance categories (Cat.):** C = common, R = rare, V = very rare, P = present - to fill if data are deficient (DD) or in addition to population size information
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation); VP = 'Very poor' (use this category only, if not even a rough estimation of the population size can be made, in this case the fields for population size can remain empty, but the field "Abundance categories" has to be filled in)

4. SITE DESCRIPTION

4.1 General site character

[Back to top](#)

Habitat class	% Cover
N02	0.5
N06	95.0
N16	3.0
N07	1.5
Total Habitat Cover	100

Other Site Characteristics

1 Terrestrial: Soil &
 Geology: mud,peat,sandstone,sedimentary,metamorphic,clay,igneous,nutrient-rich,neutral,sand,alluvium,nutrien
 Terrestrial: Geomorphology and landscape: lowland,upland,valley,floodplain

4.2 Quality and importance

Petromyzon marinus for which this is considered to be one of the best areas in the United Kingdom. Lampetra fluviatilis for which this is considered to be one of the best areas in the United Kingdom. Lampetra planeri for which this is considered to be one of the best areas in the United Kingdom. Salmo salar for which the area is considered to support a significant presence.

4.3 Threats, pressures and activities with impacts on the site

The most important impacts and activities with high effect on the site

Negative Impacts			
Rank	Threats and pressures [code]	Pollution (optional) [code]	inside/outside [i o b]
H	J02		B
M	C03		B
M	F02		I
H	I01		B
L	A04		I
M	M01		B
M	K01		I
H	J03		B
M	M02		B
M	F01		B
M	K03		I
L	A02		I
M	I03		O
L	E01		O
M	C01		B
H	E03		B
M	H04		B
L	A01		I
M	D02		B
L	A06		I
M	A07		B
L	B02		I
H	H01		B

Positive Impacts			
Rank	Activities, management [code]	Pollution (optional) [code]	inside/outside [i o b]

Rank: H = high, M = medium, L = low

Pollution: N = Nitrogen input, P = Phosphor/Phosphate input, A = Acid input/acidification,

T = toxic inorganic chemicals, O = toxic organic chemicals, X = Mixed pollutions

i = inside, o = outside, b = both

4.5 Documentation

Conservation Objectives - the Scottish Natural Heritage 'site link' below provides access to the Conservation Objectives for this site. See also the 'UK Approach' document for more information (link via the JNCC website).

Link(s): http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

http://gateway.snh.gov.uk/sitelink/documentview.jsp?p_pa_code=8367&p_Doc_Type_ID=29

5. SITE PROTECTION STATUS (optional)

[Back to top](#)

5.1 Designation types at national and regional level:

Code	Cover [%]	Code	Cover [%]	Code	Cover [%]
UK00	95.8	UK04	4.2		

6. SITE MANAGEMENT

[Back to top](#)

6.1 Body(ies) responsible for the site management:

Organisation:	Scottish Natural Heritage
Address:	
Email:	

6.2 Management Plan(s):

An actual management plan does exist:

☐	Yes
☐	No, but in preparation
☒	No

6.3 Conservation measures (optional)

For available information, including on Conservation Objectives, see Section 4.5.

EXPLANATION OF CODES USED IN THE NATURA 2000 STANDARD DATA FORMS

The codes in the table below are also explained in the [official European Union guidelines for the Standard Data Form](#). The relevant page is shown in the table below.

1.1 Site type

CODE	DESCRIPTION	PAGE NO
A	Designated Special Protection Area	53
B	SAC (includes candidates Special Areas of Conservation, Sites of Community Importance and designated SAC)	53
C	SAC area the same as SPA. Note in the UK Natura 2000 submission this is only used for Gibraltar	53

3.1 Habitat representativity

CODE	DESCRIPTION	PAGE NO
A	Excellent	57
B	Good	57
C	Significant	57
D	Non-significant presence	57

3.1 Habitat code

CODE	DESCRIPTION	PAGE NO
1110	Sandbanks which are slightly covered by sea water all the time	57
1130	Estuaries	57
1140	Mudflats and sandflats not covered by seawater at low tide	57
1150	Coastal lagoons	57
1160	Large shallow inlets and bays	57
1170	Reefs	57
1180	Submarine structures made by leaking gases	57
1210	Annual vegetation of drift lines	57
1220	Perennial vegetation of stony banks	57
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	57
1310	Salicornia and other annuals colonizing mud and sand	57
1320	Spartina swards (Spartinion maritimae)	57
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	57
1340	Inland salt meadows	57
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	57
2110	Embryonic shifting dunes	57
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	57
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	57
2140	Decalcified fixed dunes with Empetrum nigrum	57
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	57
2160	Dunes with Hippophila rhamnoides	57
2170	Dunes with Salix repens ssp. argentea (Salicion arenariae)	57
2190	Humid dune slacks	57
21A0	Machairs (* in Ireland)	57
2250	Coastal dunes with Juniperus spp.	57
2330	Inland dunes with open Corynephorus and Agrostis grasslands	57
3110	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	57
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	57
3140	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	57
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	57

CODE	DESCRIPTION	PAGE NO
3160	Natural dystrophic lakes and ponds	57
3170	Mediterranean temporary ponds	57
3180	Turloughs	57
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitriche-Batrachion vegetation	57
4010	Northern Atlantic wet heaths with Erica tetralix	57
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	57
4030	European dry heaths	57
4040	Dry Atlantic coastal heaths with Erica vagans	57
4060	Alpine and Boreal heaths	57
4080	Sub-Arctic Salix spp. scrub	57
5110	Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	57
5130	Juniperus communis formations on heaths or calcareous grasslands	57
6130	Calaminarian grasslands of the Violetalia calaminariae	57
6150	Siliceous alpine and boreal grasslands	57
6170	Alpine and subalpine calcareous grasslands	57
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	57
6230	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	57
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	57
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	57
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	57
6520	Mountain hay meadows	57
7110	Active raised bogs	57
7120	Degraded raised bogs still capable of natural regeneration	57
7130	Blanket bogs (* if active bog)	57
7140	Transition mires and quaking bogs	57
7150	Depressions on peat substrates of the Rhynchosporion	57
7210	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	57
7220	Petrifying springs with tufa formation (Cratoneurion)	57
7230	Alkaline fens	57
7240	Alpine pioneer formations of the Caricion bicoloris-atrofuscae	57
8110	Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	57
8120	Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	57
8210	Calcareous rocky slopes with chasmophytic vegetation	57
8220	Siliceous rocky slopes with chasmophytic vegetation	57
8240	Limestone pavements	57
8310	Caves not open to the public	57
8330	Submerged or partially submerged sea caves	57
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion roburi-petraeae or Ilici-Fagenion)	57
9130	Asperulo-Fagetum beech forests	57
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	57
9180	Tilio-Acerion forests of slopes, screes and ravines	57
9190	Old acidophilous oak woods with Quercus robur on sandy plains	57
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles	57
91C0	Caledonian forest	57
91D0	Bog woodland	57
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	57
91J0	Taxus baccata woods of the British Isles	57

3.1 Relative surface

CODE	DESCRIPTION	PAGE NO
A	15%-100%	58
B	2%-15%	58
C	< 2%	58

3.1 Conservation status habitat

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	59
B	Good conservation	59
C	Average or reduced conservation	59

3.1 Global grade habitat

CODE	DESCRIPTION	PAGE NO
A	Excellent value	59
B	Good value	59
C	Significant value	59

3.2 Population (abbreviated to 'Pop.' in data form)

CODE	DESCRIPTION	PAGE NO
A	15%-100%	62
B	2%-15%	62
C	< 2%	62
D	Non-significant population	62

3.2 Conservation status species (abbreviated to 'Con.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	63
B	Good conservation	63
C	Average or reduced conservation	63

3.2 Isolation (abbreviated to 'Iso.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Population (almost) Isolated	63
B	Population not-isolated, but on margins of area of distribution	63
C	Population not-isolated within extended distribution range	63

3.2 Global Grade (abbreviated to 'Glo.' Or 'G.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	63
B	Good value	63
C	Significant value	63

3.3 Assemblages types

CODE	DESCRIPTION	PAGE NO
WATR	Non breeding waterfowl assemblage	UK specific code
SBA	Breeding seabird assemblage	UK specific code
BBA	Breeding bird assemblage (applies only to sites classified pre 2000)	UK specific code

4.1 Habitat class code

CODE	DESCRIPTION	PAGE NO
N01	Marine areas, Sea inlets	65
N02	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	65
N03	Salt marshes, Salt pastures, Salt steppes	65
N04	Coastal sand dunes, Sand beaches, Machair	65
N05	Shingle, Sea cliffs, Islets	65
N06	Inland water bodies (Standing water, Running water)	65
N07	Bogs, Marshes, Water fringed vegetation, Fens	65
N08	Heath, Scrub, Maquis and Garrigue, Phygrana	65
N09	Dry grassland, Steppes	65
N10	Humid grassland, Mesophile grassland	65
N11	Alpine and sub-Alpine grassland	65
N14	Improved grassland	65
N15	Other arable land	65
N16	Broad-leaved deciduous woodland	65
N17	Coniferous woodland	65
N19	Mixed woodland	65
N21	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	65
N22	Inland rocks, Screes, Sands, Permanent Snow and ice	65
N23	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	65
N25	Grassland and scrub habitats (general)	65
N26	Woodland habitats (general)	65

4.3 Threats code

CODE	DESCRIPTION	PAGE NO
A01	Cultivation	65
A02	Modification of cultivation practices	65
A03	Mowing / cutting of grassland	65
A04	Grazing	65
A05	Livestock farming and animal breeding (without grazing)	65
A06	Annual and perennial non-timber crops	65
A07	Use of biocides, hormones and chemicals	65
A08	Fertilisation	65
A10	Restructuring agricultural land holding	65
A11	Agriculture activities not referred to above	65
B01	Forest planting on open ground	65
B02	Forest and Plantation management & use	65
B03	Forest exploitation without replanting or natural regrowth	65
B04	Use of biocides, hormones and chemicals (forestry)	65
B06	Grazing in forests/ woodland	65
B07	Forestry activities not referred to above	65
C01	Mining and quarrying	65
C02	Exploration and extraction of oil or gas	65
C03	Renewable abiotic energy use	65
D01	Roads, paths and railroads	65
D02	Utility and service lines	65
D03	Shipping lanes, ports, marine constructions	65
D04	Airports, flightpaths	65
D05	Improved access to site	65
E01	Urbanised areas, human habitation	65
E02	Industrial or commercial areas	65

CODE	DESCRIPTION	PAGE NO
E03	Discharges	65
E04	Structures, buildings in the landscape	65
E06	Other urbanisation, industrial and similar activities	65
F01	Marine and Freshwater Aquaculture	65
F02	Fishing and harvesting aquatic resources	65
F03	Hunting and collection of wild animals (terrestrial), including damage caused by game (excessive density), and taking/removal of terrestrial animals (including collection of insects, reptiles, amphibians, birds of prey, etc., trapping, poisoning, poaching, predator control, accidental capture (e.g. due to fishing gear), etc.)	65
F04	Taking / Removal of terrestrial plants, general	65
F05	Illegal taking/ removal of marine fauna	65
F06	Hunting, fishing or collecting activities not referred to above	65
G01	Outdoor sports and leisure activities, recreational activities	65
G02	Sport and leisure structures	65
G03	Interpretative centres	65
G04	Military use and civil unrest	65
G05	Other human intrusions and disturbances	65
H01	Pollution to surface waters (limnic & terrestrial, marine & brackish)	65
H02	Pollution to groundwater (point sources and diffuse sources)	65
H03	Marine water pollution	65
H04	Air pollution, air-borne pollutants	65
H05	Soil pollution and solid waste (excluding discharges)	65
H06	Excess energy	65
H07	Other forms of pollution	65
I01	Invasive non-native species	65
I02	Problematic native species	65
I03	Introduced genetic material, GMO	65
J01	Fire and fire suppression	65
J02	Human induced changes in hydraulic conditions	65
J03	Other ecosystem modifications	65
K01	Abiotic (slow) natural processes	65
K02	Biocenotic evolution, succession	65
K03	Interspecific faunal relations	65
K04	Interspecific floral relations	65
K05	Reduced fecundity/ genetic depression	65
L05	Collapse of terrain, landslide	65
L07	Storm, cyclone	65
L08	Inundation (natural processes)	65
L10	Other natural catastrophes	65
M01	Changes in abiotic conditions	65
M02	Changes in biotic conditions	65
U	Unknown threat or pressure	65
XO	Threats and pressures from outside the Member State	65

5.1 Designation type codes

CODE	DESCRIPTION	PAGE NO
UK00	No Protection Status	67
UK01	National Nature Reserve	67
UK02	Marine Nature Reserve	67
UK04	Site of Special Scientific Interest (UK)	67

Conservation Objectives for River Teith Special Area of Conservation

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and

To ensure for the qualifying species that the following are maintained in the long term:

- **Population of the species, including range of genetic types for salmon, as a viable component of the site**
- **Distribution of the species within site**
- **Distribution and extent of habitats supporting the species**
- **Structure, function and supporting processes of habitats supporting the species**
- **No significant disturbance of the species**

Qualifying Species:

- Atlantic salmon
- Brook lamprey
- River lamprey
- Sea lamprey

Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (this is the codified version of Directive 79/409/EEC as amended)

**CITATION FOR SPECIAL PROTECTION AREA
(SPA)**

**FORTH ISLANDS
(UK9004171)**

INCLUDING MARINE EXTENSION

Site Description:

Forth Islands SPA consists of a series of islands supporting the main seabird colonies in the Firth of Forth. The islands of Inchmickery, Isle of May, Fidra, The Lamb, Craigleith and Bass Rock were classified on 25 April 1990. The extension to the site, classified on the 16 February 2004 consists of the island of Long Craig, which, at the time of classification, supported the largest colony of roseate tern in Scotland. It is the most northerly of only six regular British colonies. The seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.

The boundary of the SPA overlaps with the boundaries of the following Sites of Special Scientific Interest: Long Craig, Inchmickery, Forth Islands, Bass Rock and the Isle of May. A small overlap also occurs with the Firth of Forth SPA.

Qualifying Interest N.B All figures relate to numbers at the time of classification except where amended by the 2001 SPA Review and or subsequent surveys (roseate tern and common tern):

Forth Islands SPA qualifies under **Article 4.1** by regularly supporting populations of European importance of the **Annex 1** species: **Arctic tern** *Sterna paradisaea* (mean between 1992 and 1996 of 540 pairs, 1.2% of the GB population); **roseate tern** *Sterna dougallii* (mean between 1997 and 2001 of 8 pairs, 13% of the GB population); **common tern** *Sterna hirundo* (mean between 1997 and 2001 of 334 pairs, 3% of the GB population) and **sandwich tern** *Sterna sandvicensis* (an average of 440 pairs, 3% of the GB population).

Forth Islands SPA further qualifies under **Article 4.2** by regularly supporting populations of European importance of the **migratory** species: **northern gannet** *Morus bassanus* (21,600 pairs, 8.2% of the world biogeographic population); **European shag** *Phalacrocorax aristotelis* (2,400 pairs, 1.9% of the N Europe biogeographic population); **lesser black-backed gull** *Larus fuscus* (1,500 pairs, 1.2% of total *L.f. graellsii* biogeographic population) and **Atlantic puffin** *Fratercula arctica* (14,000 pairs, 1.5% of the total *F.a.grabae* biogeographic population).

Forth Islands SPA also qualifies under **Article 4.2** by regularly supporting **in excess of 20,000 individual seabirds**. The site regularly supports 90,000 seabirds (three year mean, 1986 – 1988) including nationally important populations of the following species: **razorbill** *Alca torda* (1,400 pairs, 1.4% of the GB population); **common guillemot** *Uria aalge* (16,000 pairs, 2.2% of the GB population); **black-legged kittiwake** *Rissa tridactyla* (8,400 pairs, 1.7% of the GB population); **herring gull** *Larus argentatus* (6,600 pairs, 4.1% of the GB population); **great cormorant** *Phalacrocorax carbo* (200 pairs, 2.8% of the GB population); **northern gannet** (21,600

pairs, 13.6% of the GB population); **lesser black-backed gull** (1,500 pairs, 1.8% of the GB population); **European shag** (2,400 pairs, 6.6% of the GB population); **Atlantic puffin** (14,000 pairs, 3.1% of the GB population); **Arctic tern** (540 pairs); **common tern** (334 pairs); **roseate tern** (8 pairs), and **sandwich tern** (440 pairs).

Area: 9,797.01 ha

National Grid References: NT650995

OS Sheet 1:50,000 - 59, 65, 66 & 67

Classified on 25 April 1990; extended 16 February 2004, marine extension classified on 25 September 2009

This (amended) citation adopted on 25 May 2018.

Conservation Objectives for Forth Islands Special Protection Area

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- **Population of the species as a viable component of the site**
- **Distribution of the species within site**
- **Distribution and extent of habitats supporting the species**
- **Structure, function and supporting processes of habitats supporting the species**
- **No significant disturbance of the species**

Qualifying Species:

- Arctic tern (*Sterna paradisaea*)
- Common tern (*Sterna hirundo*)
- Cormorant (*Phalacrocorax carbo*)*
- Gannet (*Morus bassanus*)
- Guillemot (*Uria aalge*)*
- Herring gull (*Larus argentatus*)*
- Kittiwake (*Rissa tridactyla*)*
- Lesser black-backed gull (*Larus fuscus*)
- Puffin (*Fratercula arctica*)
- Razorbill (*Alca torda*)*
- Roseate tern (*Sterna dougallii*)
- Sandwich tern (*Sterna sandvicensis*)
- Shag (*Phalacrocorax aristotelis*)

- Seabird assemblage

* indicates assemblage qualifier only

The site overlaps with Isle of May Special Area of Conservation

EC Directive 79/409 on the Conservation of Wild Birds

CITATION FOR SPECIAL PROTECTION AREA (SPA)

**IMPERIAL DOCK LOCK, LEITH
CITY OF EDINBURGH (UK9004451)**

Site Description:

The **Imperial Dock Lock, Leith** Special Protection Area (SPA) is a man-made structure at the mouth of the Imperial Dock in the heart of the Port of Leith, and lies within the City of Edinburgh Local Authority area. The boundary of the SPA is coincidental with that of the Imperial Dock Lock.

Qualifying Interest:

The Imperial Dock Lock, Leith SPA qualifies under **Article 4.1** by regularly supporting breeding populations of European importance of the **Annex I** species **common tern** *Sterna hirundo* (an average of 558 pairs, 1997-2001; 5% GB). This location supports the largest colony of common tern in the Forth, and one of the largest colonies in Britain.

Area: 0.11 ha

National Grid References: NT269773

OS Sheet 1:50,000 – 66

Conservation Objectives for Imperial Dock Lock, Leith Special Protection Area

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- **Population of the species as a viable component of the site**
- **Distribution of the species within site**
- **Distribution and extent of habitats supporting the species**
- **Structure, function and supporting processes of habitats supporting the species**
- **No significant disturbance of the species**

Qualifying Species:

- **Common tern (*Sterna hirundo*)**

NATURA 2000 – STANDARD DATA FORM

Special Areas of Conservation under the EC Habitats Directive (includes candidate SACs, Sites of Community Importance and designated SACs).

Each Natura 2000 site in the United Kingdom has its own Standard Data Form containing site-specific information. The data form for this site has been generated from the Natura 2000 Database submitted to the European Commission on the following date:

22/12/2015

The information provided here, follows the officially agreed site information format for Natura 2000 sites, as set out in the [Official Journal of the European Union recording the Commission Implementing Decision of 11 July 2011](#) (2011/484/EU).

The Standard Data Forms are generated automatically for all of the UK's Natura 2000 sites using the European Environment Agency's Natura 2000 software. The structure and format of these forms is exactly as produced by the EEA's Natura 2000 software (except for the addition of this coversheet and the end notes). The content matches exactly the data submitted to the European Commission.

Please note that these forms contain a number of codes, all of which are explained either within the data forms themselves or in the end notes.

Further technical documentation may be found here
http://bd.eionet.europa.eu/activities/Natura_2000/reference_portal

As part of the December 2015 submission, several sections of the UK's previously published Standard Data Forms have been updated. For details of the approach taken by the UK in this submission please refer to the following document:
http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

More general information on Special Areas of Conservation (SACs) in the United Kingdom is available from the [SAC home page on the JNCC website](#). This webpage also provides links to Standard Data Forms for all SACs in the UK.

Date form generated by the Joint Nature Conservation Committee
25 January 2016.



NATURA 2000 - STANDARD DATA FORM

For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)

SITE UK0030172

SITENAME Isle of May

TABLE OF CONTENTS

- [1. SITE IDENTIFICATION](#)
- [2. SITE LOCATION](#)
- [3. ECOLOGICAL INFORMATION](#)
- [4. SITE DESCRIPTION](#)
- [5. SITE PROTECTION STATUS AND RELATION WITH CORINE BIOTOPES](#)
- [6. SITE MANAGEMENT](#)

1. SITE IDENTIFICATION

1.1 Type B	1.2 Site code UK0030172	Back to top

1.3 Site name

Isle of May

1.4 First Compilation date 2001-01	1.5 Update date 2015-12

1.6 Respondent:

Name/Organisation: Joint Nature Conservation Committee
Address: Joint Nature Conservation Committee Monkstone House City Road Peterborough PE1 1JY
Email:

Date site proposed as SCI:	2001-01
Date site confirmed as SCI:	2004-12
Date site designated as SAC:	2005-03
National legal reference of SAC designation:	Regulations 8 and 11-15 of The Conservation (Natural Habitats, &c) Regulations 1994 (http://www.legislation.gov.uk/ukxi/1994/2716/contents/made).

2. SITE LOCATION

[Back to top](#)

2.1 Site-centre location [decimal degrees]:

Longitude

-2.573611111

Latitude

56.19027778

2.2 Area [ha]:

356.64

2.3 Marine area [%]

93.0

2.4 Sitelength [km]:

0.0

2.5 Administrative region code and name

NUTS level 2 code

Region Name

UKZZ	Extra-Regio
UKM2	Eastern Scotland

2.6 Biogeographical Region(s)

Atlantic (100.0
%)

3. ECOLOGICAL INFORMATION

[Back to top](#)

3.1 Habitat types present on the site and assessment for them

Annex I Habitat types						Site assessment			
Code	PF	NP	Cover [ha]	Cave [number]	Data quality	A B C D	A B C		
						Representativity	Relative Surface	Conservation	Global
1170			79.96		G	B	C	C	C

- **PF:** for the habitat types that can have a non-priority as well as a priority form (6210, 7130, 9430) enter "X" in the column PF to indicate the priority form.
- **NP:** in case that a habitat type no longer exists in the site enter: x (optional)
- **Cover:** decimal values can be entered
- **Caves:** for habitat types 8310, 8330 (caves) enter the number of caves if estimated surface is not available.
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation)

3.2 Species referred to in Article 4 of Directive 2009/147/EC and listed in Annex II of Directive 92/43/EEC and site evaluation for them

Species					Population in the site					Site assessment	
G	Code	Scientific Name	S	NP	T	Size	Unit	Cat.	D.qual.	A B C D	A B C

						Min	Max				Pop.	Con.	Iso.	Glo.
M	1364	Halichoerus grypus			p	5900	5900	i		G	B	B	C	B

- **Group:** A = Amphibians, B = Birds, F = Fish, I = Invertebrates, M = Mammals, P = Plants, R = Reptiles
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Type:** p = permanent, r = reproducing, c = concentration, w = wintering (for plant and non-migratory species use permanent)
- **Unit:** i = individuals, p = pairs or other units according to the Standard list of population units and codes in accordance with Article 12 and 17 reporting (see [reference portal](#))
- **Abundance categories (Cat.):** C = common, R = rare, V = very rare, P = present - to fill if data are deficient (DD) or in addition to population size information
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation); VP = 'Very poor' (use this category only, if not even a rough estimation of the population size can be made, in this case the fields for population size can remain empty, but the field "Abundance categories" has to be filled in)

4. SITE DESCRIPTION

[Back to top](#)

4.1 General site character

Habitat class	% Cover
N05	1.7
N03	11.3
N01	87.0
Total Habitat Cover	100

Other Site Characteristics

1 Terrestrial: Soil & Geology: basalt 2 Terrestrial: Geomorphology and landscape: coastal 3 Marine: Geology: igneous 4 Marine: Geomorphology: subtidal rock (including rocky reefs),cliffs,islands

4.2 Quality and importance

Reefs for which the area is considered to support a significant presence. Halichoerus grypus for which this is considered to be one of the best areas in the United Kingdom.

4.3 Threats, pressures and activities with impacts on the site

The most important impacts and activities with high effect on the site

Negative Impacts			
Rank	Threats and pressures [code]	Pollution (optional) [code]	inside/outside [i o b]
H	F02		I
M	H03		B
L	I03		O
L	G01		I
M	G05		I
H	K02		I
L	J02		B
M	K03		I
M	F01		B

Positive Impacts			
Rank	Activities, management [code]	Pollution (optional) [code]	inside/outside [i o b]
M	G01		I
M	D01		B

L	L05		I
M	H06		O
M	E01		O

Rank: H = high, M = medium, L = low

Pollution: N = Nitrogen input, P = Phosphor/Phosphate input, A = Acid input/acidification,

T = toxic inorganic chemicals, O = toxic organic chemicals, X = Mixed pollutions

i = inside, o = outside, b = both

4.5 Documentation

Conservation Objectives - the Scottish Natural Heritage 'site link' below provides access to the Conservation Objectives for this site. See also the 'UK Approach' document for more information (link via the JNCC website).

Link(s): http://jncc.defra.gov.uk/pdf/Natura2000_StandardDataForm_UKApproach_Dec2015.pdf

http://gateway.snh.gov.uk/sitelink/documentview.jsp?p_pa_code=8278&p_Doc_Type_ID=29

5. SITE PROTECTION STATUS (optional)

[Back to top](#)

5.1 Designation types at national and regional level:

Code	Cover [%]	Code	Cover [%]	Code	Cover [%]
UK00	88.3	UK04	11.7	UK01	11.7

6. SITE MANAGEMENT

[Back to top](#)

6.1 Body(ies) responsible for the site management:

Organisation:	Scottish Natural Heritage
Address:	
Email:	

6.2 Management Plan(s):

An actual management plan does exist:

☐	Yes
☐	No, but in preparation
☒	No

6.3 Conservation measures (optional)

For available information, including on Conservation Objectives, see Section 4.5.

EXPLANATION OF CODES USED IN THE NATURA 2000 STANDARD DATA FORMS

The codes in the table below are also explained in the [official European Union guidelines for the Standard Data Form](#). The relevant page is shown in the table below.

1.1 Site type

CODE	DESCRIPTION	PAGE NO
A	Designated Special Protection Area	53
B	SAC (includes candidates Special Areas of Conservation, Sites of Community Importance and designated SAC)	53
C	SAC area the same as SPA. Note in the UK Natura 2000 submission this is only used for Gibraltar	53

3.1 Habitat representativity

CODE	DESCRIPTION	PAGE NO
A	Excellent	57
B	Good	57
C	Significant	57
D	Non-significant presence	57

3.1 Habitat code

CODE	DESCRIPTION	PAGE NO
1110	Sandbanks which are slightly covered by sea water all the time	57
1130	Estuaries	57
1140	Mudflats and sandflats not covered by seawater at low tide	57
1150	Coastal lagoons	57
1160	Large shallow inlets and bays	57
1170	Reefs	57
1180	Submarine structures made by leaking gases	57
1210	Annual vegetation of drift lines	57
1220	Perennial vegetation of stony banks	57
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	57
1310	Salicornia and other annuals colonizing mud and sand	57
1320	Spartina swards (Spartinion maritimae)	57
1330	Atlantic salt meadows (Glauco-Puccinellietalia maritimae)	57
1340	Inland salt meadows	57
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	57
2110	Embryonic shifting dunes	57
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	57
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	57
2140	Decalcified fixed dunes with Empetrum nigrum	57
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	57
2160	Dunes with Hippophila rhamnoides	57
2170	Dunes with Salix repens ssp. argentea (Salicion arenariae)	57
2190	Humid dune slacks	57
21A0	Machairs (* in Ireland)	57
2250	Coastal dunes with Juniperus spp.	57
2330	Inland dunes with open Corynephorus and Agrostis grasslands	57
3110	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	57
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	57
3140	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	57
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	57

CODE	DESCRIPTION	PAGE NO
3160	Natural dystrophic lakes and ponds	57
3170	Mediterranean temporary ponds	57
3180	Turloughs	57
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitriche-Batrachion vegetation	57
4010	Northern Atlantic wet heaths with Erica tetralix	57
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	57
4030	European dry heaths	57
4040	Dry Atlantic coastal heaths with Erica vagans	57
4060	Alpine and Boreal heaths	57
4080	Sub-Arctic Salix spp. scrub	57
5110	Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	57
5130	Juniperus communis formations on heaths or calcareous grasslands	57
6130	Calaminarian grasslands of the Violetalia calaminariae	57
6150	Siliceous alpine and boreal grasslands	57
6170	Alpine and subalpine calcareous grasslands	57
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	57
6230	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	57
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	57
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	57
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	57
6520	Mountain hay meadows	57
7110	Active raised bogs	57
7120	Degraded raised bogs still capable of natural regeneration	57
7130	Blanket bogs (* if active bog)	57
7140	Transition mires and quaking bogs	57
7150	Depressions on peat substrates of the Rhynchosporion	57
7210	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	57
7220	Petrifying springs with tufa formation (Cratoneurion)	57
7230	Alkaline fens	57
7240	Alpine pioneer formations of the Caricion bicoloris-atrofuscae	57
8110	Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	57
8120	Calcareous and calcshist screes of the montane to alpine levels (Thlaspietea rotundifolii)	57
8210	Calcareous rocky slopes with chasmophytic vegetation	57
8220	Siliceous rocky slopes with chasmophytic vegetation	57
8240	Limestone pavements	57
8310	Caves not open to the public	57
8330	Submerged or partially submerged sea caves	57
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion roburi-petraeae or Ilici-Fagenion)	57
9130	Asperulo-Fagetum beech forests	57
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	57
9180	Tilio-Acerion forests of slopes, screes and ravines	57
9190	Old acidophilous oak woods with Quercus robur on sandy plains	57
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles	57
91C0	Caledonian forest	57
91D0	Bog woodland	57
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	57
91J0	Taxus baccata woods of the British Isles	57

3.1 Relative surface

CODE	DESCRIPTION	PAGE NO
A	15%-100%	58
B	2%-15%	58
C	< 2%	58

3.1 Conservation status habitat

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	59
B	Good conservation	59
C	Average or reduced conservation	59

3.1 Global grade habitat

CODE	DESCRIPTION	PAGE NO
A	Excellent value	59
B	Good value	59
C	Significant value	59

3.2 Population (abbreviated to 'Pop.' in data form)

CODE	DESCRIPTION	PAGE NO
A	15%-100%	62
B	2%-15%	62
C	< 2%	62
D	Non-significant population	62

3.2 Conservation status species (abbreviated to 'Con.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	63
B	Good conservation	63
C	Average or reduced conservation	63

3.2 Isolation (abbreviated to 'Iso.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Population (almost) Isolated	63
B	Population not-isolated, but on margins of area of distribution	63
C	Population not-isolated within extended distribution range	63

3.2 Global Grade (abbreviated to 'Glo.' Or 'G.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	63
B	Good value	63
C	Significant value	63

3.3 Assemblages types

CODE	DESCRIPTION	PAGE NO
WATR	Non breeding waterfowl assemblage	UK specific code
SBA	Breeding seabird assemblage	UK specific code
BBA	Breeding bird assemblage (applies only to sites classified pre 2000)	UK specific code

4.1 Habitat class code

CODE	DESCRIPTION	PAGE NO
N01	Marine areas, Sea inlets	65
N02	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	65
N03	Salt marshes, Salt pastures, Salt steppes	65
N04	Coastal sand dunes, Sand beaches, Machair	65
N05	Shingle, Sea cliffs, Islets	65
N06	Inland water bodies (Standing water, Running water)	65
N07	Bogs, Marshes, Water fringed vegetation, Fens	65
N08	Heath, Scrub, Maquis and Garrigue, Phygrana	65
N09	Dry grassland, Steppes	65
N10	Humid grassland, Mesophile grassland	65
N11	Alpine and sub-Alpine grassland	65
N14	Improved grassland	65
N15	Other arable land	65
N16	Broad-leaved deciduous woodland	65
N17	Coniferous woodland	65
N19	Mixed woodland	65
N21	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	65
N22	Inland rocks, Screes, Sands, Permanent Snow and ice	65
N23	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	65
N25	Grassland and scrub habitats (general)	65
N26	Woodland habitats (general)	65

4.3 Threats code

CODE	DESCRIPTION	PAGE NO
A01	Cultivation	65
A02	Modification of cultivation practices	65
A03	Mowing / cutting of grassland	65
A04	Grazing	65
A05	Livestock farming and animal breeding (without grazing)	65
A06	Annual and perennial non-timber crops	65
A07	Use of biocides, hormones and chemicals	65
A08	Fertilisation	65
A10	Restructuring agricultural land holding	65
A11	Agriculture activities not referred to above	65
B01	Forest planting on open ground	65
B02	Forest and Plantation management & use	65
B03	Forest exploitation without replanting or natural regrowth	65
B04	Use of biocides, hormones and chemicals (forestry)	65
B06	Grazing in forests/ woodland	65
B07	Forestry activities not referred to above	65
C01	Mining and quarrying	65
C02	Exploration and extraction of oil or gas	65
C03	Renewable abiotic energy use	65
D01	Roads, paths and railroads	65
D02	Utility and service lines	65
D03	Shipping lanes, ports, marine constructions	65
D04	Airports, flightpaths	65
D05	Improved access to site	65
E01	Urbanised areas, human habitation	65
E02	Industrial or commercial areas	65

CODE	DESCRIPTION	PAGE NO
E03	Discharges	65
E04	Structures, buildings in the landscape	65
E06	Other urbanisation, industrial and similar activities	65
F01	Marine and Freshwater Aquaculture	65
F02	Fishing and harvesting aquatic resources	65
F03	Hunting and collection of wild animals (terrestrial), including damage caused by game (excessive density), and taking/removal of terrestrial animals (including collection of insects, reptiles, amphibians, birds of prey, etc., trapping, poisoning, poaching, predator control, accidental capture (e.g. due to fishing gear), etc.)	65
F04	Taking / Removal of terrestrial plants, general	65
F05	Illegal taking/ removal of marine fauna	65
F06	Hunting, fishing or collecting activities not referred to above	65
G01	Outdoor sports and leisure activities, recreational activities	65
G02	Sport and leisure structures	65
G03	Interpretative centres	65
G04	Military use and civil unrest	65
G05	Other human intrusions and disturbances	65
H01	Pollution to surface waters (limnic & terrestrial, marine & brackish)	65
H02	Pollution to groundwater (point sources and diffuse sources)	65
H03	Marine water pollution	65
H04	Air pollution, air-borne pollutants	65
H05	Soil pollution and solid waste (excluding discharges)	65
H06	Excess energy	65
H07	Other forms of pollution	65
I01	Invasive non-native species	65
I02	Problematic native species	65
I03	Introduced genetic material, GMO	65
J01	Fire and fire suppression	65
J02	Human induced changes in hydraulic conditions	65
J03	Other ecosystem modifications	65
K01	Abiotic (slow) natural processes	65
K02	Biocenotic evolution, succession	65
K03	Interspecific faunal relations	65
K04	Interspecific floral relations	65
K05	Reduced fecundity/ genetic depression	65
L05	Collapse of terrain, landslide	65
L07	Storm, cyclone	65
L08	Inundation (natural processes)	65
L10	Other natural catastrophes	65
M01	Changes in abiotic conditions	65
M02	Changes in biotic conditions	65
U	Unknown threat or pressure	65
XO	Threats and pressures from outside the Member State	65

5.1 Designation type codes

CODE	DESCRIPTION	PAGE NO
UK00	No Protection Status	67
UK01	National Nature Reserve	67
UK02	Marine Nature Reserve	67
UK04	Site of Special Scientific Interest (UK)	67

Conservation Objectives for Isle of May Special Area of Conservation

To avoid deterioration of the qualifying habitat (listed below) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and

To ensure for the qualifying habitat that the following are maintained in the long term:

- **Extent of the habitat on site**
- **Distribution of the habitat within site**
- **Structure and function of the habitat**
- **Processes supporting the habitat**
- **Distribution of typical species of the habitat**
- **Viability of typical species as components of the habitat**
- **No significant disturbance of typical species of the habitat**

Qualifying Habitat:

- **Reefs**

NB The conservation objectives for the qualifying species are on the next page

**Conservation Objectives for
Isle of May Special Area of Conservation**

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and

To ensure for the qualifying species that the following are maintained in the long term:

- **Population of the species as a viable component of the site**
- **Distribution of the species within site**
- **Distribution and extent of habitats supporting the species**
- **Structure, function and supporting processes of habitats supporting the species**
- **No significant disturbance of the species**

Qualifying Species:

- **Grey seal**

The site overlaps with Forth Islands Special Protection Area

Citation

Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (this is the codified version of Directive 79/409/EEC as amended)

CITATION FOR SPECIAL PROTECTION AREA (SPA) OUTER FIRTH OF FORTH AND ST ANDREWS BAY COMPLEX (UK9020316)

Site Description:

The Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA) is a large estuarine/marine site on south-east coast of Scotland consisting of the two closely adjacent Firths of Forth and Tay. In the mid Firth of Forth a belt of mud-rich sediments lies between areas of sandy gravels and shell material on either side along the shore. As the estuary widens towards the outer firth, there are extensive areas of sandy and gravelly muds and fine sediments. In contrast St Andrews Bay contains clean sands and gravel with only small areas of muddy sediments. Water depth is variable but large areas, in both the Firth of Forth and St Andrews Bay, are shallow and less than 10m deep.

The area supports a wide variety of both pelagic and demersal fish, including sandeels, and crustaceans, molluscs and marine worms, all of which, especially sandeels, comprise the prey of the waterfowl species

Qualifying Interest:

The Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA) qualifies under **Article 4.1** by regularly supporting a non-breeding population of European importance of the following **Annex 1** species: **red-throated diver** *Gavia stellata* during the period 2001/02 to 2004/05 (a mean peak estimate of 851 individuals; 5.0% of the Great Britain population); **Slavonian grebe** *Podiceps auritus* during the period 2006/07 to 2010/11 (an average of 30 individuals (2.7% of the Great Britain population); **Little Gull** *Larus minutus* during the period 2001/02 to 2004/05 (126 individuals; more than 50 individuals) and feeding **common tern** *Sterna hirundo* and **Arctic tern** *Sterna paradisaea* from the adjacent breeding colonies.

The Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA) further qualifies under **Article 4.2** by regularly supporting populations of European importance of the following migratory waterfowl species: **Common eider** *Somateria mollissima* average peak counts recorded during the five year period 2001/02 to 2004/05 (21,546 individuals 2.1% of the biogeographic population and 35.9% of the Great Britain population) and by regularly supporting **in excess of 20,000 individual waterfowl** including nationally important populations of the following species during the five year period 2001/02 to 2004/05: **long tailed duck** *Clangula hyemalis* (1,948 individuals, 17.7% of the Great Britain population), **common scoter** *Melanitta nigra* (4,677 individuals, 4.7% of the Great Britain population) and during the period 2006/07-2010/11: **velvet scoter** *Melanitta fusca* (775 individuals, 31% of the Great Britain population), **common goldeneye** *Bucephala clangula* (589 individuals, 2.9% of the Great Britain population) and **red-breasted merganser** *Mergus serrator* (431 individuals, 5.1% of the Great Britain population).

The Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA) further qualifies under **Article 4.2** by regularly supporting populations of European importance of the

following migratory species of seabird: foraging **European shag** *Phalacrocorax aristotelis* from the nearby colonies, and **Northern gannet** *Morus bassanus* during the period 1980-2006 (10,945 individuals, 1.4% of biogeographical population and 2.7% of the Great Britain population).

The Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA) further qualifies under **Article 4.2** by regularly supporting in excess of **20,000 individual seabirds during the breeding season** including nationally important populations of the following species during the period 1980-2006: **Atlantic puffin** *Fratercula arctica* (61,086 individuals, 5.3% of the Great Britain population), **black-legged kittiwake** *Rissa tridactyla* (12,020 individuals, 1.6% of the Great Britain population) **Manx shearwater** *Puffinus puffinus* (2,885 individuals, more than 2,000 individuals), **common guillemot** *Uria aalge* (28,123 individuals, more than 2,000 individuals) and **herring gull** *Larus argentatus* (3,044 individuals, 1.1% of the Great Britain population).

The Outer Firth of Forth and St Andrews Bay Complex Special Protection Area (SPA) further qualifies under **Article 4.2** by regularly supporting in excess of **20,000 individual seabirds during the non-breeding season** including nationally important populations of the following species during the period 2003/04-2005/06: **black-headed gull** *Chroicocephalus ridibundus* (26,835 individuals, 1.2% of the Great Britain population), **common gull** *Larus canus* (14,647 individuals, 2.1% of the Great Britain population), and **herring gull** *Larus argentatus* (12,313 individuals, 1.7% of the Great Britain population) and, during the period 1980-2006: **common guillemot** *Uria aalge* (21,968 individuals, more than 2,000 individuals), **European shag** *Phalacrocorax aristotelis* (2,426 individuals, 2.2% of the Great Britain population), **black-legged kittiwake** *Rissa tridactyla* (3,191 individuals, more than 2,000 individuals) and **razorbill** *Alca torda* (5,481 individuals, more than 2,000 individuals).

Area: 2,720.68 km² (272,068.09 ha)

Location: 56° 08.177' N, 002° 44.526' W (coordinates are supplied in WGS 1984)

OS Sheet: 1:50,000 - 54, 59, 66, 67

03/12/2020

NatureScot

STANDARD DATA FORM for sites within the 'UK national site network of European sites'

Special Protection Areas (SPAs) are classified and Special Areas of Conservation (SACs) are designated under:

- the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales (including the adjacent territorial sea) and to a limited extent in Scotland (reserved matters) and Northern Ireland (excepted matters);
- the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) in Scotland;
- the Conservation (Natural Habitats, &c) Regulations (Northern Ireland) 1995 (as amended) in Northern Ireland; and
- the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) in the UK offshore area.

Each SAC or SPA (forming part of the UK national site network of European sites) has its own Standard Data Form containing site-specific information. The information provided here generally follows the same documenting format for SACs and SPAs, as set out in the [Official Journal of the European Union recording the Commission Implementing Decision of 11 July 2011 \(2011/484/EU\)](#).

Please note that these forms contain a number of codes, all of which are explained either within the data forms themselves or in the end notes.

More general information on SPAs and SACs in the UK is available from the [SPA homepage](#) and [SAC homepage](#) on the JNCC website. These webpages also provide links to Standard Data Forms for all SAC and SPA sites in the UK.

<https://jncc.gov.uk/>



NATURA 2000 - STANDARD DATA FORM

For Special Protection Areas (SPA),
Proposed Sites for Community Importance (pSCI),
Sites of Community Importance (SCI) and
for Special Areas of Conservation (SAC)

SITE UK9020316

SITENAME Outer Firth of Forth and St Andrews Bay Complex

TABLE OF CONTENTS

- [1. SITE IDENTIFICATION](#)
- [2. SITE LOCATION](#)
- [3. ECOLOGICAL INFORMATION](#)
- [4. SITE DESCRIPTION](#)
- [6. SITE MANAGEMENT](#)
- [7. MAP OF THE SITE](#)

1. SITE IDENTIFICATION

1.1 Type	1.2 Site code Back to top
A	UK9020316

1.3 Site name

Outer Firth of Forth and St Andrews Bay Complex

1.4 First Compilation date	1.5 Update date
2020-12	-

1.6 Respondent:

Name/Organisation: Joint Nature Conservation Committee

Address: Joint Nature Conservation Committee Monkstone House City Road Peterborough
PE1 1JY

Email:

1.7 Site indication and designation / classification dates

Date site classified as SPA:	2020-12
National legal reference of SPA designation	Regulations 9A and 11-15 of The Conservation (Natural Habitats, &c.) Regulations 1994 (http://www.legislation.gov.uk/ukxi/1994/2716/contents/made) as amended by the Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2011 (http://www.legislation.gov.uk/ssi/2011/155/contents/made) and Regulations 12, 19 and 20 of The Conservation of Offshore Marine Habitats and Species Regulations 2017 (http://www.legislation.gov.uk/ukxi/2017/1013/contents/made).

2. SITE LOCATION

[Back to top](#)

2.1 Site-centre location [decimal degrees]:

Longitude

-2.7421

Latitude

56.1363

2.2 Area [ha]:

272068.09

2.3 Marine area [%]

100.0

2.5 Administrative region code and name

NUTS level 2 code

Region Name

UKZZ

Extra-Regio

2.6 Biogeographical Region(s)

Atlantic (100.0
%)

3. ECOLOGICAL INFORMATION

[Back to top](#)

3.2 Species referred to in Article 4 of Directive 2009/147/EC and listed in Annex II of Directive 92/43/EEC and site evaluation for them

Species					Population in the site						Site assessment			
G	Code	Scientific Name	S	NP	T	Size		Unit	Cat.	D.qual.	A B C D	A B C		
						Min	Max				Pop.	Con.	Iso.	Glo
B	A200	Alca torda			w	5481	5481	i		M			C	
B	A067	Bucephala clangula			w	589	589	i		G	B		C	
B	A064	Clangula hyemalis			w	1948	1948	i		G	A		C	
B	A204	Fratercula arctica			r	61086	61086	i		M	B		C	
B	A001	Gavia stellata			w	851	851	i		G	B		C	
B	A184	Larus argentatus			r	3044	3044	i		M	C		C	
B	A184	Larus argentatus			w	12313	12313	i		M	C		C	
B	A182	Larus canus			w	14647	14647	i		M	B		C	
B	A177	Larus minutus			w	126	126	i		M			C	
B	A179	Larus ridibundus			w	26835	26835	i		M	C		C	
B	A066	Melanitta fusca			w	775	775	i		G	A		C	

B	A065	Melanitta nigra		w	4677	4677	i	G	B		C	
B	A069	Mergus serrator		w	431	431	i	G	B		C	
B	A016	Morus bassanus		r	10945	10945	i	M	B		C	
B	A018	Phalacrocorax aristotelis		w	2426	2426	i	M	B		C	
B	A018	Phalacrocorax aristotelis		r	2400	2400	p	M	B		C	
B	A007	Podiceps auritus		w	30	30	i	G	B		C	
B	A013	Puffinus puffinus		r	2885	2885	i	M	C		C	
B	A188	Rissa tridactyla		r	12020	12020	i	M	C		C	
B	A188	Rissa tridactyla		w	3191	3191	i	M			C	
B	A063	Somateria mollissima		w	21546	21546	i	G	A		C	
B	A193	Sterna hirundo		r	892	892	p	M	B		C	
B	A194	Sterna paradisaea		r	540	540	p	M	C		C	
B	A199	Uria aalge		r	28213	28213	i	M	C		C	
B	A199	Uria aalge		w	21968	21968	i	M			C	

- **Group:** A = Amphibians, B = Birds, F = Fish, I = Invertebrates, M = Mammals, P = Plants, R = Reptiles
- **S:** in case that the data on species are sensitive and therefore have to be blocked for any public access enter: yes
- **NP:** in case that a species is no longer present in the site enter: x (optional)
- **Type:** p = permanent, r = reproducing, c = concentration, w = wintering (for plant and non-migratory species use permanent)
- **Unit:** i = individuals, p = pairs or other units according to the Standard list of population units and codes in accordance with Article 12 and 17 reporting (see [reference portal](#))
- **Abundance categories (Cat.):** C = common, R = rare, V = very rare, P = present - to fill if data are deficient (DD) or in addition to population size information
- **Data quality:** G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation); VP = 'Very poor' (use this category only, if not even a rough estimation of the population size can be made, in this case the fields for population size can remain empty, but the field "Abundance categories" has to be filled in)

4. SITE DESCRIPTION

4.1 General site character

[Back to top](#)

Habitat class	% Cover
N01	100.0
Total Habitat Cover	100

Other Site Characteristics

1 Marine: Soil and Geology - mud, sand, gravel. 2 Marine: Geomorphology: subtidal rock (including rocky reefs), open coast (including bay), subtidal sediments (including sandbank/mud), estuary.

4.2 Quality and importance

ARTICLE 4.1 QUALIFICATION (2009/147/EC) Over winter the area regularly supports: *Gavia stellata*, 5% of the GB population, mean peak estimate 2001/02 to 2004/05: *Podiceps auritus*, 2.7% of the GB population, mean peak 2006/07 to 2010/11: *Larus minutus*, more than 50 individuals, mean peak 2001/02 to 2004/05. In the breeding season the area regularly supports feeding: *Sterna paradisaea*, 1.2% of the GB population, mean between 1992 and 1996 from adjacent breeding colonies on the Forth Islands SPA and *Sterna hirundo*, 8.8% of the GB population, mean between 1997 and 2001 from adjacent breeding colonies on the Forth Islands SPA and Imperial Dock Lock Leith SPA. ARTICLE 4.2 QUALIFICATION (2009/147/EC) Over winter the area regularly supports: *Somateria mollissima*, 2.1% of the biogeographic population, mean peak 2001/02 to 2004/05. In the breeding season the area regularly supports: foraging *Phalacrocorax aristotelis* from nearby colonies on the Forth Islands SPA, 1.7% of the biogeographic population, no count period specified; foraging *Morus bassanus* from nearby colonies in this instance the Bass Rock part of the Forth Islands SPA, 1.4% of the biogeographic population, modelled estimates based on data from 1980 - 2006. ARTICLE 4.2 QUALIFICATION (2009/147/EC) An internationally important assemblage of birds in the non-breeding season the area regularly supports: in excess of 30,500 individual waterbirds (no count period specified). An internationally important assemblage of birds in the non-breeding season the area regularly supports: in excess of 20,000 individual waterbirds (five year period 2001/02 to 2004/05). Including: *Clangula hyemalis*, *Melanitta nigra*, *Gavia stellata* and *Somateria mollissima*. An internationally important assemblage of birds in the non-breeding season the area regularly supports: in excess of 20,000 individual waterbirds (five year period 2006/07 to 20010/11). Including: *Melanitta fusca*, *Bucephala clangula*, *Mergus serrator* and *Podiceps auritus*. An internationally important assemblage of birds in the breeding season the area regularly supports: 122,245 individual seabirds (no count period specified). An internationally important assemblage of birds in the breeding season the area regularly supports: in excess of 20,000 individual seabirds (mean peak 1980 to 2006). Including: *Fratercula arctica*, *Rissa tridactyla*, *Puffinus puffinus*, *Uria aalge*, *Larus argentatus*, *Sterna paradisaea*, *Sterna hirundo*, *Phalacrocorax aristotelis* and *Morus bassanus*. An internationally important assemblage of birds in the non-breeding season the area regularly supports: 44,628 individual seabirds (no count period specified). An internationally important assemblage of birds in the non-breeding season the area regularly supports: in excess of 20,000 individual seabirds (2003/04 to 2005/06). Including: *Chroicocephalus ridibundus*, *Larus canus* and *Larus argentatus*. An internationally important assemblage of birds in the non-breeding season the area regularly supports: in excess of 20,000 individual seabirds (mean peak 1980 to 2006). Including; *Uria aalge*, *Phalacrocorax aristotelis*, *Rissa tridactyla*, *Alca torda* and *Larus minutus*.

4.3 Threats, pressures and activities with impacts on the site

The most important impacts and activities with high effect on the site

Negative Impacts			
Rank	Threats and pressures [code]	Pollution (optional) [code]	inside/outside [i o b]
L	F01		b
H	F02		b
M	G01		b
M	F06		b
L	D02		b
H	D03		b
M	M02		b
H	H03		b
M	E03		b
M	G05		b
H	C03		b
M	D04		b
H	H01		b
M	M01		b
M	J03		b

Rank: H = high, M = medium, L = low

Pollution: N = Nitrogen input, P = Phosphor/Phosphate input, A = Acid input/acidification,

T = toxic inorganic chemicals, O = toxic organic chemicals, X = Mixed pollutions

Positive Impacts			
Rank	Activities, management [code]	Pollution (optional) [code]	inside/outside [i o b]

i = inside, o = outside, b = both

4.5 Documentation

Conservation and Management Advice package in preparation – links to be inserted.

6. SITE MANAGEMENT

[Back to top](#)

6.1 Body(ies) responsible for the site management:

Organisation:	Offshore: For information about relevant management offshore please contact JNCC
Address:	
Email:	

Organisation:	Inshore (within 12nm): NatureScot
Address:	
Email:	

6.2 Management Plan(s):

An actual management plan does exist:

☐	Yes
☒	No, but in preparation
☐	No

6.3 Conservation measures (optional)

For available information, including on Conservation Objectives, see Section 4.5.

7. MAP OF THE SITES

[Back to top](#)

INSPIRE ID:

Map delivered as PDF in electronic format (optional)

☐ Yes ☒ No

Reference(s) to the original map used for the digitalisation of the electronic boundaries (optional).

EXPLANATION OF CODES USED IN THE SPECIAL AREA OF CONSERVATION (SAC) AND SPECIAL PROTECTION AREA (SPA) STANDARD DATA FORMS

The codes in the table below generally follow those explained in the [official European Union guidelines for the Standard Data Form](#) (also referencing the relevant page number).

1.1 Site type

CODE	DESCRIPTION	PAGE NO
A	SPA (classified Special Protection Area)	53
B	cSAC, SCI or SAC (candidate Special Area of Conservation, Site of Community Importance, designated Special Area of Conservation)	53
C	SPA area/boundary is the same as the cSAC/SCI/SAC i.e. a co-classified/designated site (Note: this situation only occurs in Gibraltar)	53

3.1 Habitat code

CODE	DESCRIPTION	PAGE NO
1110	Sandbanks which are slightly covered by sea water all the time	57
1130	Estuaries	57
1140	Mudflats and sandflats not covered by seawater at low tide	57
1150	Coastal lagoons	57
1160	Large shallow inlets and bays	57
1170	Reefs	57
1180	Submarine structures made by leaking gases	57
1210	Annual vegetation of drift lines	57
1220	Perennial vegetation of stony banks	57
1230	Vegetated sea cliffs of the Atlantic and Baltic Coasts	57
1310	Salicornia and other annuals colonizing mud and sand	57
1320	Spartina swards (Spartinion maritimae)	57
1330	Atlantic salt meadows (Glaucio-Puccinellietalia maritimae)	57
1340	Inland salt meadows	57
1420	Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)	57
2110	Embryonic shifting dunes	57
2120	Shifting dunes along the shoreline with Ammophila arenaria ("white dunes")	57
2130	Fixed coastal dunes with herbaceous vegetation ("grey dunes")	57
2140	Decalcified fixed dunes with Empetrum nigrum	57
2150	Atlantic decalcified fixed dunes (Calluno-Ulicetea)	57
2160	Dunes with Hippophya• rhamnoides	57
2170	Dunes with Salix repens ssp. argentea (Salicion arenariae)	57
2190	Humid dune slacks	57
21A0	Machairs (* in Ireland)	57
2250	Coastal dunes with Juniperus spp.	57
2330	Inland dunes with open Corynephorus and Agrostis grasslands	57
3110	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae)	57
3130	Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoëto-Nanojuncetea	57
3140	Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.	57
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition - type vegetation	57

CODE	DESCRIPTION	PAGE NO
3160	Natural dystrophic lakes and ponds	57
3170	Mediterranean temporary ponds	57
3180	Turloughs	57
3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitriche-Batrachion vegetation	57
4010	Northern Atlantic wet heaths with Erica tetralix	57
4020	Temperate Atlantic wet heaths with Erica ciliaris and Erica tetralix	57
4030	European dry heaths	57
4040	Dry Atlantic coastal heaths with Erica vagans	57
4060	Alpine and Boreal heaths	57
4080	Sub-Arctic Salix spp. scrub	57
5110	Stable xerothermophilous formations with Buxus sempervirens on rock slopes (Berberidion p.p.)	57
5130	Juniperus communis formations on heaths or calcareous grasslands	57
6130	Calaminarian grasslands of the Violetalia calaminariae	57
6150	Siliceous alpine and boreal grasslands	57
6170	Alpine and subalpine calcareous grasslands	57
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites)	57
6230	Species-rich Nardus grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)	57
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	57
6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels	57
6510	Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)	57
6520	Mountain hay meadows	57
7110	Active raised bogs	57
7120	Degraded raised bogs still capable of natural regeneration	57
7130	Blanket bogs (* if active bog)	57
7140	Transition mires and quaking bogs	57
7150	Depressions on peat substrates of the Rhynchosporion	57
7210	Calcareous fens with Cladium mariscus and species of the Caricion davallianae	57
7220	Petrifying springs with tufa formation (Cratoneurion)	57
7230	Alkaline fens	57
7240	Alpine pioneer formations of the Caricion bicoloris-atrofuscae	57
8110	Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani)	57
8120	Calcareous and calcshist scree of the montane to alpine levels (Thlaspietalia rotundifoliae)	57
8210	Calcareous rocky slopes with chasmophytic vegetation	57
8220	Siliceous rocky slopes with chasmophytic vegetation	57
8240	Limestone pavements	57
8310	Caves not open to the public	57
8330	Submerged or partially submerged sea caves	57
9120	Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robur-petraeae or Ilici-Fagenion)	57
9130	Asperulo-Fagetum beech forests	57
9160	Sub-Atlantic and medio-European oak or oak-hornbeam forests of the Carpinion betuli	57
9180	Tilio-Acerion forests of slopes, scree and ravines	57
9190	Old acidophilous oak woods with Quercus robur on sandy plains	57
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles	57
91C0	Caledonian forest	57
91D0	Bog woodland	57
91E0	Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)	57
91J0	Taxus baccata woods of the British Isles	57

3.1 Habitat representativity (abbreviated to 'Representativity' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent representativity	57
B	Good representativity	57
C	Significant representativity	57
D	Non-significant presence representativity	57

3.1 Relative surface

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	58
B	> 2%-15%	58
C	≤ 2%	58

3.1 Degree of conservation (abbreviated to 'Conservation' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	59
B	Good conservation	59
C	Average or reduced conservation	59

3.1 Global assessment (abbreviated to 'Global' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	59
B	Good value	59
C	Significant value	59

3.2 Population (abbreviated to 'Pop.' in data form)

CODE	DESCRIPTION	PAGE NO
A	> 15%-100%	62
B	> 2%-15%	62
C	≤ 2%	62
D	Non-significant population	62

3.2 Degree of conservation (abbreviated to 'Con.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent conservation	63
B	Good conservation	63
C	Average or reduced conservation	63

3.2 Isolation (abbreviated to 'Iso.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Population (almost) Isolated	63
B	Population not-isolated, but on margins of area of distribution	63
C	Population not-isolated within extended distribution range	63

3.2 Global Grade (abbreviated to 'Glo.' or 'G.' in data form)

CODE	DESCRIPTION	PAGE NO
A	Excellent value	63
B	Good value	63
C	Significant value	63

3.3 Other species – essentially covers bird assemblage types

CODE	DESCRIPTION	PAGE NO
WATR	Non-breeding waterbird assemblage	UK specific code
SBA	Breeding seabird assemblage	UK specific code

BBA	Breeding bird assemblage (applies only to sites classified pre 2000)	UK specific code

4.1 Habitat class code

CODE	DESCRIPTION	PAGE NO
N01	Marine areas, Sea inlets	65
N02	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons (including saltwork basins)	65
N03	Salt marshes, Salt pastures, Salt steppes	65
N04	Coastal sand dunes, Sand beaches, Machair	65
N05	Shingle, Sea cliffs, Islets	65
N06	Inland water bodies (Standing water, Running water)	65
N07	Bogs, Marshes, Water fringed vegetation, Fens	65
N08	Heath, Scrub, Maquis and Garrigue, Phygrana	65
N09	Dry grassland, Steppes	65
N10	Humid grassland, Mesophile grassland	65
N11	Alpine and sub-Alpine grassland	65
N14	Improved grassland	65
N15	Other arable land	65
N16	Broad-leaved deciduous woodland	65
N17	Coniferous woodland	65
N19	Mixed woodland	65
N21	Non-forest areas cultivated with woody plants (including Orchards, groves, Vineyards, Dehesas)	65
N22	Inland rocks, Screes, Sands, Permanent Snow and ice	65
N23	Other land (including Towns, Villages, Roads, Waste places, Mines, Industrial sites)	65
N25	Grassland and scrub habitats (general)	65
N26	Woodland habitats (general)	65

4.3 Threats code

CODE	DESCRIPTION	PAGE NO
A01	Cultivation	65
A02	Modification of cultivation practices	65
A03	Mowing / cutting of grassland	65
A04	Grazing	65
A05	Livestock farming and animal breeding (without grazing)	65
A06	Annual and perennial non-timber crops	65
A07	Use of biocides, hormones and chemicals	65
A08	Fertilisation	65
A10	Restructuring agricultural land holding	65
A11	Agriculture activities not referred to above	65
B01	Forest planting on open ground	65
B02	Forest and Plantation management & use	65
B03	Forest exploitation without replanting or natural regrowth	65
B04	Use of biocides, hormones and chemicals (forestry)	65
B06	Grazing in forests/ woodland	65
B07	Forestry activities not referred to above	65
C01	Mining and quarrying	65
C02	Exploration and extraction of oil or gas	65
C03	Renewable abiotic energy use	65
D01	Roads, paths and railroads	65
D02	Utility and service lines	65
D03	Shipping lanes, ports, marine constructions	65
D04	Airports, flightpaths	65
D05	Improved access to site	65
E01	Urbanised areas, human habitation	65
E02	Industrial or commercial areas	65

CODE	DESCRIPTION	PAGE NO
E03	Discharges	65
E04	Structures, buildings in the landscape	65
E06	Other urbanisation, industrial and similar activities	65
F01	Marine and Freshwater Aquaculture	65
F02	Fishing and harvesting aquatic resources	65
F03	Hunting and collection of wild animals (terrestrial), including damage caused by game (excessive density), and taking/removal of terrestrial animals (including collection of insects, reptiles, amphibians, birds of prey, etc., trapping, poisoning, poaching, predator control, accidental capture (e.g. due to fishing gear), etc.)	65
F04	Taking / Removal of terrestrial plants, general	65
F05	Illegal taking/ removal of marine fauna	65
F06	Hunting, fishing or collecting activities not referred to above	65
G01	Outdoor sports and leisure activities, recreational activities	65
G02	Sport and leisure structures	65
G03	Interpretative centres	65
G04	Military use and civil unrest	65
G05	Other human intrusions and disturbances	65
H01	Pollution to surface waters (limnic & terrestrial, marine & brackish)	65
H02	Pollution to groundwater (point sources and diffuse sources)	65
H03	Marine water pollution	65
H04	Air pollution, air-borne pollutants	65
H05	Soil pollution and solid waste (excluding discharges)	65
H06	Excess energy	65
H07	Other forms of pollution	65
I01	Invasive non-native species	65
I02	Problematic native species	65
I03	Introduced genetic material, GMO	65
J01	Fire and fire suppression	65
J02	Human induced changes in hydraulic conditions	65
J03	Other ecosystem modifications	65
K01	Abiotic (slow) natural processes	65
K02	Biocenotic evolution, succession	65
K03	Interspecific faunal relations	65
K04	Interspecific floral relations	65
K05	Reduced fecundity/ genetic depression	65
L05	Collapse of terrain, landslide	65
L07	Storm, cyclone	65
L08	Inundation (natural processes)	65
L10	Other natural catastrophes	65
M01	Changes in abiotic conditions	65
M02	Changes in biotic conditions	65
U	Unknown threat or pressure	65
XO	Threats and pressures from outside the Member State	65

5.1 Designation type codes

CODE	DESCRIPTION	PAGE NO
UK00	No Protection Status	67
UK01	National Nature Reserve	67
UK04	Site of Special Scientific Interest (GB)	67
UK05	Marine Conservation Zone	67
UK06	Nature Conservation Marine Protected Area	67
UK86	Special Area (Channel Islands)	67
UK98	Area of Special Scientific Interest (NI)	67
IN00	Ramsar Convention site	67
IN08	Special Protection Area	67
IN09	Special Area of Conservation	67

EC Directive 79/409 on the Conservation of Wild Birds

CITATION FOR SPECIAL PROTECTION AREA (SPA)

SLAMANNAN PLATEAU

FALKIRK AND NORTH LANARKSHIRE (UK9004441)

Site description:

Slamannan Plateau lies just east of Cumbernauld, in the headwaters of the River Avon. It consists of two small lochs and their surrounding peatlands and associated areas of rough and improved grassland. These habitats support roosting and feeding Taiga bean geese during periods in winter.

Qualifying interest:

Slamannan Plateau qualifies under **Article 4.2** by regularly supporting nationally important numbers of migratory **Taiga bean geese** (*Anser fabalis fabalis*). Between winters 2000/2001 and 2004/05 the average peak number of geese at the site was 221, representing over 53% of the total number present in Great Britain.

Area: 591.32ha

National Grid Reference NS 810740

OS 1:50,000 sheets 64 & 65

Scottish Natural Heritage

9 October 2008

Conservation Objectives for Slamannan Plateau Special Protection Area

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- **Population of the species as a viable component of the site**
- **Distribution of the species within site**
- **Distribution and extent of habitats supporting the species**
- **Structure, function and supporting processes of habitats supporting the species**
- **No significant disturbance of the species**

Qualifying Species:

- Taiga bean goose (*Anser fabalis fabalis*)

The site overlaps with West Fannyside Moss Special Area of Conservation

**SPECIAL PROTECTION AREA (SPA) CITATION
FOR PUBLIC ISSUE**

LOCH LEVEN, TAYSIDE (UK9004111)

Site Description:

Loch Leven in central Scotland is the largest natural eutrophic lake in Britain. It is a relatively shallow loch, surrounded by farmland, with a diverse aquatic flora and shoreline vegetation. The boundary of the Loch Leven SPA follows that of the Loch Leven SSSI except for the exclusion of 4 ha of SSSI towards the northern end of the loch.

Qualifying Interest:

Loch Leven SPA qualifies under **Article 4.1** by supporting a population of European importance of wintering Icelandic whooper swan *Cygnus cygnus* (1993/94-97/98 winter peak mean of 97, 2% of British population).

Loch Leven SPA qualifies under **Article 4.2** by regularly supporting populations of European importance of wintering Icelandic/Greenlandic pink-footed geese *Anser brachyrhynchus* (1993/94-97/98 winter peak mean of 17,163, 8% of total population, all of which winters in Britain) and shoveler *Anas clypeata* (509, 1% of NW European & 5% of British).

Loch Leven SPA further qualifies under **Article 4.2** by regularly supporting a wintering waterfowl assemblage of European importance (1993/94-1997/98 winter peak mean of 34,280) which includes large populations of cormorant *Phalacrocorax carbo* (391, 3% of GB) gadwall *Anas strepera* (245, 3% of GB), teal *A. crecca* (2,771, 2% of GB), pochard *Aythya ferina* (1,095, 2% of GB), tufted duck *A. fuligula* (3,636, 6% of GB) and goldeneye *Bucephala clangula* (339, 2% of GB).

Area: 1,608 Ha

National Grid Reference: NO 145015

OS 1:50,000 sheet - 58

March 2000

Natura 2000

Scottish Natural Heritage

Conservation Objectives for Loch Leven Special Protection Area

To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site
- Distribution of the species within site
- Distribution and extent of habitats supporting the species
- Structure, function and supporting processes of habitats supporting the species
- No significant disturbance of the species

Qualifying Species:

- Cormorant (*Phalacrocorax carbo*)*
- Gadwall (*Anas strepera*)*
- Goldeneye (*Bucephala clangula*)*
- Pink-footed goose (*Anser brachyrhynchus*)
- Pochard (*Aythya ferina*)*
- Shoveler (*Anas clypeata*)
- Teal (*Anas crecca*)*
- Tufted duck (*Aythya fuligula*)*
- Whooper swan (*Cygnus cygnus*)

- Waterfowl assemblage

* indicates assemblage qualifier only

Ramsar Convention on Wetlands of International Importance Especially as
Waterfowl Habitat

CITATION FOR RAMSAR SITE

(Kampala criteria, 2005)

LOCH LEVEN (UK13033)

Site Description:

Loch Leven Ramsar site in central Scotland is the largest natural eutrophic loch in Britain. It is relatively shallow and surrounded by farmland, with a diverse aquatic flora and shoreline vegetation.

Interest Features (marked in bold): N.B All bird figures relate to numbers at the time of classification of the Special Protection Area (SPA):

Loch Leven Ramsar site qualifies under Ramsar Criterion 1 by virtue of it containing:

- **Eutrophic loch.** This is the largest such loch in lowland Scotland and is unique in Britain being both large and shallow, with only rare stratification.

Loch Leven Ramsar site also qualifies under Ramsar Criterion 2 by supporting:

- **Whooper swan** *Cygnus cygnus* (1993/1994 to 1997/1998, winter peak mean of 97 individuals, 2% of the GB population).

Loch Leven Ramsar site qualifies under Ramsar Criterion 5 by regularly supporting waterbirds in numbers of 20,000 individuals or more. In the five-year period 1993/94-1997/98 a winter peak mean of approximately 34,280 individual waterbirds was recorded. The site also qualifies under Ramsar Criterion 4 by supporting the following waterbird species at a critical stage in their life cycles:

- **Cormorant** *Phalacrocorax carbo* (391 individuals, 3% of the GB population).
- **Gadwall** *Anas strepera* (245 individuals, 3% of the GB population).
- **Teal** *Anas crecca* (2,771 individuals, 2% of the GB population).
- **Pochard** *Aythya ferina* (1,095 individuals, 2% of the GB population).
- **Tufted duck** *Aythya fuligula* (3,636 individuals, 6% of the GB population), and
- **Goldeneye** *Bucephala clangula* (339 individuals, 2% of the GB population).

Loch Leven Ramsar site further qualifies under Ramsar Criterion 6 by regularly supporting 1% or more of the individuals in a population of waterbirds (1993/1994 to 1997/1998):

- **Pink-footed goose** *Anser brachyrhynchus* (winter peak mean of 17,163 individuals, 8% the Eastern Greenland/Iceland/UK biogeographic population), and
- **Shoveler** *Anas clypeata* (winter peak mean of 509 individuals, 1% of North Western & Central Europe biogeographic population).

Pink-footed goose, shoveler and whooper swan are also components of the waterbird assemblage.

Area: 1611.29 ha
National Grid Ref: NO148016
OS Sheet 1:50,000: 58

Designated on 5 January 1976, extended 27 March 2000.

This (amended) citation adopted on 5 January 2022.

Measured site area corrected from 1608 ha

Other Designations that underpin the Ramsar Site:

These provide the statutory mechanisms for protection and management of the Ramsar site.

The boundary of the Ramsar site is coincident with Loch Leven SPA, which underpins all the bird features of the Ramsar site. The supporting habitat for the SPA's birds also underpins the Ramsar habitat feature. The eutrophic loch is considered to be supporting habitat for the SPA and Ramsar bird populations as it provides essential feeding and roosting habitat.

The Ramsar site is also coincident with Loch Leven Site of Special Scientific Interest (SSSI), which underpins the eutrophic loch feature.

Information Sheet on Ramsar Wetlands (RIS)

Categories approved by Recommendation 4.7 (1990), as amended by Resolution VIII.13 of the 8th Conference of the Contracting Parties (2002) and Resolutions IX.1 Annex B, IX.6, IX.21 and IX.22 of the 9th Conference of the Contracting Parties (2005).

Notes for compilers:

1. The RIS should be completed in accordance with the attached *Explanatory Notes and Guidelines for completing the Information Sheet on Ramsar Wetlands*. Compilers are strongly advised to read this guidance before filling in the RIS.
2. Further information and guidance in support of Ramsar site designations are provided in the *Strategic Framework for the future development of the List of Wetlands of International Importance* (Ramsar Wise Use Handbook 7, 2nd edition, as amended by COP9 Resolution IX.1 Annex B). A 3rd edition of the Handbook, incorporating these amendments, is in preparation and will be available in 2006.
3. Once completed, the RIS (and accompanying map(s)) should be submitted to the Ramsar Secretariat. Compilers should provide an electronic (MS Word) copy of the RIS and, where possible, digital copies of all maps.

1. Name and address of the compiler of this form:

Joint Nature Conservation Committee

Monkstone House

City Road

Peterborough

Cambridgeshire PE1 1JY

UK

Telephone/Fax: +44 (0)1733 – 562 626 / +44 (0)1733 – 555 948

Email: RIS@JNCC.gov.uk

FOR OFFICE USE ONLY.

DD MM YY

Designation date

Site Reference Number

2. Date this sheet was completed/updated:

Designated: 05 January 1976

3. Country:

UK (Scotland)

4. Name of the Ramsar site:

Loch Leven

5. Designation of new Ramsar site or update of existing site:

This RIS is for: Updated information on an existing Ramsar site

6. **For RIS updates only,** changes to the site since its designation or earlier update:

a) Site boundary and area:

**** Important note:** If the boundary and/or area of the designated site is being restricted/reduced, the Contracting Party should have followed the procedures established by the Conference of the Parties in the Annex to COP9 Resolution IX.6 and provided a report in line with paragraph 28 of that Annex, prior to the submission of an updated RIS.

b) Describe briefly any major changes to the ecological character of the Ramsar site, including in the application of the Criteria, since the previous RIS for the site:

7. Map of site included:

Refer to Annex III of the *Explanatory Notes and Guidelines*, for detailed guidance on provision of suitable maps, including digital maps.

a) A map of the site, with clearly delineated boundaries, is included as:

- i) **hard copy** (required for inclusion of site in the Ramsar List): yes ✓ -or- no ☐;
- ii) **an electronic format** (e.g. a JPEG or ArcView image) Yes
- iii) **a GIS file providing geo-referenced site boundary vectors and attribute tables** yes ✓ -or- no ☐;

b) Describe briefly the type of boundary delineation applied:

e.g. the boundary is the same as an existing protected area (nature reserve, national park etc.), or follows a catchment boundary, or follows a geopolitical boundary such as a local government jurisdiction, follows physical boundaries such as roads, follows the shoreline of a waterbody, etc.

The site boundary is the same as, or falls within, an existing protected area.

For precise boundary details, please refer to paper map provided at designation

8. Geographical coordinates (latitude/longitude):

56 11 48 N 03 22 30 W

9. General location:

Include in which part of the country and which large administrative region(s), and the location of the nearest large town.

Nearest town/city: Kinross

The loch is adjacent to the town of Kinross and the M90 motorway, in an open catchment of predominantly farmed land.

Administrative Region: Perth and Kinross

Administrative region: Perth and Kinross

10. Elevation (average and/or max. & min.) (metres): **11. Area** (hectares): 1611.8

Min.	106
Max.	109
Mean	108

12. General overview of the site:

Provide a short paragraph giving a summary description of the principal ecological characteristics and importance of the wetland.

Loch Leven is the largest naturally eutrophic loch in the British Isles. It is relatively shallow and is surrounded by farmland, with a diverse aquatic flora and shoreline vegetation. The site supports internationally important wintering populations of pink-footed geese and shoveler, as well as an assemblage of over 20,000 wintering waterfowl.

13. Ramsar Criteria:

Circle or underline each Criterion applied to the designation of the Ramsar site. See Annex II of the *Explanatory Notes and Guidelines* for the Criteria and guidelines for their application (adopted by Resolution VII.11).

1, 5, 6

14. Justification for the application of each Criterion listed in 13 above:

Provide justification for each Criterion in turn, clearly identifying to which Criterion the justification applies (see Annex II for guidance on acceptable forms of justification).

Ramsar criterion 1

A particularly good example of a naturally eutrophic loch. The largest loch of its kind in Britain, being both large and shallow with only rare stratification. It supports characteristic flora and fauna, including the nationally rare invertebrates *Macroplea appendiculata*, *Thanatophilus dispar* and *Saldula fucicola*.

Ramsar criterion 5

Assemblages of international importance:

Species with peak counts in winter:

18463 waterfowl (5 year peak mean 1998/99-2002/2003)

Ramsar criterion 6 – species/populations occurring at levels of international importance.

Qualifying Species/populations (as identified at designation):

Species with peak counts in spring/autumn:

Great crested grebe , *Podiceps cristatus cristatus*, NW Europe

130 individuals, representing an average of 0.8% of the GB population (5 year peak mean 1998/9-2002/3)

Northern shoveler , *Anas clypeata*, NW & C Europe

406 individuals, representing an average of 1% of the population (5 year peak mean 1998/9-2002/3)

Species/populations identified subsequent to designation for possible future consideration under criterion 6.

Species with peak counts in spring/autumn:

Mute swan , *Cygnus olor*, Britain

442 individuals, representing an average of 1.1% of the population (5 year peak mean 1998/9-2002/3)

Eurasian teal , *Anas crecca*, NW Europe

4105 individuals, representing an average of 1% of the population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Pink-footed goose , *Anser brachyrhynchus*, Greenland, Iceland/UK

14646 individuals, representing an average of 6% of the population (5 year peak mean 1997/8-2001/2)

Contemporary data and information on waterbird trends at this site and their regional (sub-national) and national contexts can be found in the Wetland Bird Survey report, which is updated annually. See www.bto.org/survey/webs/webs-alerts-index.htm.

Details of bird species occurring at levels of National importance are given in Section 22

15. Biogeography (required when Criteria 1 and/or 3 and /or certain applications of Criterion 2 are applied to the designation):

Name the relevant biogeographic region that includes the Ramsar site, and identify the biogeographic regionalisation system that has been applied.

a) biogeographic region:

Atlantic

b) biogeographic regionalisation scheme (include reference citation):

16. Physical features of the site:

Describe, as appropriate, the geology, geomorphology; origins - natural or artificial; hydrology; soil type; water quality; water depth, water permanence; fluctuations in water level; tidal variations; downstream area; general climate, etc.

Soil & geology	sand, mud, sedimentary, sandstone
Geomorphology and landscape	lowland, island
Nutrient status	highly eutrophic
pH	no information
Salinity	fresh
Soil	mainly mineral
Water permanence	usually permanent
Summary of main climatic features	Annual averages (Edinburgh, 1971–2000) (www.metoffice.com/climate/uk/averages/19712000/sites/leuchars.html) Max. daily temperature: 12.2° C Min. daily temperature: 5.1° C Days of air frost: 54.5 Rainfall: 676.2 mm Hrs. of sunshine: 1405.8

General description of the Physical Features:

Loch Leven is about 3x5 km in extent and is the largest naturally eutrophic loch in Britain and Ireland. It is relatively shallow and is surrounded by farmland, with a diverse aquatic flora and shoreline vegetation. The loch contains several islands, the largest of which, St Serf's Island, has an area of about 46 ha.

17. Physical features of the catchment area:

Describe the surface area, general geology and geomorphological features, general soil types, general land use, and climate (including climate type).

Loch Leven is one of the largest inland lakes in the UK, covering an area of 13.3 km². During the period 1830-2, the water level of Loch Leven was lowered by about 1.5 metres, reducing the surface area of the loch to about three-quarters of its original size. Most of the loch is now very shallow with an average depth of about 3.9 metres. The loch has a catchment area of 145 km² and is fed by four streams, namely the North and South Queich (Ochil Hills), the Gairney Water (Cleish Hills) and the Pow Burn (Lomond Hills). The loch's only outflow is the River Leven, canalised in the 1830s, which flows from the south-eastern corner of the loch.

18. Hydrological values:

Describe the functions and values of the wetland in groundwater recharge, flood control, sediment trapping, shoreline stabilization, etc.

No special values known

19. Wetland types:

Inland wetland

Code	Name	% Area
O	Freshwater lakes: permanent	76
Other	Other	16
Tp	Freshwater marshes / pools: permanent	8

20. General ecological features:

Provide further description, as appropriate, of the main habitats, vegetation types, plant and animal communities present in the Ramsar site, and the ecosystem services of the site and the benefits derived from them.

Swamp and reed beds - *Phragmites australis* and *Phalaris arundinacea*

Tall herb fen - *Phalaris arundinacea* dominates.

Open water and submerged macrophytes *Potamogeton pectinatus* and charophytes dominate.

Grasslands - *Arrhenatherum elatius* grassland, and *Festuca ovina* and *Agrostis capillaris* grassland.

Rush pasture - *Juncus effusus* and *Juncus acutiflorus* are typical species.

Mire - *Filipendula ulmaria* and *Angelica sylvestris* characterise this community.

Woodland /Scrub - *Alnus glutinosa* and *Urtica dioica*, with *Ulex europaeus* and *Rubus fruticosus*.

Ecosystem services

21. Noteworthy flora:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Nationally important species occurring on the site

Higher Plants:

Juncus filiformis, *Hierochloa odorata*

22. Noteworthy fauna:

Provide additional information on particular species and why they are noteworthy (expanding as necessary on information provided in 12. Justification for the application of the Criteria) indicating, e.g. which species/communities are unique, rare, endangered or biogeographically important, etc., including count data. *Do not include here taxonomic lists of species present – these may be supplied as supplementary information to the RIS.*

Birds

Species currently occurring at levels of national importance:

Species regularly supported during the breeding season:

Black-headed gull , <i>Larus ridibundus</i> , N & C Europe	6864 apparently occupied nests, representing an average of 5.3% of the GB population (Seabird 2000 Census)

Lesser black-backed gull , <i>Larus fuscus graellsii</i> , W Europe/Mediterranean/W Africa	1103 apparently occupied nests, representing an average of 1% of the GB population (Seabird 2000 Census)

Species with peak counts in spring/autumn:

Gadwall , <i>Anas strepera strepera</i> , NW Europe	447 individuals, representing an average of 2.6% of the GB population (5 year peak mean 1998/9-2002/3)

Common pochard , <i>Aythya ferina</i> , NE & NW Europe	1398 individuals, representing an average of 2.3% of the GB population (5 year peak mean 1998/9-2002/3)

Tufted duck , <i>Aythya fuligula</i> , NW Europe	3618 individuals, representing an average of 4% of the GB population (5 year peak mean 1998/9-2002/3)

Common coot , <i>Fulica atra atra</i> , NW Europe	2242 individuals, representing an average of 1.2% of the GB population (5 year peak mean 1998/9-2002/3)

Ruff , <i>Philomachus pugnax</i> , Europe/W Africa	16 individuals, representing an average of 2.2% of the GB population (5 year peak mean 1998/9-2002/3)

Species with peak counts in winter:

Great cormorant , <i>Phalacrocorax carbo carbo</i> , NW Europe	513 individuals, representing an average of 2.2% of the GB population (5 year peak mean 1998/9-2002/3)

Whooper swan , *Cygnus cygnus*,
Iceland/UK/Ireland

141 individuals, representing an average of 2.4% of the GB population (5 year peak mean 1998/9-2002/3)

Common goldeneye , *Bucephala clangula clangula*, NW & C Europe

284 individuals, representing an average of 1.1% of the GB population (5 year peak mean 1998/9-2002/3)

Species Information

Nationally important species occurring on the site

Invertebrates:

Thanatophilus dispar, *Macroplea appendiculata*, *Saldula fucicola*

23. Social and cultural values:

Describe if the site has any general social and/or cultural values e.g. fisheries production, forestry, religious importance, archaeological sites, social relations with the wetland, etc. Distinguish between historical/archaeological/religious significance and current socio-economic values.

Aesthetic

Archaeological/historical site

Environmental education/ interpretation

Fisheries production

Forestry production

Livestock grazing

Non-consumptive recreation

Scientific research

Sport fishing

Sport hunting

Tourism

b) Is the site considered of international importance for holding, in addition to relevant ecological values, examples of significant cultural values, whether material or non-material, linked to its origin, conservation and/or ecological functioning? No

If Yes, describe this importance under one or more of the following categories:

- i) sites which provide a model of wetland wise use, demonstrating the application of traditional knowledge and methods of management and use that maintain the ecological character of the wetland:
- ii) sites which have exceptional cultural traditions or records of former civilizations that have influenced the ecological character of the wetland:
- iii) sites where the ecological character of the wetland depends on the interaction with local communities or indigenous peoples:
- iv) sites where relevant non-material values such as sacred sites are present and their existence is strongly linked with the maintenance of the ecological character of the wetland:

24. Land tenure/ownership:

Ownership category	On-site	Off-site
Non-governmental organisation (NGO)	+	
National/Crown Estate	+	
Private	+	+

25. Current land (including water) use:

Activity	On-site	Off-site
Nature conservation	+	
Tourism	+	
Recreation	+	
Current scientific research	+	
Commercial forestry	+	
Fishing: recreational/sport	+	
Grazing (unspecified)	+	
Hunting: recreational/sport	+	
Sewage treatment/disposal	+	

26. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land (including water) use and development projects:

Explanation of reporting category:

1. Those factors that are still operating, but it is unclear if they are under control, as there is a lag in showing the management or regulatory regime to be successful.
2. Those factors that are not currently being managed, or where the regulatory regime appears to have been ineffective so far.

NA = Not Applicable because no factors have been reported.

Adverse Factor Category	Reporting Category	Description of the problem (Newly reported Factors only)	On-Site	Off-Site	Major Impact?
No factors reported	NA				

For category 2 factors only.

What measures have been taken / are planned / regulatory processes invoked, to mitigate the effect of these factors?

Is the site subject to adverse ecological change? NO

27. Conservation measures taken:

List national category and legal status of protected areas, including boundary relationships with the Ramsar site; management practices; whether an officially approved management plan exists and whether it is being implemented.

Conservation measure	On-site	Off-site
Site/ Area of Special Scientific Interest (SSSI/ASSI)	+	
National Nature Reserve (NNR)	+	
Special Protection Area (SPA)	+	
Management agreement	+	
Site management statement/plan implemented	+	

b) Describe any other current management practices:

The management of Ramsar sites in the UK is determined by either a formal management plan or through other management planning processes, and is overseen by the relevant statutory conservation agency. Details of the precise management practises are given in these documents.

28. Conservation measures proposed but not yet implemented:

e.g. management plan in preparation; official proposal as a legally protected area, etc.

No information available

29. Current scientific research and facilities:

e.g. details of current research projects, including biodiversity monitoring; existence of a field research station, etc.

Fauna:

Numbers of migratory and wintering wildfowl and waders are monitored annually as part of the national Wetland Birds Survey (WeBS) organised by the British Trust for Ornithology, Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee.

Ornithology: Geese and agriculture, cormorant/fishery interactions. Breeding wildfowl monitoring.

Fisheries research:

Population size and distribution.

Flora:

Monitoring of aquatic macrophytes and emergent vegetation

Miscellaneous:

The management plan for Loch Leven includes prescriptions for the following research:

Water Quality Monitoring: algal and zooplankton communities, water chemistry, part of European LIFE Project.

Facilities include a small laboratory, boats and essential equipment.

30. Current communications, education and public awareness (CEPA) activities related to or benefiting the site:

e.g. visitor centre, observation hides and nature trails, information booklets, facilities for school visits, etc.

The RSPB have a nature reserve and visitor centre at Vane Farm, providing interpretation and birdwatching facilities. SNH have an office at Kinross Pier and employ a warden to both monitor and provide information about the site.

31. Current recreation and tourism:

State if the wetland is used for recreation/tourism; indicate type(s) and their frequency/intensity.

Activities, Facilities provided and Seasonality:

SNH keep records of numbers of wildfowl shot on the estate to prevent excessive shooting or disturbance.

The Vane Farm RSPB Reserve is a popular location for birdwatchers, and provides educational and recreational facilities with the minimum disturbance to birds.

There are three areas of the loch's shore open to public access. These areas are situated where the impact of visitors is minimal.

Fishing from boats is a popular pursuit on the loch, and is controlled to minimise any impacts to bird populations.

32. Jurisdiction:

Include territorial, e.g. state/region, and functional/sectoral, e.g. Dept. of Agriculture/Dept. of Environment, etc.

Scottish Executive, Environment and Rural Affairs Department

33. Management authority:

Provide the name and address of the local office(s) of the agency(ies) or organisation(s) directly responsible for managing the wetland. Wherever possible provide also the title and/or name of the person or persons in this office with responsibility for the wetland.

Scottish Natural Heritage, 2 Anderson Place, Edinburgh, EH6 5NP

34. Bibliographical references:

Scientific/technical references only. If biogeographic regionalisation scheme applied (see 15 above), list full reference citation for the scheme.

Site-relevant references

- Anon. (ed.) (1974) *The Loch Leven I.B.P. Project. A symposium sponsored by the Royal Society of Edinburgh at the University of Stirling on 11–13 June 1973. Proceedings of the Royal Society of Edinburgh*, **74B**
- Anon. (n.d.) *Wildlife of Loch Leven*. Royal Society for the Protection of Birds
- Bailey-Watts, AE & Kirika, A (2000) Loch Leven 2000: physical, chemical and algal aspects of water quality. *Scottish Natural Heritage Commissioned Report*, No. F99LH08
- Carvalho, L & Kirika, A (2002) Loch Leven 2001: physical, chemical and algal aspects of water quality. *Scottish Natural Heritage Commissioned Report*, No. F01LH03
- Carvalho, L & Kirika, A (2005) Loch Leven 2003: physical, chemical and algal aspects of water quality. *Scottish Natural Heritage Commissioned Report*, No. **114** (ROAME No. F01LH03d)
- Carvalho, L, Kirika, A & Gunn, I (2004) Long-term patterns of change in physical, chemical and biological aspects of water quality at Loch Leven. *Scottish Natural Heritage Commissioned Report*, No. **031** (ROAME No. F01LH03)
- Greenhalgh, M (2000) Wild trout in the British Isles – their variety and conservation. *British Wildlife*, **12**(2), 114-121
- Kirika, A & Carvalho, L (2004) Loch Leven 2002: physical, chemical and algal aspects of water quality. *Scottish Natural Heritage Commissioned Report*, No. **030** (ROAME No. F01LH03B)
- Musgrove, AJ, Pollitt, MS, Hall, C, Hearn, RD, Holloway, SJ, Marshall, PE, Robinson, JA & Cranswick, PA (2001) *The Wetland Bird Survey 1999–2000: wildfowl and wader counts*. British Trust for Ornithology, Wildfowl and Wetlands Trust, Royal Society for the Protection of Birds & Joint Nature Conservation Committee, Slimbridge.
www.wwt.org.uk/publications/default.asp?PubID=14
- Pritchard, DE, Housden, SD, Mudge, GP, Galbraith, CA & Pienkowski, MW (eds.) (1992) *Important Bird Areas in the United Kingdom including the Channel Islands and the Isle of Man*. Royal Society for the Protection of Birds, Sandy
- Ratcliffe, DA (ed.) (1977) *A Nature Conservation Review. The selection of biological sites of national importance to nature conservation in Britain*. Cambridge University Press (for the Natural Environment Research Council and the Nature Conservancy Council), Cambridge (2 vols.)
- Scottish Natural Heritage (2002) *Loch Leven NNR. 'A natural place in history'*. Scottish Natural Heritage, Kinross (leaflet).
www.nnr-scotland.org.uk/publications_detail.asp?pubID=4
- Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H & Whitehead, S (eds.) (2001) *The UK SPA network: its scope and content*. Joint Nature Conservation Committee, Peterborough (3 vols.)
www.jncc.gov.uk/UKSPA/default.htm
- Stroud, DA, Mudge, GP & Pienkowski, MW (eds.) (1990) *Protecting internationally important bird sites: a review of the EEC Special Protection Area Network in Great Britain*. Nature Conservancy Council, Peterborough

Please return to: **Ramsar Secretariat, Rue Mauverney 28, CH-1196 Gland, Switzerland**

Telephone: **+41 22 999 0170** • Fax: **+41 22 999 0169** • email: **ramsar@ramsar.org**

Appendix B: Ornithological Information

1. Purpose of Appendix

This appendix provides ornithology information suitable to inform the appropriate assessment of the HRA for the Grangemouth Flood Protection Scheme (hereafter referred to as Scheme). The baseline survey data provides abundance and distribution of birds recorded within the study area, including the Zone of Influence (Zol), which combined with knowledge and understanding of avian ecology, behaviour and sensitivity to disturbance allows us to assess potential effects on the conservation objectives of the Firth of Forth SPA/Ramsar site. The baseline data were obtained from a desk study and from surveys undertaken for the Scheme. The following information is described in this appendix:

- Firth of Forth SPA/Ramsar site.
- Desk based study on available information on the qualifying bird species including conservation status, SPA population size, wider context of UK/international status/ population size estimates, trends, and threats.
- General ecology of qualifying species.
- Methods and results of project-specific bird surveys undertaken for the Scheme from 2015 – 2017 and 2022 – 2023, showing abundance and distribution of non-breeding birds through the tidal cycles during the non-breeding season.
- Wetland Bird Surveys (WeBS) data from 2014 to 2021.
- Definition of Scheme Zone of Influence (Zol) for visual and noise disturbance and evidence of how birds use the habitats within the Zol and beyond for roosting and foraging, presented using density heat maps and peak count graphs.

2. Forth Estuary, Firth of Forth SPA and Ramsar Site Information

The Firth of Forth SPA is a complex mosaic of estuarine and coastal habitats spanning the length of the Forth Estuary (approximately 93km) from the coast at Fife and East Lothian upstream to Alloa (NatureScot, 2019a). A wide range of coastal and intertidal habitats are found within the site, including saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle, and brackish lagoons. Extensive mudflats occur particularly in the inner Forth, notably at Kinneil Kerse and Skinflats on the south shore and Torry Bay on the north shore. The flats support a rich invertebrate fauna, with eelgrass (*Zostera* spp.) growing on the main mudflats, providing important food sources for the large numbers of migrating and wintering waterbirds found on the estuary. In the outer Forth, the shoreline diversifies, with sandy shores, rocky outcrops, mussel beds and some artificial sea walls. The Forth is of major importance for a rich assemblage of waterbirds in the migration periods and through the non-breeding season, including divers, sea-ducks, geese, other ducks, waders, and terns. Some of these species, notably the sea-ducks and divers, also feed, loaf and roost outside the SPA in the open waters of the estuary. Several large urban areas, including Edinburgh, are adjacent to the site and these include several areas of heavy industry. Furthermore, the Forth is one of the most important shipping areas in Scotland.

The intertidal flats, saltmarsh, rocky shores and bays that provide important food sources and shelter for the qualifying, primarily wintering, waterbird assemblages are included within the extensive 6,317.93ha designated site boundary. The Firth of Forth SPA is designated for wintering waterbirds and Sandwich tern during passage. There are 27 qualifying species - five Annex I species qualify under Article 4.1 of the EU Birds Directive (79/409/EEC) due to the presence of internationally important populations, and due the important populations of migratory species, five species and a wintering waterfowl assemblage qualify under Article 4.2.

A sub-set of these species also form the qualifying features of the Ramsar site (Ramsar Criteria Two, Four, Five and Six) and includes the following species: red-throated diver, golden plover, scaup, cormorant, curlew, eider, long-tailed duck, common scoter, velvet scoter, red-breasted merganser, oystercatcher, ringed plover, grey plover, dunlin, pink-footed goose, redshank, shelduck, turnstone, bar-tailed godwit, goldeneye, knot, Slavonian grebe and Sandwich tern (NatureScot, 2019b). The Firth of Forth SPA and Ramsar site occupy the same area and exhibit considerable overlap in the species listed as qualifying species, as such the Ramsar site's qualifying interest species are covered by the information presented for the qualifying interests of the Firth of Forth SPA. Appendix A includes the citations for the Firth of Forth SPA and Ramsar site.

The Outer Firth of Forth and St Andrews Bay Complex SPA is present approximately 18km east of the Scheme and is a large estuarine/marine site which is bordered by the Firth of Forth SPA. The Outer Firth of Forth and St Andrews Bay Complex SPA is designated for 21 species, five Annex I species qualifying under Article 4.1 of the EU Birds Directive (79/409/EEC), and a further 16 species of migratory populations of European importance. The Forth Islands SPA is also present to the east of the scheme, which is a series of islands supporting the main breeding seabird colonies in the Firth of Forth. The closest island is located 16km to the east of the Scheme. The Forth Islands SPA is designated for 17 species, four of which are Annex 1 species qualifying under Article 4.1 of the EU birds Directive (79/409/EEC), four species which qualify under Article 4.2 by regularly supporting populations of migratory species of European Importance, with the remaining species qualifying under Article 4.2 by supporting in excess of 20,000 sea birds. These two SPA sites are deemed to be of a sufficient distance whereby these designated species will not be present within the Firth of Forth SPA in large numbers and as such supported by the Firth of Forth SPA, however they may occasionally be present within the vicinity of the Scheme.

3. Qualifying Species Information

3.1 Conservation Status and SPA Population Sizes

Qualifying species, conservation objectives and pressures on feature condition as provided by NatureScot (Scotland's Environment, 2019), are presented in Table 3.1 of the HRA. The conservation status of qualifying species is summarised below in Table B1.

NatureScot monitor the condition of the qualifying species within designated sites on a rolling basis and the most recent information available for the Firth of Forth SPA is from 2015. Table B1 summarises the condition of the qualifying species. Fourteen species are considered to be in *Favourable Maintained* condition; six species are considered to be in *Favourable Declining* condition and seven species are considered to be in *Unfavourable Declining* condition.

WeBS Alerts are also included in Table B1. The WeBS Alerts system provides a method of identifying changes in numbers of waterbirds at a variety of spatial and temporal scales within SPA sites up to a UK scale. The alerts process assesses the change in numbers over short (5 year), medium (10 years) and long-term (up to 25 years) periods as well as compared to the site baseline period in the case of SPAs. The change is calculated by smoothed trends fitted through site species indices to remove temporary fluctuations, for example caused by the severity of a single winter. Alerts are for species cited within the Firth of Forth SPA, and declines of between 25% and 50% over the period trigger Medium Alerts which are flagged in amber and declines of greater than 50% trigger High Alerts which are highlighted in red. For individual species, data can be compared at site, region, and UK scale.

Table B1: Great Britain and biogeographical population, conservation status and SPA site conditions of Firth of Forth qualifying bird species

					High Alerts	LT: long-term (up to 25 years)	SB: since baseline
					Medium Alerts	ST: short- term (5 years)	MT: medium- term (10 years)
					No Alerts Triggered	Alerts not triggered or species not evaluated under WeBS Alerts	
Species	International (IUCN) Status ¹	BoCC EU ²	BoCC UK5 ³	Cited SPA Population ⁴	% of GB Population or Biogeographic Population ⁵	Latest Site Condition 2015 ⁶	2016/17 WeBS Alerts Raised ⁷
Bar-tailed godwit	Near threatened, decreasing	(Wintering) Least Concern, stable	Amber	1,974	4% (GB)	Favourable Maintained	ST, SB
Common scoter	Least concern, unknown	(Breeding) Least concern, increasing	Red	2,880	8% (GB)	Unfavourable Declining	Alerts not triggered
Cormorant	Least concern, increasing	(Breeding) Least concern, increasing	Green	682	5% (GB)	Favourable Maintained	Species not evaluated under WeBS Alerts
Curlew	Near threatened, decreasing	(Breeding) Near threatened, decreasing	Red	1,928	2% (GB)	Favourable Maintained	Alerts not triggered
Dunlin	Least concern, decreasing	(Breeding) Least concern, decreasing	Red	9,514	2% (GB)	Favourable Declining	SB

¹ Global - Species of global conservation concern are assessed by the International Union for Conservation of Nature and Natural Resources (IUCN) and placed in a series of categories based on their global status (IUCN, 2019).

² European Birds of Conservation Concern (Birdlife International, 2017).

³ Birds of Conservation Concern 5 – UK (Stanbury et al., 2021). Red list species have undergone severe breeding or wintering population declines in the UK of more than 50% over 25 years or have undergone a severe breeding range decline of more than 50% in the past 25 years or else are listed by BirdLife International as being Globally Threatened using IUCN criteria. Amber list species have undergone moderate breeding or wintering population declines in the UK of between 25% and 50% over 25 years or at least 50% of the UK breeding or non-breeding population found in 10 or fewer sites or the UK breeding population is estimated at less than 300 pairs, or non-breeding population less than 900 individuals or have undergone a breeding range decline of between 25% and 50% in the past 25 years. Green list species do not qualify under any of the red or amber criteria. In some cases this might be a result of insufficient data.

⁴ Population estimates are for the years 1993/94-1997/98 for species that qualify under Article 4.1 and 1992/93-1996/97 for those species that qualify under Article 4.2 (JNCC, 2001). Firth of Forth SPA was classified on 30 October 2001, with amended citation adopted 2 April 2018. Species count are from the years previously mentioned with no updates available.

⁵ SPA Species Account – Species List (JNCC, 2012).

⁶ Latest site condition assessed by NatureScot. The maximum limit of acceptable change in relation to SNH's Site Condition Monitoring is a decline of 50% in the wintering population over a 5 year period.

⁷ ST-short term; MT- medium term; LT – long term; SB – since baseline (Woodward et al. 2019).

					High Alerts	LT: long-term (up to 25 years)	SB: since baseline
					Medium Alerts	ST: short- term (5 years)	MT: medium- term (10 years)
					No Alerts Triggered	Alerts not triggered or species not evaluated under WeBS Alerts	
Species	International (IUCN) Status ¹	BoCC EU ²	BoCC UK5 ³	Cited SPA Population ⁴	% of GB Population or Biogeographic Population ⁵	Latest Site Condition 2015 ⁶	2016/17 WeBS Alerts Raised ⁷
Eider	Near threatened, unknown	(Breeding) Endangered, decreasing	Amber	9,400	13% (GB)	Favourable Declining	LT, SB
Goldeneye	Least concern, stable	(Breeding) Least concern, decreasing	Red	3,004	18% (GB)	Unfavourable Declining	Alerts not triggered
Golden plover	Least concern, Increasing	(Breeding) Least concern, stable	Green	2,949	1% (GB)	Favourable Maintained	MT, LT, SB
Great crested grebe	Least concern, unknown	(Breeding) Least concern, decreasing	Green	720	7% (GB)	Unfavourable Declining	MT, LT, SB
Grey plover	Least concern, decreasing	(Wintering) Least concern, decreasing	Amber	724	2% (GB)	Favourable Declining	ST, MT, SB
Knot	Near threatened, decreasing	(Wintering) Least concern, decreasing	Amber	9,258	3% North-western - Canada/ Greenland/Iceland/North- western Europe	Unfavourable Declining	ST, LT, SB
Lapwing	Near threatened, decreasing	(Breeding) Vulnerable, decreasing	Red	4,148	0.3% (GB)	Favourable Declining	MT, LT, SB
Long-tailed duck	Vulnerable, decreasing	(Wintering) Least concern, decreasing	Red	1,045	4% (GB)	Unfavourable Declining	LT, SB
Mallard	Least concern, increasing	(Wintering) Least concern, decreasing	Amber	2,564	0.5% (GB)	Favourable Declining	LT, SB
Oystercatcher	Near threatened, decreasing	(Breeding) Vulnerable, decreasing	Amber	7,846	2% (GB)	Favourable Maintained	Alerts not triggered

					High Alerts	LT: long-term (up to 25 years)	SB: since baseline
					Medium Alerts	ST: short- term (5 years)	MT: medium- term (10 years)
					No Alerts Triggered	Alerts not triggered or species not evaluated under WeBS Alerts	
Species	International (IUCN) Status ¹	BoCC EU ²	BoCC UK5 ³	Cited SPA Population ⁴	% of GB Population or Biogeographic Population ⁵	Latest Site Condition 2015 ⁶	2016/17 WeBS Alerts Raised ⁷
Pink-footed goose	Least concern, increasing	(Wintering) least concern, increasing	Amber	10,852	2% (GB) ⁸	Favourable Maintained	Not evaluated through WeBS Alerts as this species is monitored through the Goose and Swan Monitoring Project.
Red-breasted merganser	Least concern, stable	(breeding) near threatened, decreasing	Amber	670	7% (GB)	Unfavourable Declining	LT, SB
Redshank	Least concern, unknown	(breeding) vulnerable, decreasing	Amber	4,341	3% Eastern Atlantic, 4% (GB)	Favourable Maintained	Alerts not triggered
Red-throated diver	Least concern, decreasing	(breeding) least concern, unknown	Green	90	2% (GB)	Favourable Maintained	Not evaluated through WeBS Alerts as data is unsuitable for the assessment of trends at the site.
Ringed plover	Least concern, decreasing	(Breeding) least concern, increasing	Red	328	1% (GB)	Favourable Maintained	SB
Sandwich tern	Least concern, stable	(Breeding) least concern, increasing	Amber	1,617	6% (GB)	Favourable Maintained	Alerts not triggered

⁸ Frost, T.M., N.A. Calbrade, G.A. Birtles, H.J. Mellan, C. Hall, A.E. Robinson, S.R. Wotton, D.E. Balmer & G.E. Austin. 2020. Waterbirds in the UK 2018/19: The Wetland Bird Survey. BTO, RSPB and JNCC, in association with WWT. British Trust for Ornithology, Thetford.

					High Alerts	LT: long-term (up to 25 years)	SB: since baseline
					Medium Alerts	ST: short-term (5 years)	MT: medium-term (10 years)
					No Alerts Triggered	Alerts not triggered or species not evaluated under WeBS Alerts	
Species	International (IUCN) Status ¹	BoCC EU ²	BoCC UK ³	Cited SPA Population ⁴	% of GB Population or Biogeographic Population ⁵	Latest Site Condition 2015 ⁶	2016/17 WeBS Alerts Raised ⁷
Scaup	Least concern, decreasing	(Breeding) Least concern, decreasing	Red	437	4% (GB)	Unfavourable Declining	MT, LT, SB
Shelduck	Least concern, increasing	(Breeding) Least concern, stable	Amber	4,509	2% North-western Europe, 6% (GB)	Favourable Maintained	Alerts not triggered.
Slavonian grebe	Vulnerable, decreasing	(breeding) near threatened, decreasing	Red	84	21% (GB)	Favourable Declining	Not evaluated through WeBS Alerts as data is unsuitable for the assessment of trends at the site.
Turnstone	Least concern, decreasing	(Wintering) least concern, stable	Amber	860	1% Western Palearctic/GB	Favourable Maintained	SB
Velvet scoter	Vulnerable, decreasing	(breeding) vulnerable, decreasing	Red	635	21% (GB)	Favourable Maintained	Alerts not triggered.
Wigeon	Least concern, decreasing	(breeding) vulnerable, decreasing	Amber	2,139	0.78% (GB)	Favourable Maintained	Alerts not triggered.

3.2 Population Information Gathering

This section sets out key information gathered for each qualifying species in order to contextualise the importance of the study area within an international, national, Scottish and site-specific context. Information was gathered on general ecology, population sizes, distribution, trends (global, national, Scottish, and SPA-specific), and pressures/threats for each species. British Trust for Ornithology (BTO) and International Union for Conservation of Nature (IUCN) data were sourced to provide the most up to date data on population size estimates and population trend evaluations at a

European/international level to enable contextual biogeographical setting of data collected for the Scheme. The IUCN Red List of Threatened Species is a comprehensive information source on the global extinction risk status of animal, fungus and plant species and is a critical indicator of the health of the world's biodiversity. The BTO is one of the main scientific bodies that study bird populations both within and outside the UK. BTO was also used to provide up to date data on bird populations within a UK context, Scotland and within the Firth of Forth SPA specifically to allow a determination of the importance of the number of birds within the study area. The most recent Article 12 report was sourced to review the most up to date species status and trends within the UK whilst Birds of Conservation Concern (BoCC) was used to determine conservation status of birds within the SPA. Several UK-specific bird reports were reviewed as part of the assessment including reports from Wetlands International, Hayhow et al. (2017), Burns et al. (2020), Frost et al. (2019), Frost et al. (2021), JNCC (2001, 2012, 2019), Cook et al. (2013) and Woodward et al. (2019).

Various other data and information was collated from multiple sources including:

- *European/International context*
 - BTO.
 - IUCN.
 - European red list of birds (Birdlife International, 2021).
 - European birds of conservation concern: populations, trends and national responsibilities Cambridge, UK: BirdLife International (BirdLife International, 2017).
 - Wild Birds – Threatened Birds (European Commission, 2019).
 - Waterbird population estimates (Wetlands International, 2021).
- *Scotland/ United Kingdom context*
 - BTO.
 - Birds of Conservation Concern 5: the population status of birds in the United Kingdom, Channel Islands, and Isle of Man (Stanbury et al., 2021).
 - The state of the UK's birds 2020 (Burns et al., 2020).
 - Biodiversity Indicator – Abundance of wintering waterbirds (Scottish Natural Heritage⁹ (SNH), 2018).
 - Waterbirds in the UK 2019/20: The Wetland Bird Survey (Frost et al., 2021).
 - Eleventh Article 12 UK Birds Directive Report (2019): Annex B – Species' status and trends 2019 (JNCC, 2019a).
 - Eleventh Article 12 UK Birds Directive Report (2019): Annex A – General Report 2019 (JNCC, 2019b).
- *Firth of Forth SPA context*
 - BTO.
 - Firth of Forth SPA Description (JNCC, 2020).
 - SPA Species Account – Species List (JNCC, 2012).
 - Wetland bird survey alerts 2009/2010: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, SPAs and SSSIs (Cook et al., 2013).

⁹ SNH changed their name to NatureScot as of 24th August 2020

- A review of literature on the qualifying species of SPAs in the Firth of Forth and development related influences (Woodward et al., 2015).
- Wetland Bird Survey Alerts 2016/2017: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Areas of Special Scientific interest (ASSIs). (Woodward et al., 2019).

3.3 Species Accounts

The following sections provide species accounts for each qualifying species potentially affected by the Scheme, using information obtained from the above sources. Note – three of the 27 qualifying species of the SPA were not recorded during surveys for the Scheme, those being Slavonian grebe, long-tailed duck, and velvet scoter. These species are unlikely to make significant use of the areas potentially affected by the Scheme, consequently species accounts are not provided.

3.3.1 Bar-tailed Godwit

3.3.1.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 1,099,000–1,149,000 individuals (Wetlands International, 2019).

The European population has been evaluated as *Decreasing* and *Near Threatened* under the IUCN (BirdLife International, 2017a). Bar-tailed godwit is included in the Amber list of BoCC in the UK due to its moderate non-breeding population decline over the longer term (defined as the entire period used for assessments since the first BoCC review, starting in 1969) and are listed on Annex I of the Birds Directive (Hayhow, 2017). The species is vulnerable due its concentration at a small number of coastal wetlands outside the breeding season. Many European passage and wintering sites are either poorly protected or lack any protection (European Commission, 2016a). Approximately 46% of the global population overwinters in the UK, an estimated two-thirds of which are found at estuarine sites (JNCC, 2012). The 25-year trend for the non-breeding population has seen a 21% decline and the 10-year trend has seen a 5% decline (Frost et al., 2021).

3.3.1.2 Firth of Forth SPA Population and Trends

During the winter, the Firth of Forth SPA regularly supports approximately 4% or more of the GB population of bar-tailed godwit (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period of SPA citation (1992/93 to 1996/97) was 1,974 individuals (JNCC, 2001). The status of bar-tailed godwit is considered as *Favourable Maintained* at the site due to the feature targets being met and the species likely to be secure on the site under present conditions. The trend for the Forth is broadly tracking the Scottish trend, although an increasing proportion of the Scottish wintering birds are supported by the site (Woodward et al., 2015). This suggests that despite the ongoing decline in numbers at the Firth of Forth SPA site, conditions on the site remain relatively favourable for this species and are possibly becoming increasingly important on a regional scale (Cook et al., 2013).

3.3.1.3 Ecology

Bar-tailed godwit utilise the intertidal sand and mudflats within the SPA for foraging for their preferred prey of bivalves such as Baltic tellins (*Macoma balthica*), *Scrobicularia plana* and *Mya arenaria*. At some sites, polychaete worms form a larger proportion of the diet, and the species is relatively adaptable, utilising other habitats for foraging where available, such as terrestrial grassland, coastal marshes, and freshwater lagoons (Woodward et al., 2015). These birds are considered to have a high site fidelity during the non-breeding season, but small numbers will move sites within or between winters (Conklin and Battley, 2011).

Bar-tailed godwit is sensitive to disturbance compared to other waders. Disturbance of feeding flocks and especially roosts by walkers and dogs is common. Other pressures to over wintering bar-tailed godwit include climate change, agricultural intensification and afforestation, and predation is a significant threat to breeding birds. Development in the species' range is also considered a threat to important habitat (BirdLife International, 2017a).

3.3.2 Common Scoter

3.3.2.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 1,600,000 individuals with the European population estimated at 214,000-263,000 individuals (Wetlands International, 2019). The overall population trend is unknown, however has been evaluated as of *Least Concern* by IUCN (BirdLife International, 2018f) due to the extremely large range.

3.3.2.2 Firth of Forth population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 8% of the British population of common scoter (JNCC, 2001). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 2,880 individuals (JNCC, 2001). The status of common scoter is considered as *Unfavourable Declining* at the site. The population trend in the SPA is declining which tracks that of the Scottish trend. The proportion of the Scottish population supported by this site is stable. This suggests that despite the ongoing decline in numbers, the conditions on the site remain relatively favourable for this species.

3.3.2.3 Ecology

Common scoter spend most of their time on the sea feeding and roosting in flocks at significant distances offshore. Birds frequently fly between favoured feeding areas foraging on a range of mollusc species caught by diving up to 20m deep over sandy substrate (Woodward et al., 2015) (SNH, 2016).

Pressures include disturbance from recreational water use and impacts on water quality through pollution or sediment movement.

3.3.3 Cormorant

3.3.3.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 1,400,000-2,100,000 individuals with the European population estimated at 803,000-1,020,000 individuals (Wetlands International, 2019). The overall population trend is increasing and has been evaluated as of *Least Concern* by IUCN (BirdLife International, 2018g) due to the extremely large distribution of the species.

Cormorant is included in the Green list of BoCC in the UK. The 25-year trend for the non-breeding population has seen a 54% increase and the 10-year trend has seen a 30% increase (Frost et al., 2021).

3.3.3.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 5% of the British population of cormorant (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 682 individuals (JNCC, 2001). The status of cormorant is considered as *Favourable Maintained* at the site. Despite the increasing trend the numbers of cormorant over-wintering on Firth of Forth SPA have been decreasing long-term. BTO had previously issued alerts for the long, medium, and short terms. Numbers of this species over-wintering within Scotland and Great Britain have been decreasing long-term. The trend on the site appears to be tracking that of the region and British trends. The stable proportion of both regional and country-wide numbers supported by this site

suggest the environmental conditions remain relatively favourable for this species. In conclusion, the similarity between the declining site trend and the regional and British trends suggests that the declining numbers result from broad-scale population trends (Cook et al., 2013).

3.3.3.3 Ecology

Cormorant feed by diving underwater from the surface feeding on a wide range of small fish (generally smaller than 20cm in length but occasionally up to 75cm or 1.5kg) such as butterfish, sand eels, flatfish, and eels in shallow water, generally less than 20m deep. Birds have a foraging range up to 50km and roost on man-made structures (e.g., buoys, jetties, harbour walls) as well as natural rocky headlands, islands, beaches and on estuaries at low tide (SNH, 2016).

Cormorant is less sensitive to disturbance than many other species and few pressures exist, however birds are shot under licence at inland fisheries in Scotland.

3.3.4 Curlew

3.3.4.1 International/UK Population Size Estimates and Trends

Curlew is an intertidal wader that spends the non-breeding season within the Firth of Forth estuary. The global population is estimated at 835,000-1,310,000 individuals (Wetlands International, 2019) and has declined by 20-30% in the past 15 years (BirdLife International, 2017b). The European population is experiencing similar declines (decreasing by 30-49% in 30 years) and has been evaluated as Declining and Near Threatened under the IUCN (BirdLife International, 2015a) and is classed as a Species of European Conservation Concern (SPEC) 2 species.

Curlew is included on the Red list of BoCC in the UK due to its declining breeding population and is listed on Annex II of the Birds Directive. Approximately 30% of the global population overwinters in the UK, an estimated two-thirds of which are found at estuarine sites, with the remainder on non-estuarine coasts and adjacent farmland (Cayford and Waters, 1996; JNCC, 2012). The 25-year trend for the non-breeding population has seen a 33% decline and the 10-year trend has seen a 18% decline (Frost et al., 2021). The UK supports between 19% and 27% of the global breeding population of curlew, however, there has been an overall range decline of 65% calculated in the UK between 1970 and 2018 (Burns et al., 2020). Between 1995 and 2012, the breeding populations declined by 55% in Scotland and 30% in England. The Scottish population is supplemented by Scandinavian breeders in winter (Frost et al., 2019).

3.3.4.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 2% or more of the GB population of curlew (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 1,928 individuals (JNCC, 2001). The status of curlew is considered as *Favourable Maintained* at the site due to the feature targets being met and the species likely to be secure on the site under present conditions. Winter numbers are variable at the site however the trend is tracking that of Scottish and National trends. This suggests that conditions on the site remain relatively favourable for this species (Woodward et al., 2015). Numbers of curlew over-wintering on Firth of Forth SPA have been decreasing in the medium-term having previously peaked. However, changes in numbers have been insufficient to have triggered alerts for this species (Cook et al., 2013; Woodward et al., 2019).

3.3.4.3 Ecology

Curlew utilise the intertidal sand and mudflats within the SPA for foraging, they also utilise grassland surrounding the site for both foraging and roosting (MacArthur Green, 2017).

Within intertidal areas they feed on larger prey items such as crabs, large worms and bivalves. Their de-curved bill is ideally suited to extracting deep-living worms such as Lugworms (*Arenicola marina*). Curlew are also known to heavily utilise agricultural grassland as foraging sites especially during periods of high tide. Curlew rely on large prey that

takes more time to handle in contrast to many other wader species that swallow prey relatively quickly upon finding it. As a consequence, curlew are territorial foragers and tend to occur widely spaced from each other to avoid competitive conflicts. Curlew are usually well dispersed across the estuary while feeding, but generally roost communally, usually along salt marshes and sand banks (Berg, 1993). These birds are considered to have a high site fidelity and are reliant on the site (intertidal mud and sandflats) but highly likely to utilise alternative habitats at certain times (e.g., during high tide).

Afforestation, overgrazing, predation, and disturbance of roost sites are likely to be key drivers of decline (Franks et al., 2017). In addition, the drying of soils on the breeding grounds, which is already a problem due to the drainage of lowland meadows and upland bogs, may be exacerbated by climate change. The decline in this species may also be associated with a climate-induced north-easterly shift in distribution estimated to be 119 km between 1981-2000 (Maclean et al., 2008; Carroll et al., 2015), which has coincided with stable or increasing wintering numbers in the Wadden Sea (Hustings et al., 2008).

3.3.5 Dunlin

3.3.5.1 International/UK Population Size Estimates and Trends

The global population is estimated to be between 4,295,000-6,800,000 individuals (Wetlands International, 2019). The European population has been evaluated as *Depleted*, due to a large historical decline, however, internationally their population trend is *Stable* (Birdlife International, 2017c) although classed as a SPEC 3 species. The majority of dunlin wintering in Scotland originate from the western part of their breeding range and moult mainly in the Wadden Sea before starting to arrive in Scotland during October (Swann and Etheridge, 1996). Dunlin are included in the Red list of BoCC in the UK with wide-ranging pressures which are complicated by 'short stopping', whereby species have shifted their wintering grounds north-eastwards in response to increased temperatures caused by climate change (Stanbury et al., 2021). Approximately 30% of the international flyway population overwinter in Britain (JNCC, 2012). The 25-year trend for the non-breeding population has seen a 45% decline and the 10-year trend has seen a 7% decline (Frost et al., 2021). The Wetland Bird Survey reported the dunlin population had declined by 23% between 2004 and 2014, although it is still Britain's most abundant wading bird (Hayhow et al., 2017).

3.3.5.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 2% or more of the GB population of dunlin (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 9,514 individuals which represents 0.7% of the biogeographical population (JNCC, 2001). The status of dunlin is considered as *Favourable Declining* at the site due to moderate non-breeding population decline over the longer term and moderate recent breeding range reduction. Numbers of dunlin over-wintering on Firth of Forth SPA have been decreasing in the medium-term having previously peaked. Alerts have been triggered for the period since baseline (Woodward et al., 2019). The trend for the Forth is broadly tracking the Scottish trend, although with an increasing proportion of Scottish wintering birds being supported by the site. This suggests that despite the recent decline in numbers, conditions on the site remain relatively favourable for this species and the site is becoming increasingly important on a regional scale for this species (Woodward et al., 2015).

3.3.5.3 Ecology

Dunlin feed predominantly on small invertebrates of estuarine mudflats, particularly polychaete worms and small gastropods. Dunlin feed in flocks, in the muddier sections of the estuaries and close to the tide edge. Dunlin are considered to have a high site fidelity and are totally reliant on wetland habitats.

The reason for the long-term decline in dunlin is unknown but it is thought the wintering population is declining because of climate change with many opting to remain near their breeding grounds because of milder winters (Hayhow

et al., 2017), and dunlin responding to changes in food availability (Burns et al., 2020). Fewer chicks may also have been reared in the Arctic because of climate change. Long-term changes in internationally important waterbird populations are also partly explained by climate change (Johnston et al., 2013). Improved survival as a result of milder winters has been reported for several species including dunlin. In the winter this species is restricted to a small number of estuaries, so it is vulnerable to any changes in this habitat for example through land reclamation (drainage) (del Hoyo et al., 1996), and the invasion of alien plant species (such as the grass *Spartina anglica* which has spread on British mudflats, resulting in the reduction in size of feeding areas available) (del Hoyo et al., 1996). The species is also threatened by disturbance on intertidal mudflats from construction work and walkers (Burton et al., 2002).

3.3.6 Eider

3.3.6.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 3,300,000-4,000,000 individuals with the European population estimated at 791,000-955,000 pairs (Wetlands International, 2019). Although the population trend is unknown, the European population has been evaluated as *Near Threatened* IUCN (BirdLife International, 2017) due to the population size declining overall at a rate of >40% over three generations (27 years). Eider is included in the amber list of BoCC in the UK due to the recent non-breeding population decline (Hayhow et al., 2017). The 25-year trend for the non-breeding population has seen a 27% decline and the 10-year trend has seen an 17% decline (Frost et al., 2021).

3.3.6.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 13% of the British population of eider (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 9,400 individuals (JNCC, 2001). Eider is present year-round in the Firth of Forth with a peak in late summer /early autumn as numbers are supplemented by young birds. The status of eider is considered as *Favourable Declining* at the site. Winter counts of eider have declined in recent years in the Firth of Forth site at a more rapid rate than for Scotland as a whole; the proportion of the Scottish population supported by the area is therefore declining.

3.3.6.3 Ecology

Eider feed either by diving in deep water or upending in shallow water. Frequent flights are made between roost and feeding sites. Eider form large flocks during July and August when birds undergo a moult and are flightless for several weeks (Hayhow et al., 2017). Pressures include nest predation by mammals and recreational disturbance by walkers and dogs.

3.3.7 Goldeneye

3.3.7.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 2,700,000-4,700,000 individuals with the European population estimated at over 900,000 mature individuals (Wetlands International, 2019). The European population has been evaluated as *Stable* and of *Least Concern* by IUCN (BirdLife International, 2018h). Goldeneye is included in the Red list of BoCC in the UK with wide-ranging pressures which are complicated by 'short stopping', whereby species have shifted their wintering grounds north-eastwards in response to increased temperatures caused by climate change (Stanbury et al., 2021). The 25-year trend for the non-breeding population has seen a 58% decline and the 10-year trend has seen a 26% decline (Frost et al., 2021).

3.3.7.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 18% of the British population of goldeneye (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 3,004 individuals (JNCC, 2001). The status of goldeneye is considered as *Unfavourable Declining* at the site due to a declining proportion of Scottish wintering birds being supported by the Forth. The declines in numbers of goldeneye on the Forth have been linked to improvements in sewage treatment, as feeding flocks were only recorded at outfalls where sewage continued to be discharged in large quantities (Campbell, 1984). However, numbers have been increasing in the short-term following this previous decline. The recent increase in the proportion of regional and even country-wide numbers supported by this site suggest the environmental conditions remain relatively favourable and that this site is becoming increasingly important for this species as a result of regional scale pressures.

3.3.7.3 Ecology

Goldeneye are associated primarily with the sub-tidal area during the winter months, however, are sensitive to water-based disturbance.

3.3.8 Golden Plover

3.3.8.1 International/UK Population Size Estimates and Trends

Golden plover is a migratory plover found around the coast, on coastal marshes and estuaries, on wetlands and inland on agricultural land in the lowlands of Britain. Golden plover feed in the inter-tidal area, retreating to roosts both at the shore and inland at high tide. Golden plovers are listed on Annex I of the Bird's Directive (European Commission, 2016b). The European population of golden plover is estimated at 1,300,000-1,750,000 individuals and is evaluated as *Increasing* and of *Least Concern* under the IUCN given the large population size and range (Birdlife International, 2016a). Golden plover is included in the Green list of BoCC in the UK and is therefore in the least critical group (Hayhow et al., 2017). The 25-year trend for the non-breeding population has seen a 6% decrease and the 10-year trend has seen a 14% decline (Frost et al., 2021). The numbers of golden plover over-wintering in Great Britain have been decreasing in the short-term having previously peaked.

3.3.8.2 Firth of Forth Population and Trends

Numbers over-wintering in Scotland have also decreased, as have numbers over-wintering on the Firth of Forth SPA. This has resulted in the BTO issuing alerts for this species for the medium and long term and the period since baseline. The trend of decline within the Forth appears to be similar to that of the Scottish declines, but not the British trend. Numbers in the Forth represent a declining proportion of the Scottish numbers, which suggests that site-specific pressures, may be affecting this species in the estuary (Woodward et al., 2019). During the winter the Firth of Forth SPA regularly supports a European important population and nationally important population (1% or more of the GB population) of golden plover (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 2,949 individuals (JNCC, 2001). The status of golden plover is considered as *Favourable Maintained* at the site due to the feature targets being met and the species likely to be secure on the site under present conditions. Golden plover is considered to have a high site fidelity returning to the same favoured sites each year (Woodward et al., 2015).

3.3.8.3 Ecology

Golden plover forage by day and by night, returning to the same favoured sites each year (SNH, 2016). Their diet consists mainly of insects, particularly beetles and some plant material. Birds feed mainly on pasture and arable farmland in winter and roost on mudflats and saltmarshes.

Golden plover tend to be more tolerant of visual disturbances compared to other wader species e.g. redshank. The main threats for the species are the loss (hydrological works, sand extraction, afforestation) and deterioration (traditional agriculture abandonment) of habitat and disturbances during the breeding period (BirdLife International, 2016a) although improved survival as a result of milder winters has also been reported for several species including golden plover. The species has suffered minor range contractions due to the cultivation and afforestation of heathlands (Ratcliffe, 1977; del Hoyo et al., 1996) and is susceptible to very cold winter temperatures and severe weather conditions (Ratcliffe, 1977).

3.3.9 Great Crested Grebe

3.3.9.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 915,000-1,400,000 individuals with the European population estimated at 660,000-997,000 mature individuals (Wetlands International, 2019). The species has been evaluated as of Least Concern under the IUCN given the extremely large population range (BirdLife International, 2018a). The overall population trend is uncertain as some populations are decreasing, while others are increasing or have unknown trends (Wetlands International, 2015). Great crested grebe is included in the Green list of BoCC in the UK. The breeding population of great crested grebe in the UK is increasing and consequently winter numbers are also rising, although these can be significantly reduced as a result of high mortality in severe winters. However, overall maximum counts in Britain have declined from a peak of 9,580 in 1992-93, but annual indices suggest that numbers have been very stable over this period, at around a third higher than during the 1980s (Pollitt et al., 2000). As with the breeding population, this increase is largely attributed to increases in the availability of suitable habitat. Approximately 6% of the global population overwinters in GB, an estimated 14% of which is within SPA sites (JNCC, 2012). The 25-year trend for the non-breeding population has seen an 8% decline and the 10-year trend has seen a 14% decline (Frost et al., 2021).

3.3.9.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 7% or more of the GB population of great crested grebe (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 720 individuals (JNCC, 2001). The status of great crested grebe is considered as *Unfavourable Declining*. Overall population trend for the site suggests a severe decline. The trend for the Forth is broadly tracking the Scottish trend, although a declining proportion of Scottish wintering birds are being supported by the site. This suggests that conditions on the Forth are deteriorating for this species. Numbers of great crested grebe within the Firth of Forth have declined, tracking that of the region, with the magnitude of the decline being of sufficient scale for BTO to trigger alerts for this species for the medium and long-term and since the baseline period (Woodward et al., 2019).

3.3.9.3 Ecology

Great crested grebe feed predominantly on fish, insects, crustaceans, and molluscs. No particular pressures have been identified however there is a severe declining trend occurring for the species (Woodward et al., 2015). Great crested grebes are sensitive to pollution incidents. A pollution incident on the Firth of Forth in February 1978 was notable in that it affected 241 great crested grebes (Campbell et al., 1978). Gittings (2018) recorded impacts to roosting grebes from disturbances during nocturnal vessel activity at Cork Harbour SPA.

3.3.10 Grey Plover

3.3.10.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 738,000-935,000 individuals with the European population estimated at 10,000-20,000 mature individuals (Wetlands International, 2019). The species has been evaluated as Decreasing

however of Least Concern under the IUCN based on the large population size (BirdLife International, 2017d). Grey plover is included in the Amber list of BoCC in the UK due to its declining over wintering population (Stanbury et al., 2021). Approximately 26% of the global population overwinters in the UK, with an estimated 90% of the British wintering population within SPA sites (JNCC, 2012). The 25-year trend for the non-breeding population has seen a 36% decline and the 10-year trend has seen a 20% decline (Frost et al., 2021). The numbers of grey plover that overwinter in Great Britain have been stable in the short-term (5-year trend) having previously declined (Woodward et al., 2019).

3.3.10.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 2% or more of the GB population of grey plover (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 724 individuals (JNCC, 2001). The status of grey plover is considered as *Favourable Declining* at the site. Grey plover numbers overwintering within Scotland and on the Firth of Forth SPA have been decreasing in the medium-term having previously peaked. This has led the BTO to issue alerts for the short and medium-terms and the period since designation. The trend on the Forth appears to be tracking the Scottish trend, although not the British trend (Cook et al., 2013). The proportion of Scottish birds found on the Forth is declining suggesting that site-specific pressures may be affecting this species (Woodward et al., 2015).

3.3.10.3 Ecology

Grey plover is found on estuaries and lagoons during winter, feeding inter-tidally on marine polychaete worms, molluscs and crustaceans in mudflats and joining mixed wader roosts at the shore or inland at high tide. There is some evidence that the distribution of this species is shifting north-eastwards in response to climate change (Woodward et al., 2015). Recreation/disturbance (disturbance by walkers and dogs) was cited as a pressure for grey plover.

3.3.11 Knot

3.3.11.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 891,000-979,000 individuals with the European population estimated at 30,000-60,000 mature individuals (Wetlands International, 2019). The species has been evaluated as *Decreasing* and *Near Threatened* under the IUCN based on the moderately rapid rate of decline (BirdLife International, 2018b) and is classed as a SPEC 3 species. Knot is included in the Amber list of BoCC in the UK due to its declining breeding and wintering population (Stanbury et al., 2021)). Within Britain the knot is one of the most recorded bird species during the WeBS Core Counts. Overwintering knot are almost exclusively estuarine in Britain as elsewhere (Piersma, 1994) and at favoured sites they occur at very high densities. Approximately 70% of the global population overwinters in the UK, an estimated 84% of which within SPA sites (JNCC, 2012). The 25-year trend for the non-breeding population has seen a 13% decline and the 10-year trend has seen a 3% decline, however the knot population showed signs of short-term stabilisation in numbers over the most recent five-year period (Frost et al., 2021).

3.3.11.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 3% or more of the North-eastern Canada/Greenland/Iceland/North-western Europe population of knot (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 9,258 individuals (JNCC, 2001). The status of knot is considered as *Unfavourable Declining*. The trend for the Forth broadly tracks the Scottish trend, although a declining proportion of Scottish wintering birds are being supported by the site. This suggests that conditions on the site are deteriorating for this species (Woodward et al., 2015). Numbers of knot within the Firth of Forth have declined with the magnitude of the decline being of sufficient scale for BTO to trigger alerts for this species for the short and long-term and since the site was designated. The contrast between the declining site and regional

trends with the British trend suggests that declining numbers underpinning these alerts are most likely due to broad-scale redistribution or broad regional pressures rather than site specific pressures (Cook et al., 2013; Woodward et al., 2019).

3.3.11.3 Ecology

Knot forage in often very large flocks on open mudflats, feeding on mainly molluscs, including Baltic tellins, mussels (*Mytilus edulis*), cockles (*Cerastoderma edule*) and mudsnails (*Hydrobia ulvae*), the latter especially in early winter. Flocks will move with the tide and may cover very extensive areas of mudflat (Woodward et al., 2015).

Although the overall European population of knot is now defined as stable (Tucker and Heath, 1994), there was a large decline in the non-breeding population in the 1970s. This was attributed to a series of poor breeding seasons (Boyd, 1992), but habitat changes and land claim at wintering sites were also instrumental (Smit and Piersma, 1989). Knot are sensitive to disturbance, especially at roost sites (Woodward et al., 2015).

3.3.12 Lapwing

3.3.12.1 International/UK Population Size Estimates and Trends

The global population is estimated at 5,600,000-10,500,000 individuals with the European population estimated at 3,190,000-5,170,000 mature individuals (Wetlands International, 2019). The European population has experienced declines since 1980 estimated to be between 30-49% in 30 years (Wetlands International, 2015). As a result, the species has been evaluated as Decreasing and Near Threatened under the IUCN based on the moderately rapid rate of decline (BirdLife International, 2017e) and is classed as a SPEC 2 species. Lapwing is included in the Red list of BoCC in the UK due to its declining breeding and wintering population (Stanbury et al., 2021). Within Britain the lapwing is the most widespread non-breeding wader with the majority of wintering birds arriving from central Europe and Russia. Approximately 9% of the global population overwinters in the UK, with an estimated 3% wintering within SPA sites with the remainder on non-estuarine coasts and adjacent farmland (JNCC, 2012). The 25-year trend for the non-breeding population has seen a 40% decline and the 10-year trend has seen a 9% decline (Frost et al., 2021).

3.3.12.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 0.3% or more of the GB population of lapwing (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 4,148 individuals (JNCC, 2001). The status of lapwing is considered as *Favourable Declining*. Numbers of lapwing within the Firth of Forth have declined in the medium-term having previously peaked. Whilst the trend in lapwing numbers within the Firth of Forth appears to be tracking that of the region and British trends, suggesting that declines are part of a national trend rather than due to site specific pressures, the magnitude of the decline has been of a sufficient scale for BTO to trigger alerts for this species for the medium and long-term and since the site was designated (Woodward et al., 2019). Whilst the trends at the site and regional level are similar, BTO reports that numbers of lapwing in the Firth of Forth are contributing to an increasing proportion of the regional totals. This suggests that, despite the ongoing decline in numbers, conditions on the Forth remain relatively favourable for this species (Woodward et al., 2015).

3.3.12.3 Ecology

Lapwing feeds mainly on pasture, wet meadows, and arable farmland in winter with roosts in fields or on saltmarshes. Estuarine sites can become important in cold weather when other sites freeze. Gillings and Fuller (1999) suggest that flocks will feed on cultivated land during the early part of the winter, and then may switch to grassland during late to mid-winter in response to cold weather.

Steep declines in western Europe have been linked to agricultural intensification reducing breeding productivity as a result (BirdLife International, 2017e). Climate change may further reduce the value of Scottish sites as wintering grounds (Woodward et al., 2015).

3.3.13 Mallard

3.3.13.1 International/UK Population Size Estimates and Trends

Mallard is a duck species found across much of the northern hemisphere. The global population is estimated to number >19,000,000 individuals with the European population is estimated at 5,700,000-9,220,000 mature individuals (Wetlands International, 2019).

The European population has been evaluated as *Increasing* and of *Least Concern* under the IUCN (BirdLife International, 2015b). Mallard is included in the Amber list of BoCC in the UK due to its recent declining non-breeding population (Stanbury et al., 2021). The 25-year trend for the non-breeding population has seen a 35% decline and the 10-year trend has seen a 15% decline (Frost et al., 2021). The decline in the wintering population in the UK is thought to be caused by a reduction in long distance movement by European mallards, perhaps because of milder winters in mainland Europe (Woodward et al., 2015).

3.3.13.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 0.5% of the British population of mallard (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 2,564 individuals (JNCC, 2001). The status of mallard is considered as *Favourable Declining* at the site. The Forth trend is tracking the Scottish trend, and the proportion of Scottish wintering birds using the site is stable. This suggests conditions on the site remain favourable for this species (Woodward et al., 2015). The BTO has issued alerts for this species for the long-term and the period since designation (Woodward et al., 2019). Wintering numbers of mallard in Scotland were at an all-time low in 2017 (SNH, 2018).

3.3.13.3 Ecology

Mallard feed predominantly by dabbling in shallow water or upending in slightly deeper water during the day and occasionally by night (SNH, 2016). Birds will eat both plant and animal matter and may occasionally graze ashore. Mallard are often tolerant of humans, especially in urban areas, however localised disturbances can impact birds.

3.3.14 Oystercatcher

3.3.14.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 925,000 – 1,030,000 individuals and the European population is estimated at 526,000-692,000 mature individuals (Wetlands International, 2019). The European population has been evaluated as *Decreasing* and *Near Threatened* under the IUCN (BirdLife International, 2017f). Oystercatcher is included in the Amber list of BoCC in the UK due to its declining non-breeding population (Standbury et al., 2021). The numbers of overwintering oystercatchers in Great Britain have been decreasing over the medium-term. Declines in Scotland have been particularly pronounced, but the reasons for this are unclear. The 25-year trend for the non-breeding population has seen a 24% decline and the 10-year trend has seen a 16% decline (Frost et al., 2019).

3.3.14.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 2% of the British population of oystercatcher (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 7,846 individuals (JNCC, 2001). The status of oystercatcher is considered as *Favourable Maintained* at the site

due to the feature targets being met and the species likely to be secure on the site under present conditions. The proportion of Scottish wintering birds using the Forth has remained stable after an increase in the early 1990s. This suggests conditions on the site remain favourable for this particular species. Overall trends within the SPA appear to be tracking that of the region and British trends, suggesting that declines are part of a national trend rather than due to site-specific pressures (Woodward et al., 2015).

3.3.14.3 Ecology

Oystercatcher feed on shellfish, especially large cockles and mussels, ragworms (*Nereidae* species) and lugworms (*Arenicola* species) on mudflats, and are considered to be highly site faithful in winter.

Pressures include dredging for shellfish. Oystercatcher is considered less sensitive to disturbances than other wader species (Woodward et al., 2015).

3.3.15 Pink-footed Goose

3.3.15.1 International/UK Population Size Estimates and Trends

The global population is estimated at 410,000 individuals (Wetlands International, 2015) whilst the European population is estimated at 114,00-148,000 mature individuals. The European population has been evaluated as Increasing and of Least Concern under the IUCN (BirdLife International, 2016b). The UK supports the entire global population of wintering Iceland/Greenland breeding pink-footed goose (not including the Svalbard breeding population which overwinter in the Netherlands, Denmark, and Belgium); between 50-66% of the UK population are present in Scotland during autumn and winter (Mitchell, 2012). Between 68,897 and 153,348 individuals were recorded in east central Scotland during October and November 2019 (Brides et al., 2020). Pink-footed goose is included in the Amber list of Birds of Conservation Concern in the UK due to its declining non-breeding population (Stanbury et al., 2021) however the 25-year trend for the non-breeding population has seen a 111% increase and the 10-year trend has seen a 47% increase (Frost et al., 2021).

3.3.15.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 2% of the biogeographic population of pink-footed goose (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 10,852 individuals (JNCC, 2001). An important roost site is located on the Skinflats northwest of the Port of Grangemouth in the estuary which regularly supports 2,000 birds. The status of pink-footed goose is considered as *Favourable Maintained* at the site due to the feature targets being met and the species likely to be secure on the site under present conditions. Winter numbers in and around the Firth of Forth have increased in line with national trends (Woodward et al., 2015).

3.3.15.3 Ecology

Pink-footed geese utilise fields surrounding the site and are influenced by the cropping regime and changes throughout the winter in response to food availability. They will feed on a variety of crops including stubble fields, potato and beet remains, grass, and winter-sown cereals. Research has shown that there can be a preference for stubble fields in the autumn and early winter and grassland later in the winter (Mitchell, 2012).

Pressures include conflict with farmers as a result of increasing numbers, changes in agricultural practice affecting food availability, disturbance to roosts and hunting (Woodward et al., 2015).

3.3.16 Red-breasted Merganser

3.3.16.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 495,000-605,000 individuals with the European population estimated at 140,000-240,000 mature individuals (Wetlands International, 2019). The European population is evaluated as Stable and of Least Concern under the IUCN (BirdLife International, 2018c). Red-breasted merganser is included in the Amber list of BoCC in the UK due to its declining population (Stanbury et al., 2021). The 25-year trend for the non-breeding population has seen a 47% decline and the 10-year trend has seen a 22% decline (Frost et al., 2021).

3.3.16.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 7% or more of the GB population of red-breasted merganser (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 670 individuals (JNCC, 2001). The status of red-breasted merganser is considered as *Unfavourable Declining* at the site due to site-specific pressures. A declining proportion of Scottish wintering birds are being supported by the Forth. This suggests conditions on the Forth are deteriorating relative to other sites for this particular species (Woodward et al., 2015). This has resulted in the BTO issuing alerts for this species for the long-term and the period since designation (Woodward et al., 2019).

3.3.16.3 Ecology

Red-breasted merganser are associated with the sub-tidal area of the Firth of Forth and rarely come ashore during the winter months, hence are not sensitive to increased use/disturbance of the shoreline, although they would be sensitive to water-based recreation (Gillingwater, 2018).

3.3.17 Redshank

3.3.17.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 1,300,000-3,100,000 individuals with the European population estimated at 680,000-968,000 mature individuals (Wetlands International, 2019). The overall population trend is uncertain, but the European trend is thought to have undergone a moderate decline. Redshank has been evaluated as of *Least Concern* under the IUCN as a result of its large population range (BirdLife International, 2016c) and is classed as a SPEC 2 species. Redshank is included on the Amber list of BoCC in the UK due to its declining breeding and over-wintering population in Great Britain (Stanbury et al., 2021).

The UK is of international importance for redshank with almost 80% of the biogeographic population overwintering in the UK, including many of the British and Irish breeding birds that remain resident throughout the year. Redshank wintering in Britain are a combination of three populations (Delany et al., 2009): Nominate *totanus* (breeding in northern Europe); *Totanus totanus robusta* (breeding in Iceland and the Faroe Islands) and *T. t. Britannica* (breeding in Britain and Ireland). The 25-year trend for the UK non-breeding population has seen a 21% decline and the 10-year trend has seen a 9% decline (Frost et al., 2021). Non-breeding areas in north and west Scotland are amongst the most northerly redshank wintering sites in the world. There has been a north-westerly shift in core wintering range, suggestive of short-stopping towards Iceland (Maclean et al., 2008).

3.3.17.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 3% or more of the Eastern Atlantic population and 4% or more of the GB population of redshank (JNCC, 2012) and birds are widely distributed in low numbers around the shores of the estuary. The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 4,341 individuals (JNCC, 2001). The status of redshank is considered as *Favourable*

Maintained at the site due to the feature targets being met and the species likely to be secure on the site under present conditions. The trend for the Forth broadly tracks the Scottish trend, although a declining proportion of Scottish wintering birds are being supported by the site. This suggests conditions on the site are deteriorating relative to other sites for this species (Woodward et al., 2015). The numbers of redshank breeding and over-wintering in Great Britain have been declining and there have been declines in the numbers of redshank overwintering on Firth of Forth SPA. These changes broadly follow the trend at the National level, but appear slightly above those at the Regional level, which suggests that conditions for this species within the Forth are deteriorating relative to other sites.

3.3.17.3 Ecology

Redshank feed on invertebrates, including annelid worms, molluscs and crustaceans (especially amphipods) along the coasts, mudflats and tidal estuaries. These birds are considered to be highly site faithful in winter. Redshank are susceptible to harsh winter weather and prolonged cold spells. Improved survival as a result of milder winters has been reported for redshank (Burns et al., 2020).

Widespread declines in Britain and Europe have been attributed to agricultural intensification and loss of important wetland sites on the breeding grounds (Woodward et al., 2015). The patterns in overall declines in wintering totals appear suggestive of a climate induced shift in wintering distribution combined with low first-winter survival (BTO, 2010).

3.3.18 Red-throated Diver

3.3.18.1 International/UK Population Size Estimates and Trends

The non-breeding biogeographic population is estimated at 75,000 individuals (Wetlands International, 2019). The overall population trend is *Decreasing* with the European population evaluated as of *Least Concern* by IUCN due to the extremely large range of the species (BirdLife International, 2018d).

Red-throated diver is included in the Green list of BoCC in the UK (Hayhow et al., 2017) and is listed on Annex I of the Bird's Directive (European Commission, 2016c). An estimated 4,850 red-throated diver winter in Britain and Ireland (O'Brien et al., 2008).

3.3.18.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 2% of the GB population and 0.1% of the international population of red-throated diver (JNCC, 2012). The Firth of Forth is one of the most important sites in the UK for supporting a wintering population of red-throated diver. The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 88 individuals (JNCC, 2001). The status of red-throated diver is considered as *Favourable Maintained* at the site. The number of birds appears relatively stable within the SPA however this species is difficult to survey comprehensively from the shore (Woodward et al., 2015).

3.3.18.3 Ecology

Red-throated diver is principally a marine species in winter, occurring on sheltered inshore waters above soft substrates and sometimes in large numbers further offshore.

Numbers may fluctuate widely in response to weather and other factors affecting the food supply of sand eels, small crustaceans, sprat, and herring (Lack, 1986).

3.3.19 Ringed Plover

3.3.19.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 415,000-1,400,000 individuals (Wetlands International, 2019). The European population has been evaluated as *Decreasing* however of *Least Concern* under the IUCN due to the large population range (BirdLife International, 2016d). Ringed plover is included in the Red list of BoCC in the UK due to its severe recent non-breeding population decline (Hayhow et al., 2017). Approximately 60% of the global population overwinters in the UK (JNCC, 2012). The 25-year trend for the UK non-breeding population has seen a 50% decline and the 10-year trend has seen a 19% decline, however the species has showed higher numbers present during winter than the previous years, notwithstanding negative 10 year and 25-year trends. (Frost et al., 2021).

3.3.19.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 1% or more of the GB population of ringed plover (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 328 individuals (JNCC, 2001). The status of ringed plover is considered as *Favourable Maintained* within the SPA despite the decrease in numbers on the Forth. This is mainly due to an increasing proportion of Scottish wintering birds being supported by the Firth of Forth, suggesting site conditions remain relatively favourable for this species (Woodward et al., 2015).

3.3.19.3 Ecology

Ringed plover feed on marine worms, crustaceans and molluscs in sand and shingle shores, sandbanks and mudflats, and roost close to the feeding sites on bare ground and in low vegetation (Woodward et al., 2015).

Important migratory stop-over habitats on the Baltic Sea coastline are threatened by petroleum pollution, wetland drainage for irrigation, land abandonment and changing land management practices leading to scrub overgrowth (BirdLife International, 2016d). Additionally, Leech et al. (2004) found that as mean winter temperatures have increased since 1960, climatic constraints have eased, and an increasingly large proportion of wader populations have wintered on the east coast where the quality of the feeding grounds is higher, and the birds are nearer to their northern breeding grounds. This distributional shift is more evident for smaller waders including ringed plover which experience greater rates of heat loss due to their relatively high surface area: volume ratio than larger species and therefore potentially incur greater thermodynamic costs in cold weather (Leech et al., 2004).

3.3.20 Sandwich Tern

3.3.20.1 International/UK Population Size Estimates and Trends

The global population is estimated at 490,000-640,000 individuals with the European population estimated at 160,000-295,000 mature individuals (Wetlands International, 2019). The overall population trend is *Stable* with the European population evaluated as of *Least Concern* by IUCN (BirdLife International, 2018e) due to the extremely large range.

Sandwich tern is included in the Amber list of BoCC in the UK due to the recent moderate breeding population decline and localised breeding population (Hayhow et al., 2017).

3.3.20.2 Firth of Forth Population and Trends

The Firth of Forth SPA regularly supports approximately 6% of the GB population of Sandwich tern during the breeding season (JNCC, 2012). Sandwich tern now winters in large enough numbers to have a winter population estimate of 53 in Great Britain. The mean peak number of this species within the SPA during the baseline period (1992/93 to

1996/97) was 1,617 individuals (JNCC, 2001). The status of Sandwich tern is considered as *Favourable Maintained* at the site. The Firth of Forth is recognised as an important area for large numbers of Sandwich tern that congregate in the Forth post-breeding. A study by Bos, J. (2008) was undertaken to determine post breeding movements and origins of Sandwich tern in the Firth of Forth. Bos recorded ringed birds that originated from breeding sites in Scotland, Ireland, England, Belgium, and The Netherlands. The majority of UK birds observed in the Forth were ringed in Northumberland, about 100km away at the Farne Islands, Coquet Island and Amble as well as in Cleveland, Orkney, Grampian, Highland, and Fife. Sandwich tern winter off west Africa, travelling as far as South Africa and the Indian Ocean. Birds dive to catch prey in surface waters.

3.3.20.3 Ecology

The number of colonies in Scotland and in particular the Forth has declined dramatically. Birds often roost in estuaries at low tide and on coastal lagoons. The species is potentially displaced from colonies by disturbance, predation and increasing gull colonies. It is sensitive to the availability of suitable size (age-class) fish (Woodward et al., 2015).

3.3.21 Scaup

3.3.21.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 4,920,000-5,130,000 individuals with the European wintering population estimated at over 120,000 mature individuals (Wetlands International, 2019). The European population was broadly stable during 1990-2000 however overall, the trend has been evaluated as *decreasing* with substantial declines in north-western Europe, and the species underwent a large decline (>50%) overall and is now classed as a SPEC 3 species. Despite the decline they have been classed as of *Least Concern* globally under the IUCN (BirdLife International, 2018i) due to the extremely large range. Scaup is classified as *Vulnerable* on the European Red List of Birds (Birdlife International, 2021)

Scaup is included in the Red list of BoCC in the UK due to its recent declining non-breeding population (Hayhow et al., 2017). The 25-year trend for the non-breeding population has seen a 47% decline and the 10-year trend has seen a 60% decline. This is due to a lack of effective implementation of conservation measures in SPAs, with unsustainable levels of bycatch and declining food quality due to intensive fishing in their most important wintering areas in the Baltic Sea (Frost et al., 2021) (Marchowski et al. 2019, 2020).

3.3.21.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 4% of the British population of scaup (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 437 individuals (JNCC, 2001).

The status of scaup is considered as *Unfavourable Declining* at the site. Numbers using the site declined sharply, from >60% of Scottish wintering birds in the late 1970s to less than 5% in recent years. The substantial declines in scaup occurring on the Firth of Forth during the late 1970s and early 1980s being directly linked to sewage treatment improvement works (reduced sewage outputs leading to reduced mollusc abundance which supported less scaup) (Campbell, 1984). Scaup is now only recorded in very small numbers in winter (Cook et al., 2013). Consequently, alerts have been triggered for the medium and long-terms and the period since designation (Woodward et al., 2019).

3.3.21.3 Ecology

Scaup are gregarious outside the breeding season, feeding by diving in shallow waters mostly for molluscs in winter, especially mussels *Mytilus* species. Birds feed on cockle and clam species in estuaries and *Hydrobia* species in brackish

waters. Scaup winter in sheltered coastal waters e.g., estuaries. SNH (2016) note that improving water quality may have a negative effect on abundance of some food sources, such as molluscs.

3.3.22 Shelduck

3.3.22.1 International/UK Population Size Estimates and Trends

The global population of shelduck is estimated to number 625,000–750,000 individuals (Wetlands International, 2019). The northwest European population of shelduck breed and winter along the coasts of Britain, Scandinavia, the Baltic and continental Europe. Non-breeding shelduck in the UK are part of the north-west European population, which comprises 300,000 individuals (Rose and Scott, 1997). Approximately 24.5% (73,500 individuals) of the biogeographic population of shelduck are found in the UK during winter mainly along coasts. Although birds breed in Scotland, they undertake a moult migration each autumn to a moulting site located on the tidal mudflats of Germany's Wadden Sea before migrating to wintering areas (del Hoyo et al., 1992). A small number of birds moult in British estuaries, notably including the Forth (Woodward et al., 2015). In Europe the population trend is estimated to be *increasing* and for this reason the species is evaluated as *Least Concern* under the IUCN with the European population regarded as *Secure* (BirdLife International, 2016e). Shelduck are included in the Amber list of BoCC in the UK due to its moderate non-breeding population decline over the longer term (Standbury et al., 2021; Hayhow et al., 2017). The 25-year trend for the non-breeding population has seen a 28% decline and the 10-year trend has seen a 11% decline (Frost et al., 2019).

3.3.22.2 Firth of Forth Population and Trends

During the winter, the Firth of Forth SPA regularly supports an internationally important population (approximately 1.2% of biogeographic population) and nationally important population (6% of GB population) of shelduck (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 4,509 individuals (JNCC, 2001). Shelducks are frequently recorded foraging intertidally around the Port of Grangemouth. The status of shelduck is considered as *Favourable Maintained* at the Forth due to the feature targets being met and the species likely to be secure on the site under present conditions. Winter numbers have remained stable at the site in recent years (Woodward et al., 2015).

3.3.22.3 Ecology

The diet of shelduck consists predominantly of salt-water molluscs primarily mudsnail which is present in almost all estuaries, and often in large numbers. Spatial distribution is strongly influenced by the behaviour of this prey, particularly in relation to water depth. Shelducks are considered to have a high site fidelity.

Key pressures include disturbance to potentially flightless moulting birds. Across UK estuary sites, counts were significantly lower in areas close to footpaths. The abundance of mudsnails is influenced by water quality and may affect the numbers of shelduck and their duration of stay. The species is also threatened by habitat loss e.g., as a result of tidal barrage Schemes in Europe (Kear, 2005; Burton, 2006).

3.3.23 Turnstone

3.3.23.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 460,000–730,000 individuals with the European population estimated at 71,800–154,000 individuals (Wetlands International, 2019). The overall population trend is *Decreasing* with the European population estimated to be decreasing by nearly 25% in 22 years. However, has been evaluated as *Least Concern* by IUCN (BirdLife International, 2016f) due to the extremely large range. Turnstone is included in the Amber list of BoCC in the UK due to the moderate decline of important non-breeding population (Hayhow et al., 2017).

Climate change may be the cause of a northerly shift in wintering range of turnstone. The 25-year trend for the non-breeding population has seen a 42% decline and the 10-year trend has seen a 21% decline – this is reflected in the Scottish 25-year trend of a 47% decline and the 10-year trend seeing a 25% decline (Frost et al., 2021).

3.3.23.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 1% Western Palearctic/GB population of turnstone (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 860 individuals (JNCC, 2001). The status of turnstone is considered as *Unfavourable Declining* at the site. The proportion of Scottish wintering birds using the Forth has remained stable after increasing in the early 1990s. This suggests the Forth area remains relatively favourable for this species. (Cook et al., 2013).

3.3.23.3 Ecology

Turnstone locate food by sight, often by turning over pebbles or seaweed. Birds are highly site faithful, both within and between winters, often remaining in flocks with the same individuals but will mix with other waders when roosting. Turnstone are not particularly sensitive to disturbance compared to other wader species. The diet of this species consists of a wide range of invertebrates and other material, including carrion. Birds are found along rocky or stony shores, but also on mudflats or sandy shores especially on tide wrack.

3.3.24 Wigeon

3.3.24.1 International/UK Population Size Estimates and Trends

The global population is estimated to number 2,800,000-3,300,000 individuals (Wetlands International, 2019). The overall trend is decreasing however has been evaluated as of least concern under the IUCN due to the extremely large population range (BirdLife International, 2017g). The European trend is estimated to be stable. Over 75% of the UK population breeds in Scotland, and the species' range may be limited by water quality (with a preference for neutral or alkaline waters), and availability of suitable nesting sites (JNCC, 2012).

Wigeon are included in the Amber list of BoCC in the UK due to its moderate non-breeding population decline over the longer term (Hayhow et al., 2017). Approximately 22% of the international flyway population overwinter in Britain (JNCC, 2012). The 25-year trend for the non-breeding population has seen a 1% decrease and the 10-year trend has seen an 6% decline (Frost et al., 2021). The Wetland Bird Survey reported the wigeon population is one of Britain's most abundant water birds.

3.3.24.2 Firth of Forth Population and Trends

During the winter the Firth of Forth SPA regularly supports approximately 0.78% or more of the GB population of wigeon (JNCC, 2012). The mean peak number of this species within the SPA during the baseline period (1992/93 to 1996/97) was 2,139 individuals (JNCC, 2001). The status of wigeon is considered as *Favourable Maintained* at the site due to the feature targets being met and the species likely to be secure on the site under present conditions. The Forth trend is tracking the Scottish trend, and the proportion of Scottish wintering birds using the site is stable. This suggests the site remains relatively favourable to this species (Woodward et al., 2015).

3.3.24.3 Ecology

Wigeon feed predominantly on leaves, seeds, stems and root bulbs of pond weeds, fine grasses horsetails and eelgrass, as well as algae (Myrfyn and Thomas, 1979). Wigeon are gregarious, forming large flocks and can feed at night. Wigeon feed close to the water's edge, when disturbed, flocks fly to the safety of open water and take a while to come back to feed, affecting their ability to forage if ongoing disturbance occurs (Woodward et al., 2015).

4. Bird Survey Methods

This section presents the methods of the bird surveys undertaken for the Scheme and of two WeBS survey Sectors which overlap with the Scheme survey areas.

4.1 2015-2017 Bird Surveys

A detailed survey methodology was previously presented in the Grangemouth Flood Alleviation Scheme: Ornithology Survey Desk Study and Proposed Scope report, prepared by MacArthur Green and CH2MHill in April 2015, and agreed with NatureScot.

The aims of the surveys were to observe and record the following:

- abundance and spatial distribution of target species at different stages of the tidal cycle;
- temporal distribution and abundance of target species between years, seasons, months, and time of day;
- behaviour of birds at different stages of the tidal cycle (e.g., feeding, roosting, loafing);
- baseline human activity levels and types of activity within the survey area;
- any evidence of anthropogenic or other disturbance within the survey area, and reactions of birds to such disturbance; and
- breeding bird distribution and abundance (data used to inform the ecological impact assessment report rather than the HRA).

A total of 16 vantage points were used, each covering a "survey Sector" similar to the method used for WeBS core count and low-tide counts (Pollitt et al., 2003) within the Forth Estuary, and the distribution of birds within each survey Sector was plotted, which provided a more detailed overview than the WeBS surveys. The 16 Sectors covered an area stretching from Dunmore to Blackness, to understand the distribution of bird species across the wider estuary. All vantage point locations are shown in MacArthur Green and CH2MHill (2015) - Figure 10 identifies the survey Sectors which comprise the study area for the final Scheme design (Sectors 4 to 11), plus the adjacent Sectors for context (Sectors 2, 3, 12 and 13).

The non-breeding bird surveys involved a programme of monthly counts from August 2015 to March 2016 and August 2016 to March 2017 from the 16 individual survey Sectors. Whilst the surveys were for non-breeding birds, surveys were conducted in the months August and September as it is known that certain designated species of the SPA can be present in large numbers outwith the core wintering bird period (October to March). The Firth of Forth SPA is designated for Sandwich tern during the passage period (August and September), as well as supporting populations of European importance for the following species which migrate in the aforementioned months: pink-footed goose, shelduck, knot, redshank and turnstone.

Each survey effectively comprised six independent hourly counts enabling a range of tidal states to be surveyed. Emphasis was placed on covering the period around high tide, in order to establish roosting distribution closest to the shoreline, when birds may be most sensitive to disturbance. Survey methods were based on the WeBS core count scheme, the main purpose being to investigate local distribution and abundance, and not to determine overall population sizes within the whole survey area.

4.2 2022 – 2023 Bird Surveys

Further bird surveys were undertaken by Jacobs ecologists from August 2022 to March 2023. These were undertaken to update the baseline survey data for the Scheme and followed the survey approach taken by MacArthur Green.

As the Scheme design had been refined at this stage, surveys were only conducted at eight vantage points from Sector 4 to Sector 11. This area spans from north of Bothkennar Pools at Skinflats, to Kinneil Lagoons east of the mouth of the River Avon.

Surveys were undertaken once per month for each survey Sector and followed a through the tide count (TTTC) survey method to capture data from the lowering, low, rising, and high tidal states. Where a full range of tides could not be surveyed due to hours of darkness, surveys prioritised capturing the high tide count.

All estuarine and shore areas within each Sector were surveyed with the use of spotting scopes and binoculars, with birds recorded every hour, with any new arrivals within the hour also recorded. Field records were inputted using GIS software installed on an iPad. If a flock left within the hour, this was recorded within the field notes rather than making a new record to avoid double counting.

Approval for these surveys was not received until August 2022 and due to the limited availability of surveyors at short notice, not all Sectors could be surveyed during the month of August. Consequently, no surveys were conducted in Sectors 7 and 8 in August 2022, however these Sectors are located outwith the SPA and the 2015/16 and 2016/17 data identified that these areas were not used by the birds in high numbers.

4.3 Zone of Influence (Zol)

As part of the ornithological investigation for the HRA, the suitability of a Zol was reviewed for each qualifying species using available academic literature and research studies. A summary of this review and the thresholds for each qualifying species can be found in Table 4.1 of the HRA. A Zol for noise and visual disturbance comprising a buffer of 300m from the edge of the Site Boundary was determined for 18 of the 27 qualifying species of the SPA. Additionally, a 650m Zol for visual disturbance was implemented for nine species (common scoter, curlew, eider, golden plover, pink-footed goose, red-throated diver, scaup, shelduck, and wigeon). This Zol is based on research undertaken on waterbird responses to disturbances from a range of activities, including construction work (Davidson and Rothwell, 1993; Cutts et al., 2013; Goodship and Furness, 2022). To avoid implementing several Zol, the recommended visual disturbance buffer of the most sensitive species (650m for curlew) has been applied to all species with a visual disturbance threshold of more than 300m. Therefore, the 650m Zol is very precautionary for some of the nine species (e.g. eider and scaup) based on a review of the literature.

The relevant Zol (300m or 650m) has been applied to the survey data results shown in Section 5 Bird Survey Results.

4.4 WeBS Data Use Methods

BTO WeBS data were obtained for two WeBS count sectors; the Forth Grangemouth to Kincardine Bridge, and Grangepans to Grangemouth Sectors. The WeBS data were obtained for the purpose of comparing them to the data gathered during surveys for the Scheme (survey data). Data was obtained for the 2015 – 2017 winter period (from September to March inclusive) to allow for comparison with the survey data of the same period. Data were also obtained for the 2019 – 2021, which was the most recently available data at the time of writing, and five-year period data for each data set to allow for the monthly counts of the WeBS data to be compared to a five-year average.

This exercise was undertaken to determine if the survey data is representative of the wider WeBS dataset (gathered across five winters) in terms of species diversity, months of presence/occurrence and general patterns of where and when peak numbers occur. Note - the datasets are not directly comparable given there are differences in methods used to collect the data, and in count Sector sizes.

The main differences between the Scheme's bird survey methodology and BTO WeBS methodology is that the counts for a specific WeBS Sector are undertaken on one pre-defined day each month, whereas the survey Sectors for the Scheme were surveyed across periods of several days. Also, WeBS data is collected from a larger area compared with

the Scheme's bird survey area; for example, survey Sectors 3, 4, 5 and 6 span approximately half of the Forth Grangemouth to Kincardine Bridge (Skinflats) WeBS Sector (Figure 10).

5. Results

This section presents the results of the bird surveys undertaken for the Scheme and of the two WeBS survey Sectors which overlap with the Scheme survey areas.

Tables B2 and B3 respectively present the 2015 - 2017 and 2022 - 2023 survey peak counts at either rising or high tide for each species each survey month in Sectors 4 to 11. The largest peak count for each species is indicated by a bold cell outline. A total of 23 qualifying species (out of 27 species) were recorded within the Zol in Sectors 4 to 11 during surveys for the Scheme. Eider and great crested grebe were only recorded during the 2015 – 2017 surveys. Common scoter, long-tailed duck, Slavonian grebe and velvet scoter were absent from the Zol.

The peak counts for each qualifying species across the two survey windows are presented in Section 5.3 Bird Survey Diagrams, Diagrams B1 to B23.

Tables B4 and B6 present the 2015 - 2017 and 2019 - 2021 data for WeBS count sector Forth Grangemouth to Kincardine Bridge. Tables B5 and B7 present the 2015 - 2017 and 2019 - 2021 data for WeBS count sector Grangepans to Grangemouth. The WeBS five-year average was also included to better understand if the survey data collected for the Scheme was representative of the area.

5.1 2015 – 2017 Bird Survey Results

Table B2: 2015 - 2017 species peak counts at high/rising tide within the Scheme Zol (survey Sectors 4 – 11). Note: the maximum peak count across both survey windows (with month, year, and Sector) from within the wider study area is also provided for each species for context.

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Bar-tailed godwit (300m Zol)																
Study Area Peak Count: 480 – Jan 2017 – Sector 9																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	12	0	0	73	110	117	480	74	68
Sector 10	0	0	0	0	60	0	270	0	0	0	20	76	43	360	340	47
Sector 11	0	0	0	0	0	0	0	0	0	0	8	0	178	0	0	48
Common scoter (650m Zol)																
Study Area Peak Count: 1 – Nov 2015 – Sector 5, Dec 2016 – Sector 11																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cormorant (300m Zol)																
Study Area Peak Count: 110 – Aug 2022 – Sector 4																
Sector 4	0	0	10	0	0	0	0	2	0	0	0	0	0	0	8	0
Sector 5	1	60	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Sector 6	7	0	2	0	0	0	2	0	2	60	8	12	0	1	6	7

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 7	5	0	4	0	2	2	0	3	6	10	8	8	4	3	1	2
Sector 8	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Sector 10	0	0	0	0	2	5	0	1	0	1	0	0	3	0	4	6
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curlew (650m Zol)																
Study Area Peak Count: 430 – Dec 2016 – Sector 11																
Sector 4	94	0	0	0	0	80	0	109	0	45	0	0	0	0	2	0
Sector 5	48	93	18	100	8	0	2	0	10	10	88	62	178	88	100	66
Sector 6	12	20	8	75	13	5	5	6	32	80	16	35	1	1	0	1
Sector 7	N/A	0	0	0	16	54	1	1	2	230	8	72	0	1	1	1
Sector 8	N/A	0	0	1	0	0	1	0	2	0	10	12	2	0	1	1
Sector 9	2	250	272	290	165	210	262	154	0	370	360	380	345	310	380	117
Sector 10	40	0	7	10	0	60	290	210	110	24	26	60	86	35	76	43
Sector 11	135	0	0	40	15	150	0	0	93	15	320	25	430	119	5	11
Dunlin (300m Zol)																
Study Area Peak Count: 11000 – Jan 2017 – Sector 9																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	2670	0	0	0
Sector 5	1	0	0	730	0	1	0	0	0	0	0	0	0	0	0	0
Sector 6	57	0	0	0	650	800	340	80	400	235	20	2800	300	60	40	500
Sector 7	3	140	0	0	1	0	0	0	12	500	0	1740	0	6	1	0
Sector 8	0	0	0	6	0	0	0	0	12	1	6	10	1	5	65	8
Sector 9	0	150	420	0	40	2500	0	0	0	230	640	4760	5700	11000	870	33
Sector 10	5	0	0	45	500	150	9000	6300	0	150	120	360	8000	9200	7450	880
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	5500	0	0	870
Eider (650m Zol)																
Study Area Peak Count: 22 – Mar 2017 – Sector 11																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	5	0	0	2	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Golden plover (650m Zol)																
Study Area Peak Count: 436 – Oct 2016 – Sector 11																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	26	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	140	0	0	12	0	0	0	0	94	73	0	42	0	0
Sector 10	0	0	180	39	25	4	34	0	0	0	172	64	0	6	0	0
Sector 11	0	0	100	210	68	60	0	0	0	18	436	0	15	76	0	0
Goldeneye (300m Zol)																
Study Area Peak Count: 23 – Jan 2017 – Sector 10																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	6	0	4	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	7	0	0	0	0	0	0	1	23	19	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Great crested grebe (300m Zol)																
Study Area Peak Count: 28 – Sep 2016 – Sector 9																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	2	0	0	0	6	4	11	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	4	0	0	0	0	0	0	3	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grey plover (300m Zol)																
Study Area Peak Count: 52 – Oct 2015 – Sector 5																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knot (300m Zol)																
Study Area Peak Count: 7300 – Jan 2017 – Sector 10																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	36	0	0	0	0	0	0	0	0	0	1	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Sector 9	0	1	0	60	0	1500	250	32	0	0	170	770	2	3600	12	0
Sector 10	3	0	0	0	100	0	1900	680	1	0	30	170	0	7300	1100	578
Sector 11	0	0	0	0	0	0	0	0	1	0	500	0	470	0	0	640
Lapwing (300m Zol)																
Study Area Peak Count: 750 - Jan 2016 – Sector 11																

Species	2015					2016							2017				
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	57	0	0	0	
Sector 5	42	180	0	6	0	0	0	0	0	0	0	0	0	0	0	0	
Sector 6	0	42	120	120	40	150	40	0	0	0	20	314	300	110	100	2	
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sector 9	0	0	8	2	0	0	0	0	0	0	4	0	0	55	0	0	
Sector 10	120	400	200	75	200	350	268	76	0	26	200	267	333	430	37	0	
Sector 11	0	0	0	0	0	0	0	0	0	0	330	0	548	0	0	0	
Mallard (300m Zol)																	
Study Area Peak Count: 180 – Oct 2015 – Sector 10																	
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sector 5	15	0	0	0	2	4	40	0	0	0	0	0	0	34	0	0	
Sector 6	0	0	0	13	0	0	0	0	0	18	6	22	7	5	2	1	
Sector 7	0	0	6	0	0	45	0	6	8	160	45	14	15	8	16	0	
Sector 8	5	0	0	27	7	0	2	0	20	64	38	8	4	6	6	2	
Sector 9	41	60	0	0	0	0	20	0	0	8	10	0	8	0	36	0	
Sector 10	23	20	180	0	30	25	0	20	0	15	8	34	45	65	15	9	
Sector 11	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	
Oystercatcher (300m Zol)																	
Study Area Peak Count: 588 – Feb 2017 – Sector 9																	
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Sector 6	12	1	3	2	1	0	7	11	6	12	15	38	25	10	20	13	
Sector 7	0	0	0	0	0	66	0	0	0	170	1	160	0	0	0	6	
Sector 8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Sector 9	17	180	150	0	95	360	230	0	0	188	500	460	366	44	588	384	
Sector 10	50	3	2	35	0	0	380	490	0	4	0	68	0	120	66	176	
Sector 11	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	
Pink-footed goose (650m Zol)																	

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Study Area Peak Count: 1370 – Nov 2016 – Sector 5																
Sector 4	0	0	0	0	0	0	0	600	0	0	0	0	0	0	8	0
Sector 5	0	0	284	0	0	0	600	0	0	0	0	1370	0	0	180	111
Sector 6	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red-breasted merganser (300m ZoI)																
Study Area Peak Count: 130 – Nov 2015 – Sector 11																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Sector 6	0	0	2	0	0	2	0	1	0	0	0	4	1	0	1	1
Sector 7	0	0	4	0	0	5	0	0	6	26	28	14	1	1	0	0
Sector 8	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
Sector 10	0	0	0	1	0	0	0	0	0	0	0	0	6	0	6	6
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Redshank (300m ZoI)																
Study Area Peak Count: 1470 – Nov 2016 – Sector 6																
Sector 4	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0	0
Sector 5	3	48	0	460	20	0	2	0	310	3	6	6	0	0	1	7
Sector 6	250	250	240	300	500	323	200	300	170	570	400	1470	400	500	190	500
Sector 7	0	55	0	0	50	400	28	36	62	540	112	420	132	80	78	3
Sector 8	85	0	55	64	11	50	149	210	206	560	160	134	120	80	250	150
Sector 9	0	40	19	150	280	175	170	0	0	220	87	630	480	600	270	198
Sector 10	290	500	195	100	170	30	460	200	580	400	260	160	550	370	560	365
Sector 11	0	500	0	0	0	0	0	0	1	0	0	0	1200	0	0	0

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Red-throated diver (650m Zol)																
Study Area Peak Count: 2 – Jan 2016 – Sector 4, Nov 2016 – Sector 7																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ringed plover (300m Zol)																
Study Area Peak Count: 210 – Sep 2016 – Sector 9																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	7	0	0	0	0	0	0	0	7	6	0	8	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0
Sector 9	0	0	18	0	0	0	0	0	0	210	2	22	0	78	22	0
Sector 10	10	0	0	30	1	19	17	0	0	0	33	0	9	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sandwich tern (300m Zol)																
Study Area Peak Count: 17 – Sep 2015 – Sector 5																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaup (650m Zol)																
Study Area Peak Count: 28 – Feb 2023 – Sector 10, Sector 11																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shelduck (650m Zol)																
Study Area Peak Count: 1460 – Aug 2016 – Sector 4																
Sector 4	300	713	100	66	0	0	0	96	0	270	0	0	55	0	0	88
Sector 5	26	1440	550	110	0	0	0	5	0	8	0	8	0	16	2	2
Sector 6	750	24	380	135	43	67	51	21	374	570	122	175	5	49	8	12
Sector 7	600	0	50	0	24	27	0	1	109	230	360	48	1	5	3	4
Sector 8	110	0	0	0	1	1	6	4	33	9	18	2	1	1	7	4
Sector 9	400	250	320	75	67	39	18	0	0	360	160	176	278	210	75	178
Sector 10	200	0	350	0	0	22	0	6	700	350	230	215	190	490	290	178
Sector 11	16	30	0	0	170	200	0	77	63	300	270	0	80	46	71	97
Turnstone (300m Zol)																
Study Area Peak Count: 12 – Nov 2015 – Sector 11																
Sector 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0	2	1	0	4	1	1	2	1
Sector 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Sector 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species	2015					2016								2017		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wigeon (650m Zol)																
Study Area Peak count: 660 – Jan 2017 – Sector 10																
Sector 4	0	0	20	0	0	0	0	8	0	18	20	0	0	0	0	0
Sector 5	0	0	0	40	0	25	70	30	0	0	0	44	0	45	14	17
Sector 6	2	0	1	5	150	10	1	0	0	45	0	58	12	25	30	2
Sector 7	21	0	0	0	70	6	0	0	0	0	0	22	8	0	0	0
Sector 8	0	0	0	10	0	15	12	4	0	0	33	33	11	0	20	17
Sector 9	0	0	2	12	20	9	27	0	0	53	18	4	25	110	45	66
Sector 10	0	0	12	15	0	10	0	135	0	6	40	80	85	660	86	88
Sector 11	0	0	1	0	35	0	0	80	0	0	80	0	26	0	28	10

5.2 2022 – 2023 Bird Survey Results

Table B3: 2022 – 2023 species peak counts at high/rising tide within the Scheme Zol (survey Sectors 4 – 11). Note: the maximum peak count across both survey windows (with month, year and Sector) from the wider study area is also provided for each species for context.

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Bar-tailed godwit (300m Zol) Study Area Peak Count: 480 – Jan 2017 – Sector 9								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	1	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	6	0	0	7	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	84	4	5	0	88
Common scoter (650m Zol) Study Area Peak Count: 1 – Nov 2015 – Sector 5, Dec 2016 – Sector 11								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Cormorant (300m Zol) Study Area Peak Count: 110 – Aug 2022 – Sector 4								
Sector 4	110	0	35	0	0	0	0	0
Sector 5	1	0	0	1	0	0	0	0
Sector 6	13	4	14	12	3	1	5	3

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 7	N/A	0	9	2	3	2	1	4
Sector 8	N/A	0	1	2	1	1	1	0
Sector 9	0	0	2	0	1	0	0	1
Sector 10	1	4	3	2	0	1	3	0
Sector 11	0	0	0	0	0	0	0	0
Curlew (650m Zol) Study Area Peak Count: 430 – Dec 2016 – Sector 11								
Sector 4	0	0	44	0	0	0	0	25
Sector 5	4	110	36	143	2	1	46	41
Sector 6	11	12	26	11	16	11	10	32
Sector 7	N/A	25	2	2	8	1	10	1
Sector 8	N/A	5	3	3	3	2	5	3
Sector 9	286	345	349	304	201	235	128	40
Sector 10	8	35	65	5	1	62	5	4
Sector 11	3	3	21	188	86	162	78	51
Dunlin (300m Zol) Study Area Peak Count: 11000 – Jan 2017 – Sector 9								
Sector 4	0	0	252	0	0	0	0	0
Sector 5	0	0	0	1	0	0	12	6
Sector 6	9	90	7	4	1150	1600	400	12
Sector 7	N/A	126	105	4	270	1	0	3
Sector 8	N/A	80	2	24	87	0	0	0
Sector 9	0	550	331	41	204	72	0	120
Sector 10	0	250	40	83	9	1	6	800
Sector 11	1	330	18	510	4	18	0	250
Eider (650m Zol) Study Area Peak Count: 22 – Mar 2017 – Sector 11								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Golden plover (650m Zol) Study Area Peak Count: 436 – Oct 2016 – Sector 11								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	18	0	76	0	0	0	0
Sector 6	0	0	409	91	20	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	6	0	0	0	0	0
Sector 10	0	3	67	3	0	0	0	0
Sector 11	0	43	309	259	8	0	0	0
Goldeneye (300m Zol) Study Area Peak Count: 23 – Jan 2017 – Sector 10								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	2	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	1	0	0
Sector 9	0	0	0	0	0	0	0	0
Sector 10	0	8	2	0	0	8	0	1
Sector 11	0	0	0	0	0	0	0	0
Great crested grebe (300m Zol) Study Area Peak Count: 28 – Sep 2016 – Sector 9								
Sector 4	0	0	0	0	0	0	0	0

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Grey plover (300m Zol) Study Area Peak Count: 52 – Oct 2015 – Sector 5								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	3	0	0	0	0	7	1
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Knot (300m Zol) Study Area Peak Count: 7300 – Jan 2017 – Sector 10								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	2	0	0	55	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	2	0	0
Sector 9	0	0	0	0	0	410	0	0
Sector 10	1	30	0	92	0	0	0	0
Sector 11	0	0	0	62	0	0	0	72
Lapwing (300m Zol) Study Area Peak Count: 750 – Jan 2016 – Sector 11								

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	40	0	162	0	0	0	0
Sector 6	35	88	98	310	86	0	82	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	10	0	15	0	0	0	0	0
Sector 10	9	33	118	101	0	0	0	0
Sector 11	342	404	12	185	390	51	0	0
Mallard (300m Zol) Study Area Peak Count: 180 – Oct 2015 -Sector 10								
Sector 4	0	0	0	0	0	0	2	0
Sector 5	0	0	2	15	0	0	5	6
Sector 6	2	0	6	7	2	7	0	8
Sector 7	N/A	2	0	0	18	0	1	3
Sector 8	N/A	13	5	7	6	8	2	5
Sector 9	0	9	90	17	10	0	20	4
Sector 10	23	8	23	10	22	4	18	5
Sector 11	0	0	0	0	0	0	0	0
Oystercatcher (300m Zol) Study Area Peak Count: 588 – Feb 2017 – Sector 9								
Sector 4	0	0	15	0	0	0	0	0
Sector 5	0	0	0	0	0	0	16	2
Sector 6	17	44	32	13	20	22	25	11
Sector 7	N/A	18	1	4	2	0	3	4
Sector 8	N/A	1	0	0	0	0	3	2
Sector 9	76	348	64	191	168	266	28	12
Sector 10	2	1	0	0	0	1	19	4
Sector 11	0	0	1	0	0	0	0	0
Pink-footed goose (650m Zol)								

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Study Area Peak Count: 1370 – Nov 2016 – Sector 5								
Sector 4	0	200	0	0	0	0	0	0
Sector 5	0	0	3	1	0	1	1	0
Sector 6	0	0	0	0	1	1	1	0
Sector 7	N/A	20	0	0	0	0	0	0
Sector 8	N/A	34	0	0	0	1	0	0
Sector 9	0	20	0	1	0	0	0	0
Sector 10	0	40	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Red-breasted merganser (300m Zol)								
Study Area Peak Count: 130 – Nov 2015 – Sector 11								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	1	0
Sector 6	14	0	0	2	2	2	2	4
Sector 7	N/A	3	5	5	2	2	0	6
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	2	4
Sector 10	0	4	7	4	1	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Redshank (300m Zol)								
Study Area Peak Count: 1470 – Nov 2016 – Sector 6								
Sector 4	0	0	67	0	0	0	0	330
Sector 5	0	10	0	10	0	0	40	120
Sector 6	540	200	161	450	320	433	120	374
Sector 7	N/A	49	1	83	172	37	3	2
Sector 8	N/A	160	204	153	67	196	117	102
Sector 9	540	170	412	120	410	375	221	210
Sector 10	81	220	146	158	53	114	165	63
Sector 11	340	0	0	187	0	28	0	506

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Red-throated diver (650m Zol) Study Area Peak Count: 2 – Jan 2016 – Sector 4, Nov 2016 – Sector 7								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	2	1	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Ringed plover (300m Zol) Study Area Peak Count: 210 – Sep 2016 – Sector 9								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	2	0	0	12	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0
Sector 10	0	0	1	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Sandwich tern (300m Zol) Study Area Peak Count: 17 – Sep 2015 – Sector 5								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	1	6	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	11	0	0	0	0	0	0	0
Sector 10	0	0	0	0	0	0	0	0

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 11	4	0	0	0	0	0	0	0
Scaup (650m Zol) Study Area Peak Count: 28 – Feb 2023 – Sector 10, Sector 11								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	0	0	0	0	0	0	0	0
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	9	0
Sector 10	0	0	0	16	0	0	17	6
Sector 11	0	0	0	0	0	0	0	13
Shelduck (650m Zol) Study Area Peak Count: 1460 – Aug 2016 – Sector 4								
Sector 4	0	0	53	10	0	0	0	73
Sector 5	10	12	0	0	2	0	6	2
Sector 6	93	52	71	2	11	6	23	47
Sector 7	N/A	1	60	66	112	9	52	12
Sector 8	N/A	0	0	0	1	0	5	12
Sector 9	1002	900	174	515	139	8	28	94
Sector 10	92	60	25	2	80	42	30	4
Sector 11	43	54	30	226	17	155	116	172
Turnstone (300m Zol) Study Area Peak Count: 12 – Nov 2015 – Sector 11								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	0	0	0	0	0
Sector 6	2	0	4	0	0	3	0	1
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	0	0	0	0	0	0
Sector 9	0	0	0	0	0	0	0	0

Species	2022					2023		
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Sector 10	0	0	0	0	0	0	0	0
Sector 11	0	0	0	0	0	0	0	0
Wigeon (650m Zol) Study Area Peak count: 660 – Jan 2017 – Sector 10								
Sector 4	0	0	0	0	0	0	0	0
Sector 5	0	0	0	10	0	0	36	36
Sector 6	0	0	0	0	4	5	0	18
Sector 7	N/A	0	0	0	0	0	0	0
Sector 8	N/A	0	46	34	23	12	69	22
Sector 9	0	0	89	131	139	0	147	69
Sector 10	0	0	45	13	36	114	64	65
Sector 11	0	0	0	2	0	0	0	19

5.3 Bird Survey Results Diagrams

Diagrams B1 to B23 below present the peak counts of 23 bird species recorded within the noise and visual disturbance Zol in each Sector during each month of the survey period. Eider and great crested grebe were only recorded during the 2015/16 – 2016/17 surveys. Common scoter, long-tailed duck, Slavonian grebe and velvet scoter were absent from the Zol.

No surveys were conducted in Sectors 7 and 8 in August 2022.

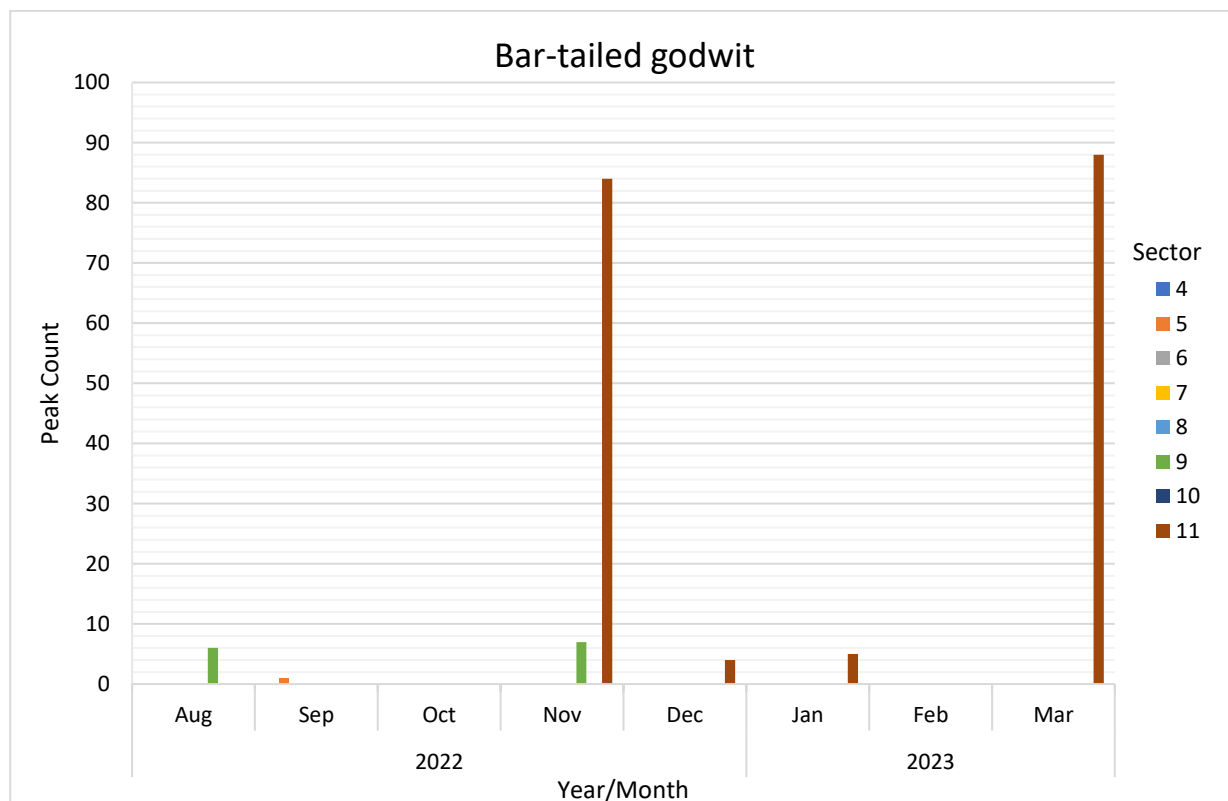
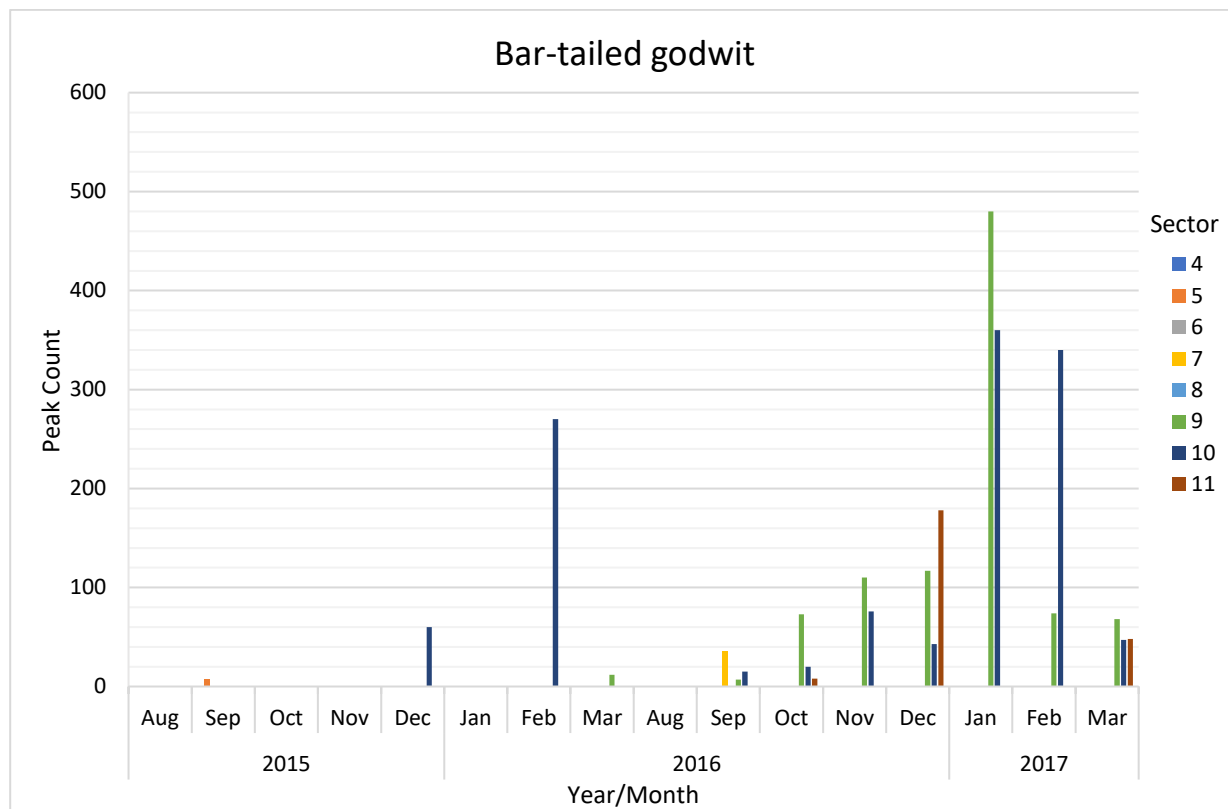


Diagram B1: Peak bar-tailed godwit records within the 300m ZoI

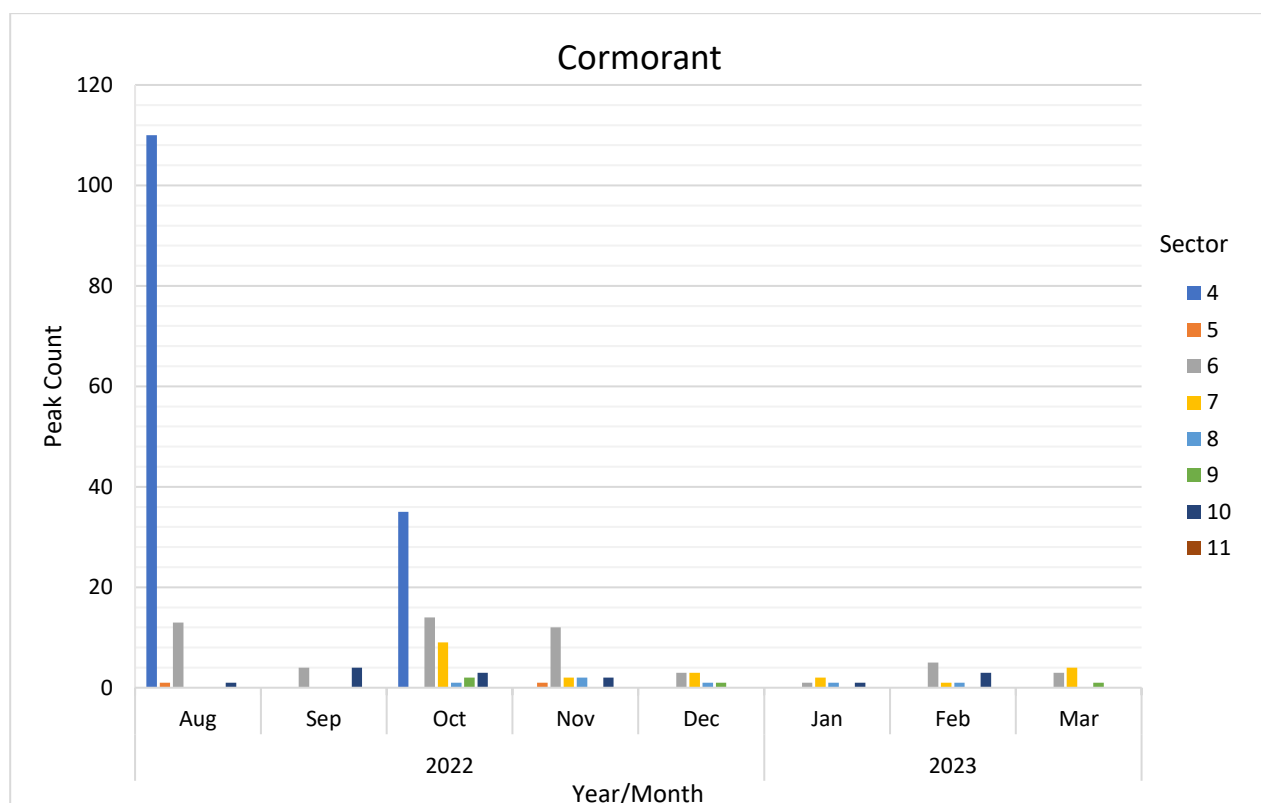
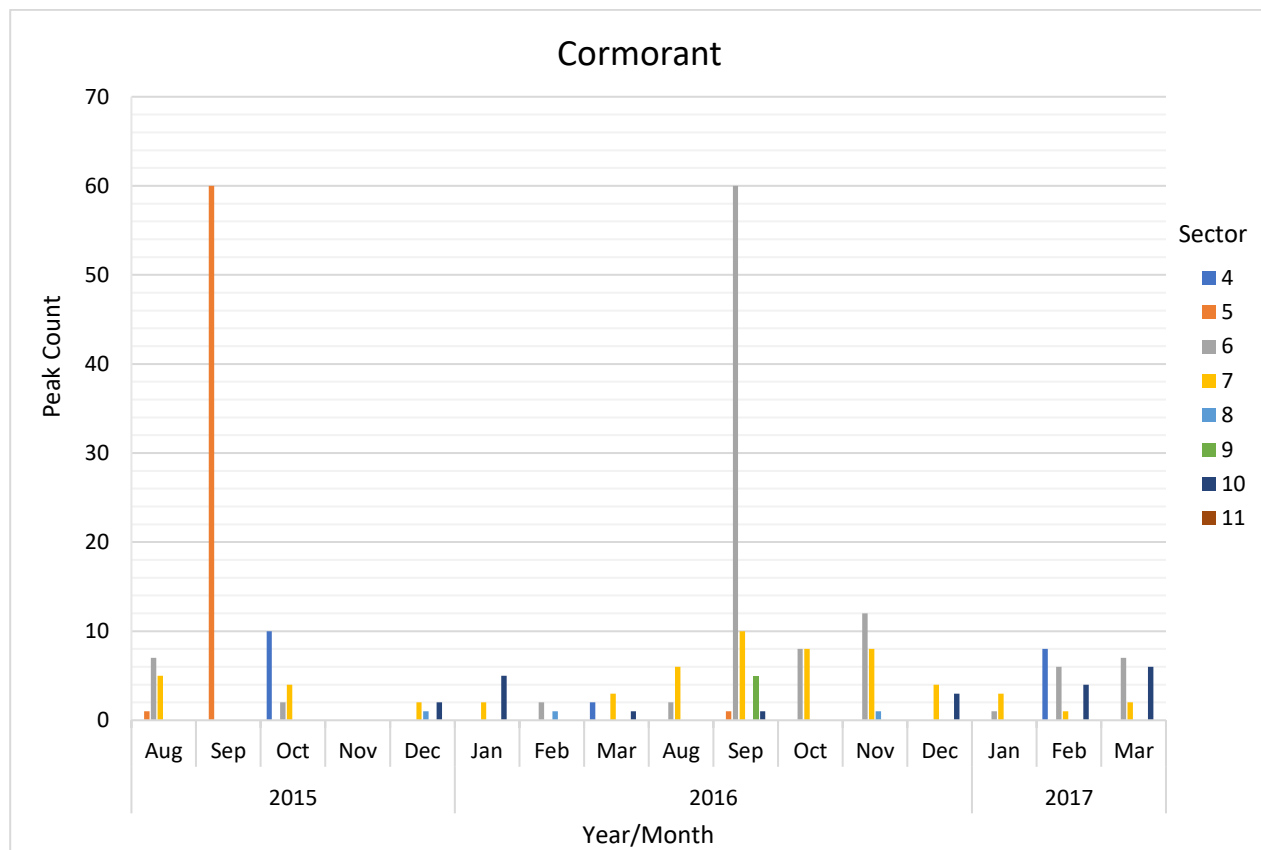


Diagram B2: Peak cormorant records within the 300m ZoI

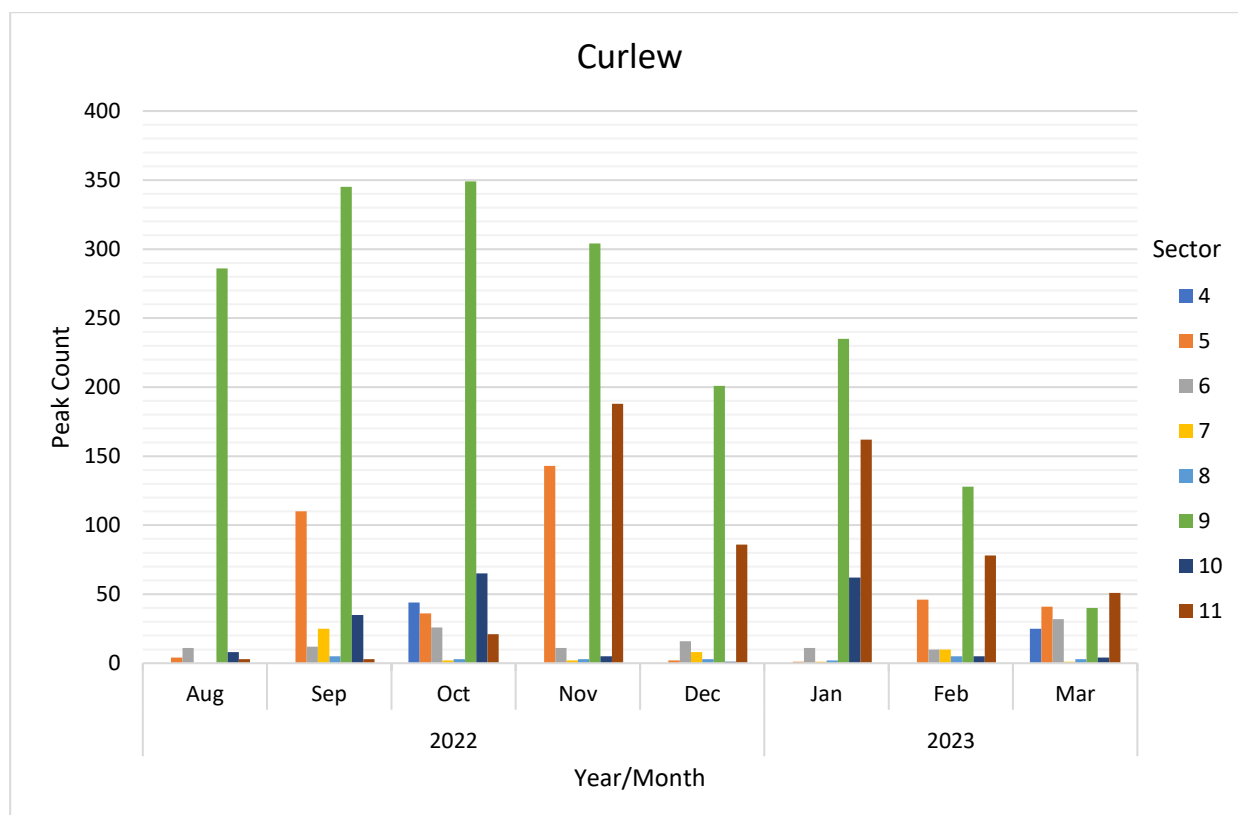
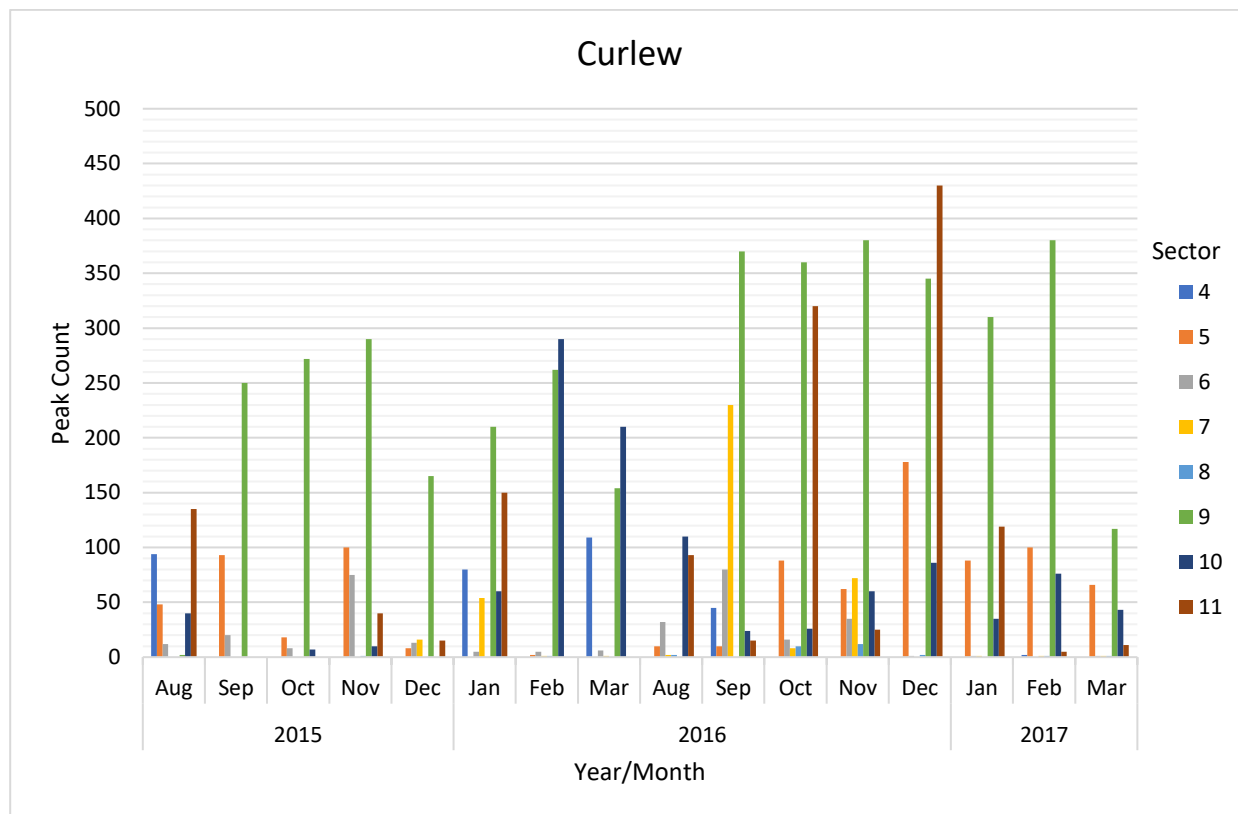


Diagram B3: Peak curlew records within the 650m Zol

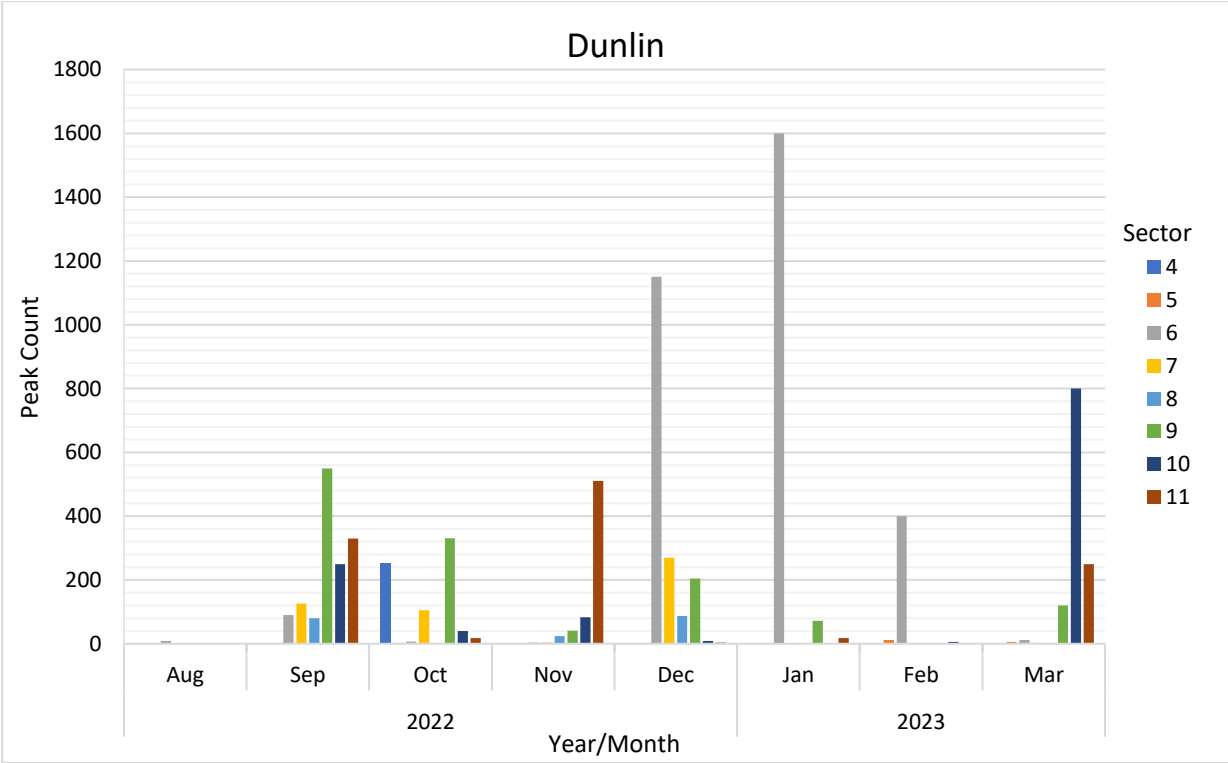
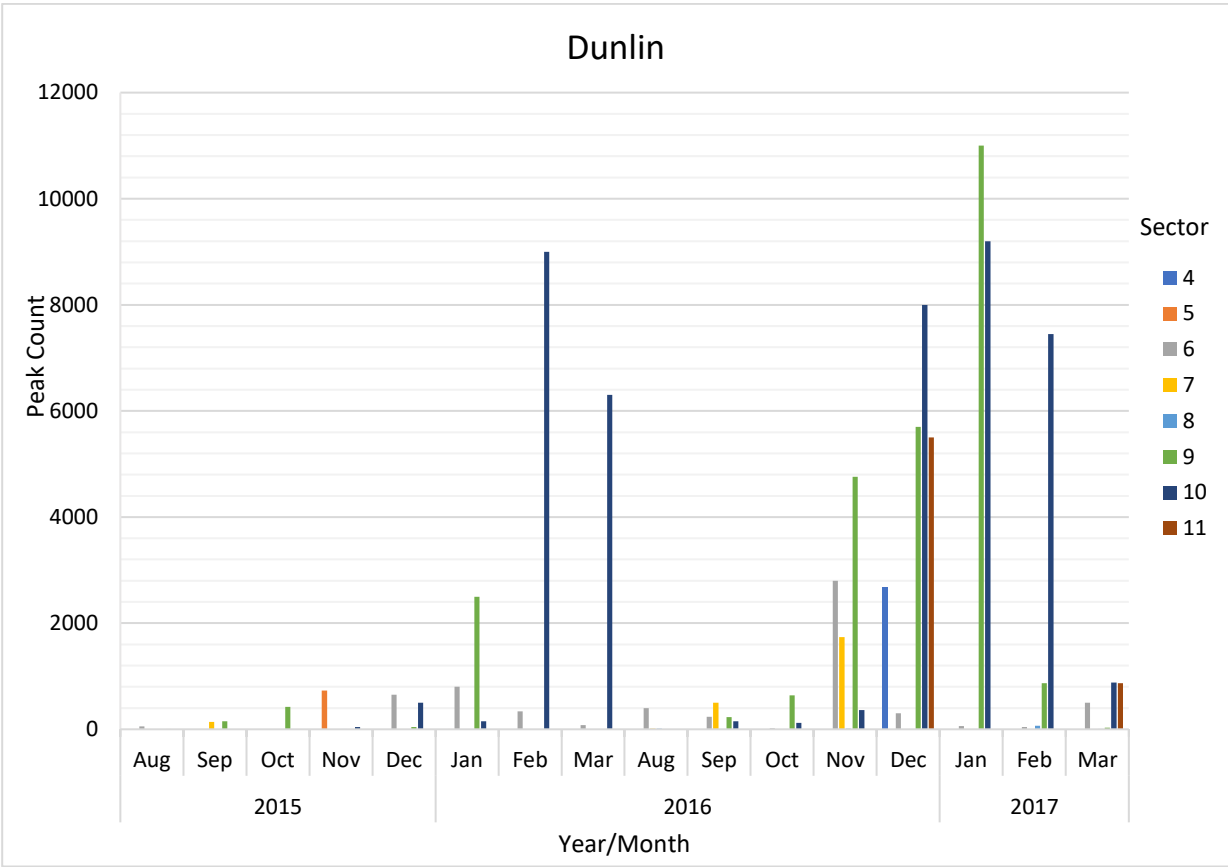


Diagram B4: Peak dunlin records within the 300m Zol

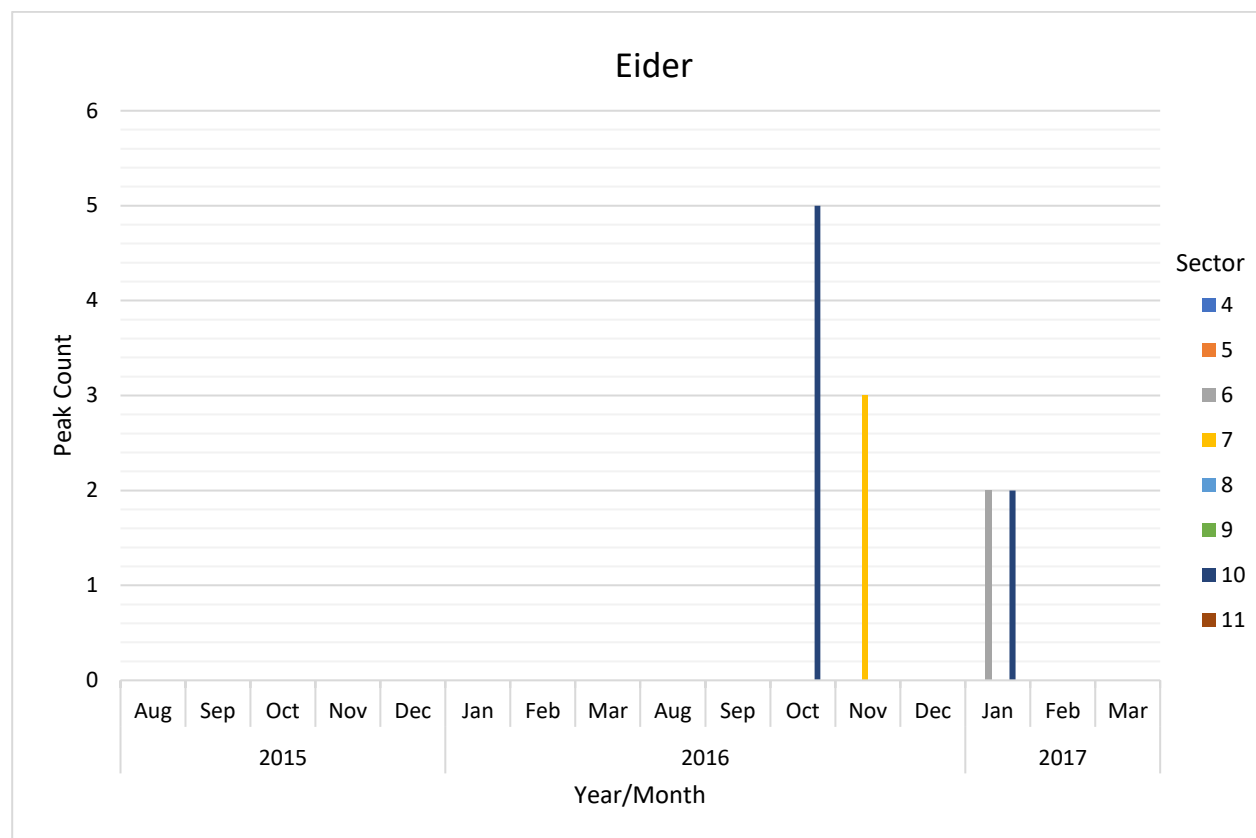


Diagram B5: Peak eider records within the 650m Zol. There were no eider recorded within Sectors 4 to 11 during the 2022/23 surveys.

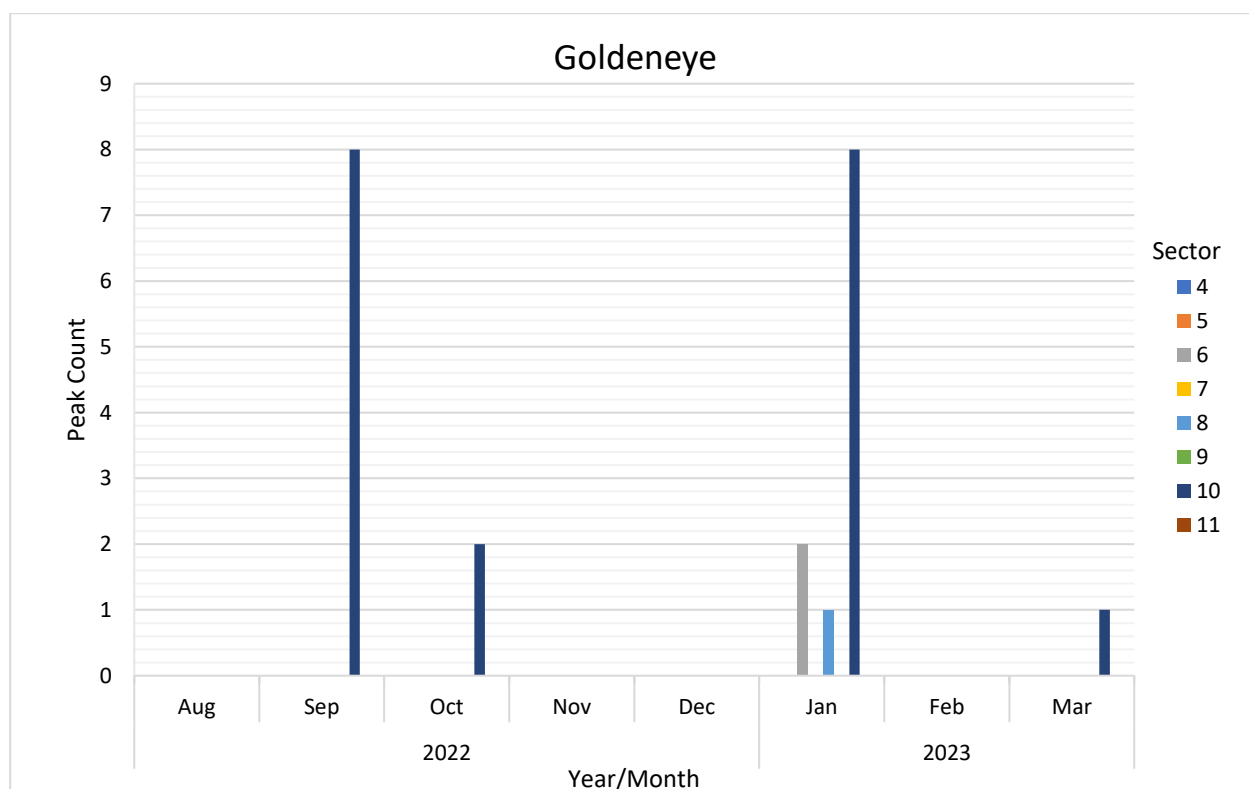
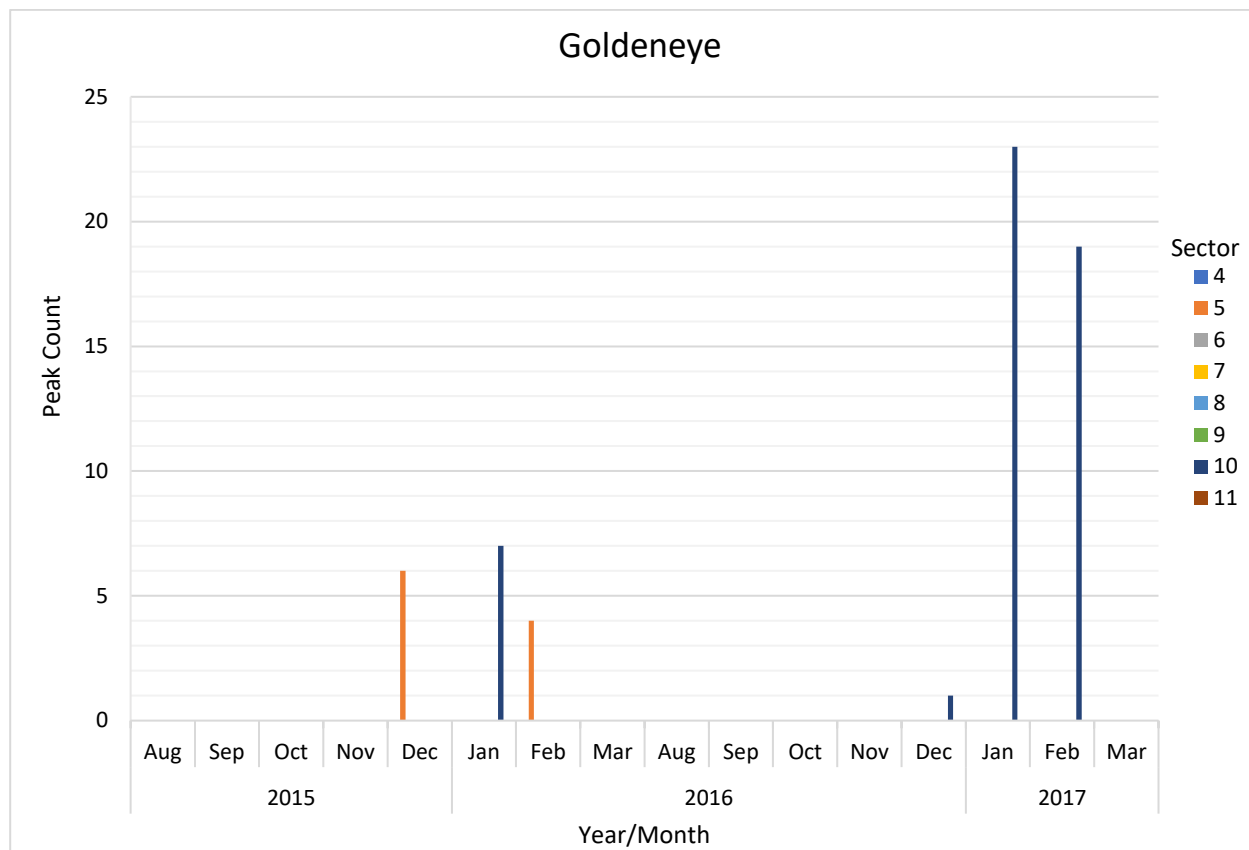


Diagram B6: Peak goldeneye records within the 300m ZoI

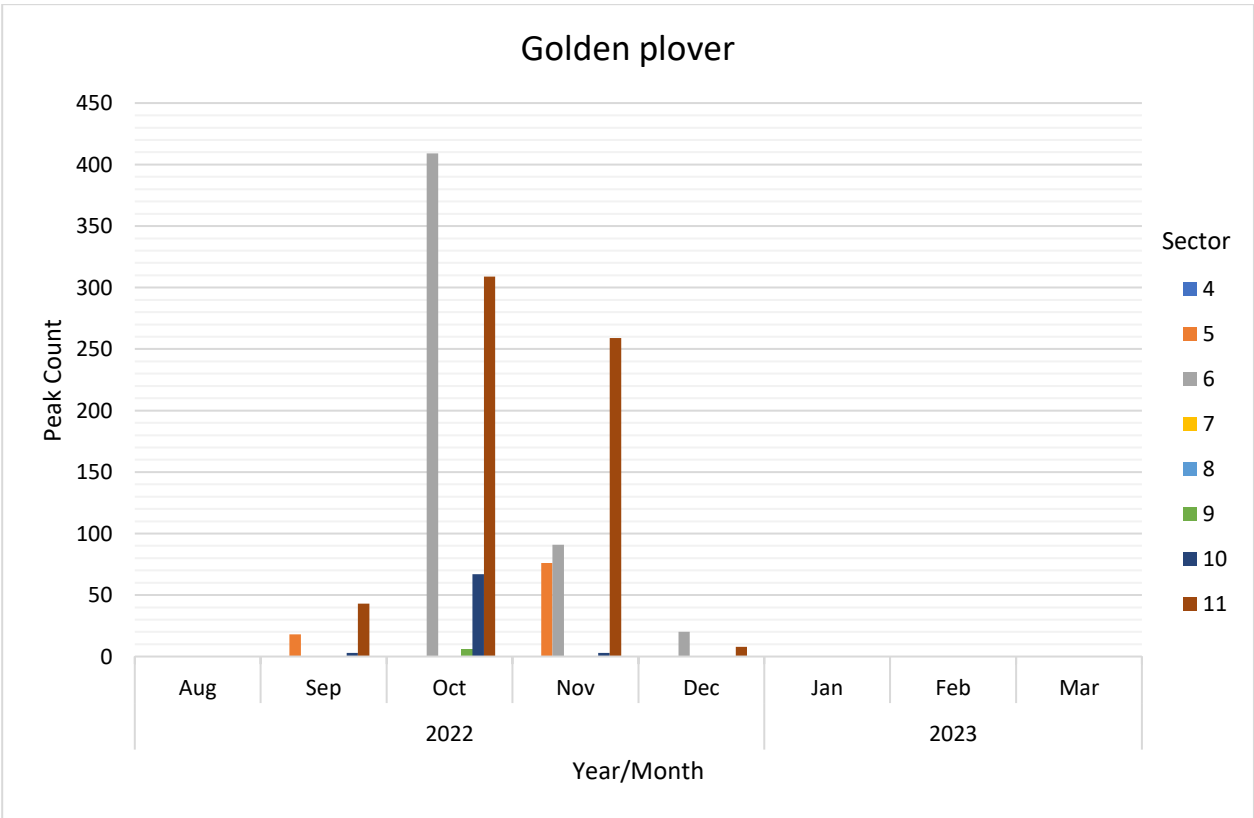
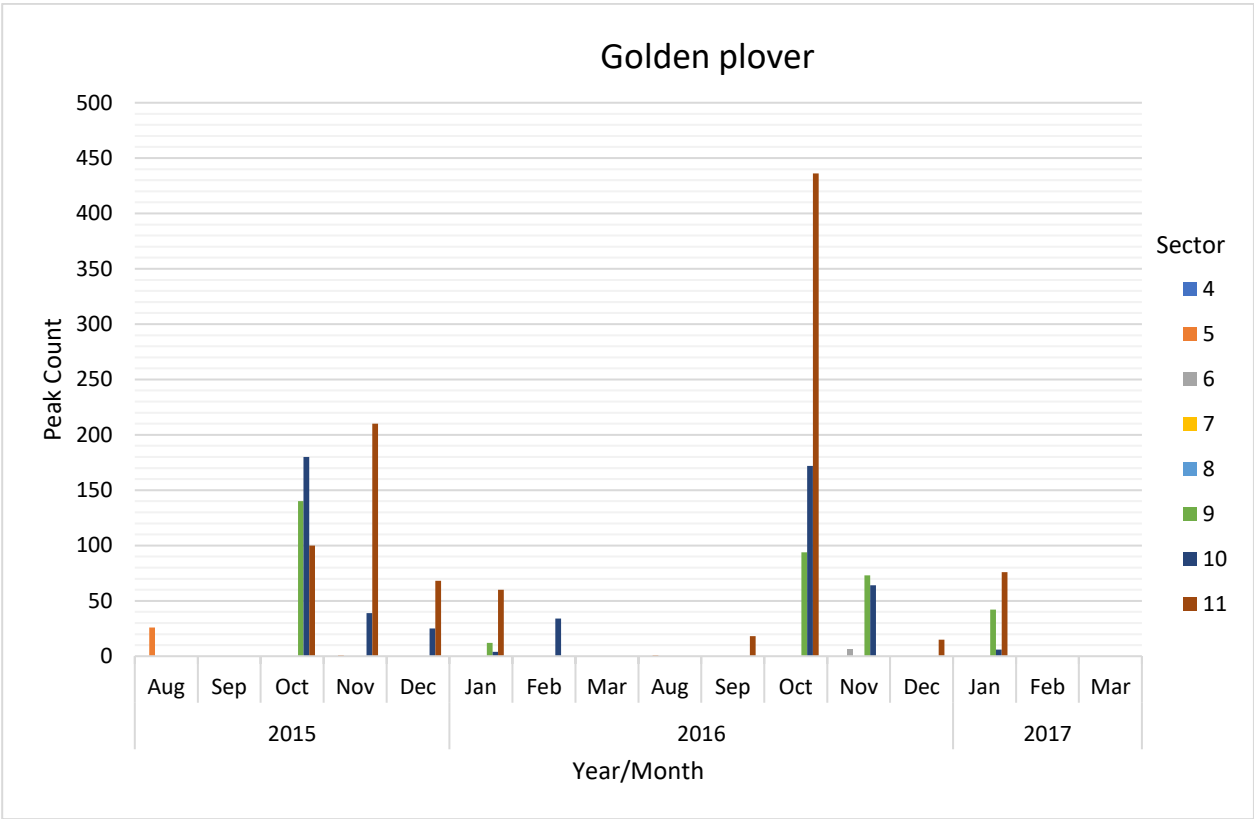


Diagram B7: Peak golden plover records within the 650m Zol

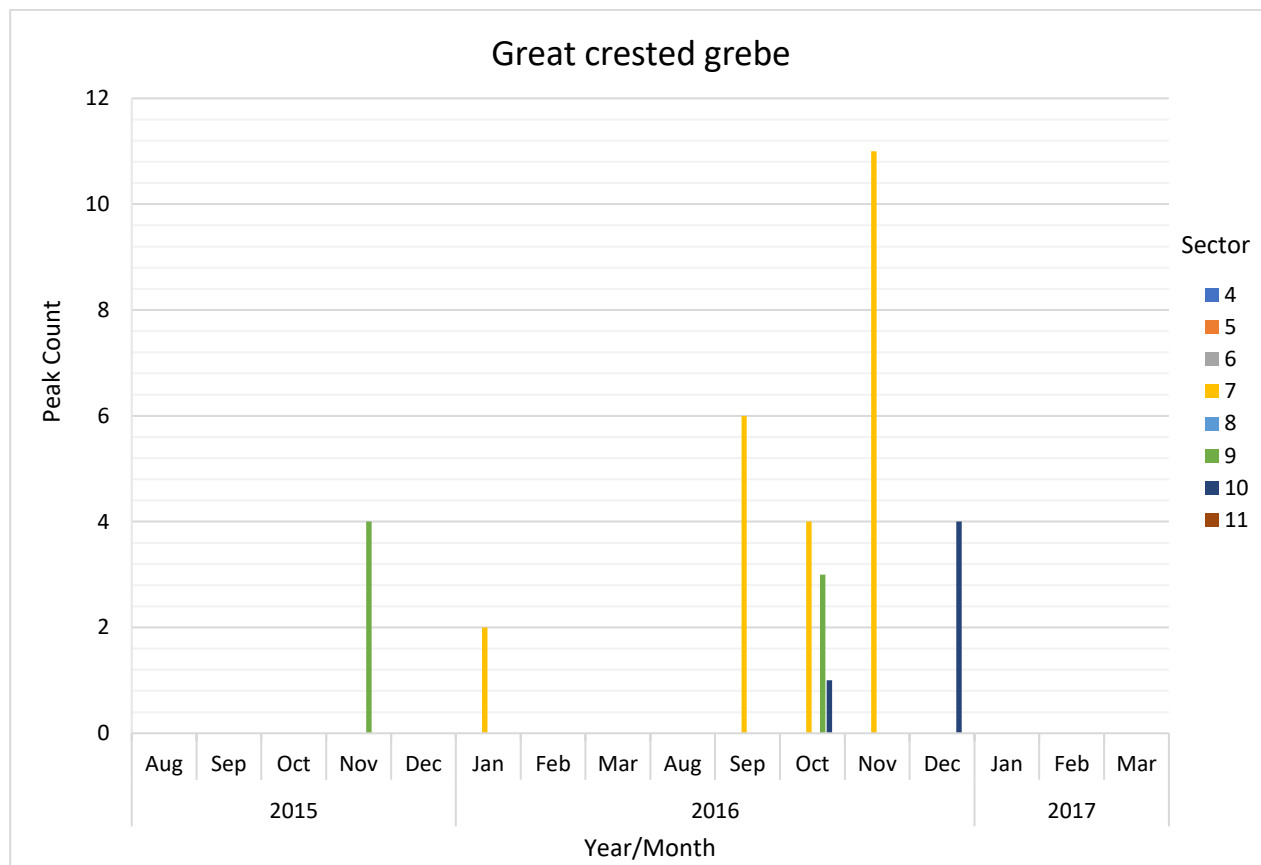


Diagram B8: Peak great crested grebe records within the 300m Zol. There were no great crested grebe recorded within Sectors 4 to 11 during the 2022/23 surveys.

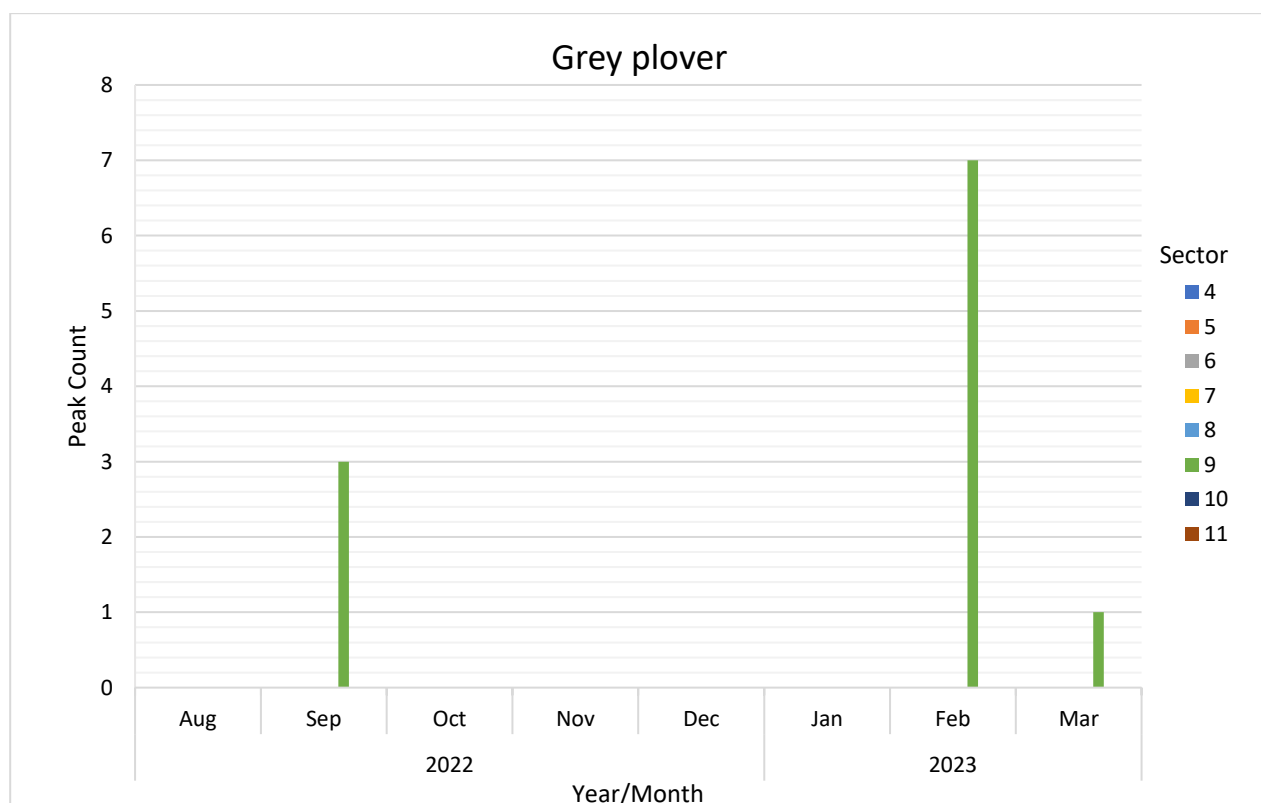
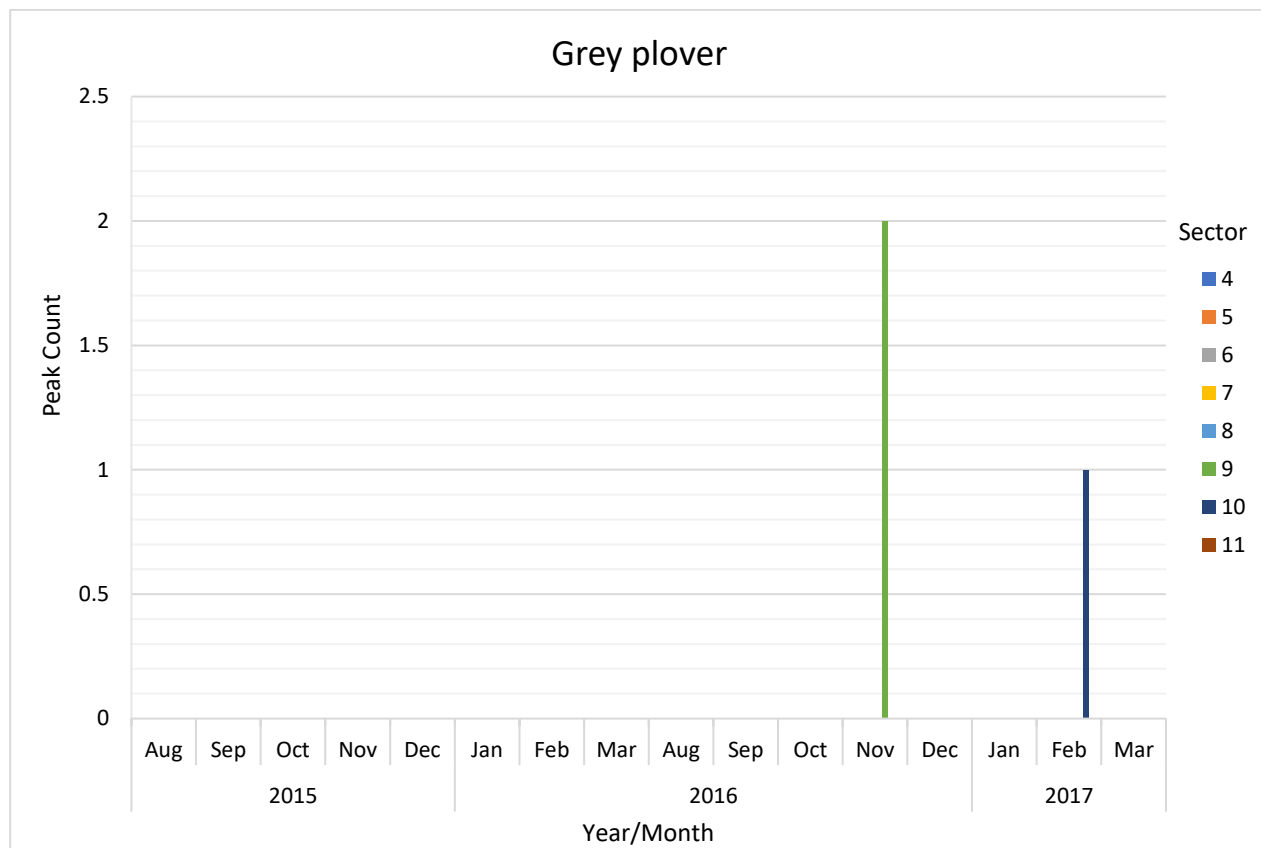


Diagram B9: Peak grey plover records within the 300m Zol

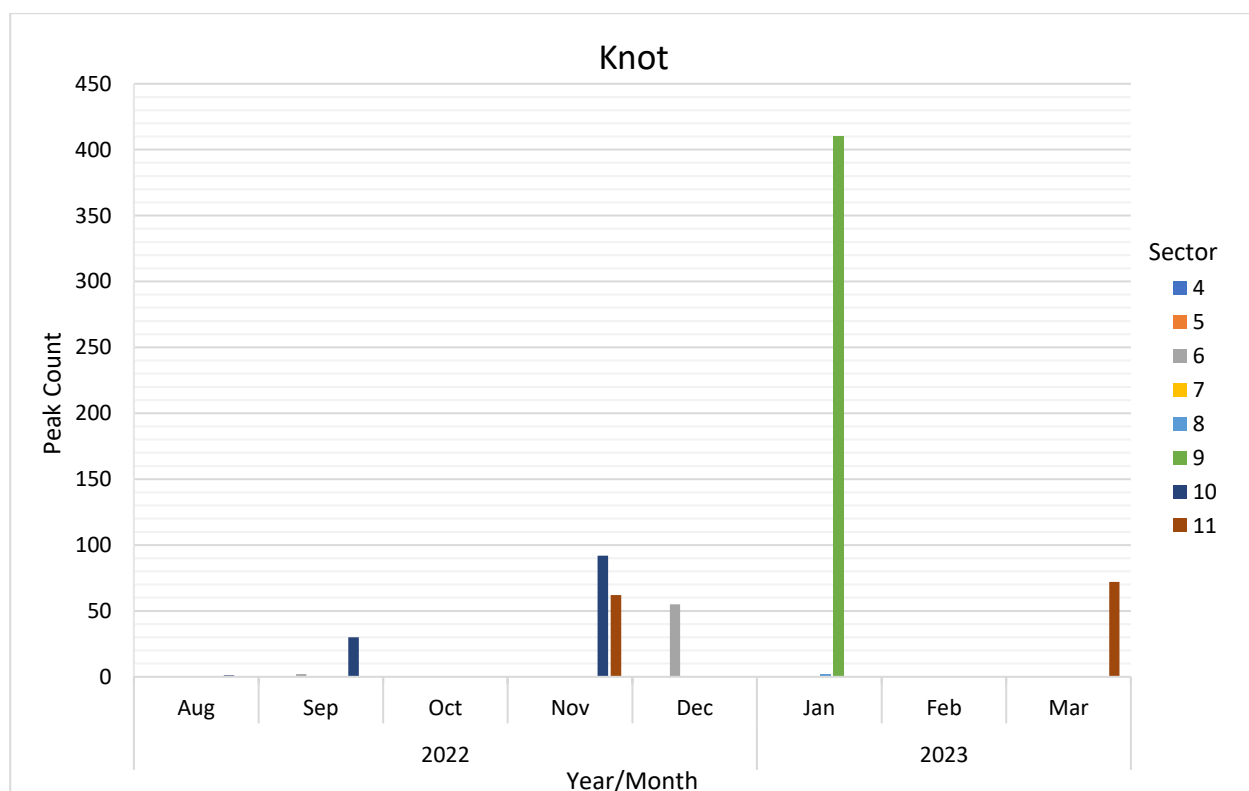
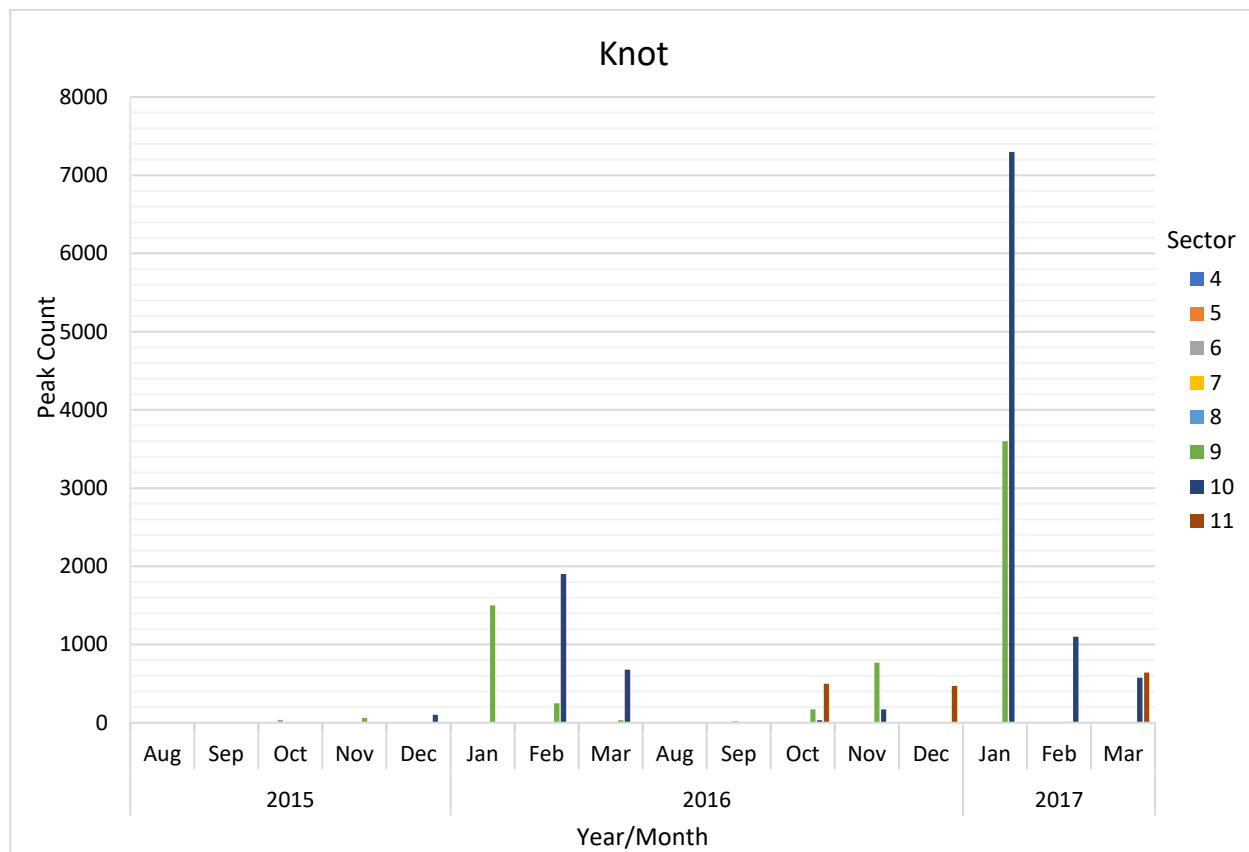


Diagram B10: Peak knot records within the 300m Zol

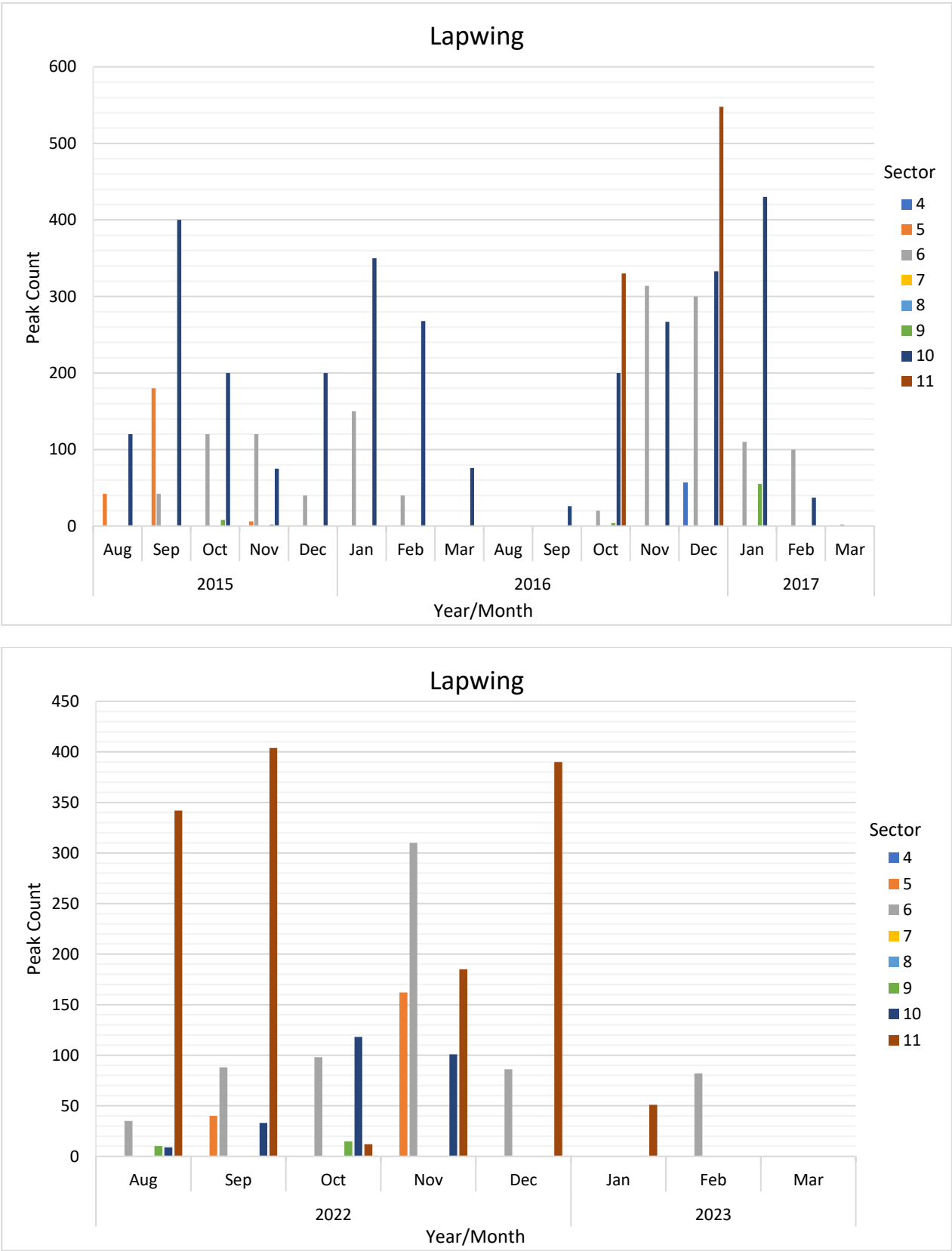


Diagram B11: Peak lapwing records within the 300m ZOI

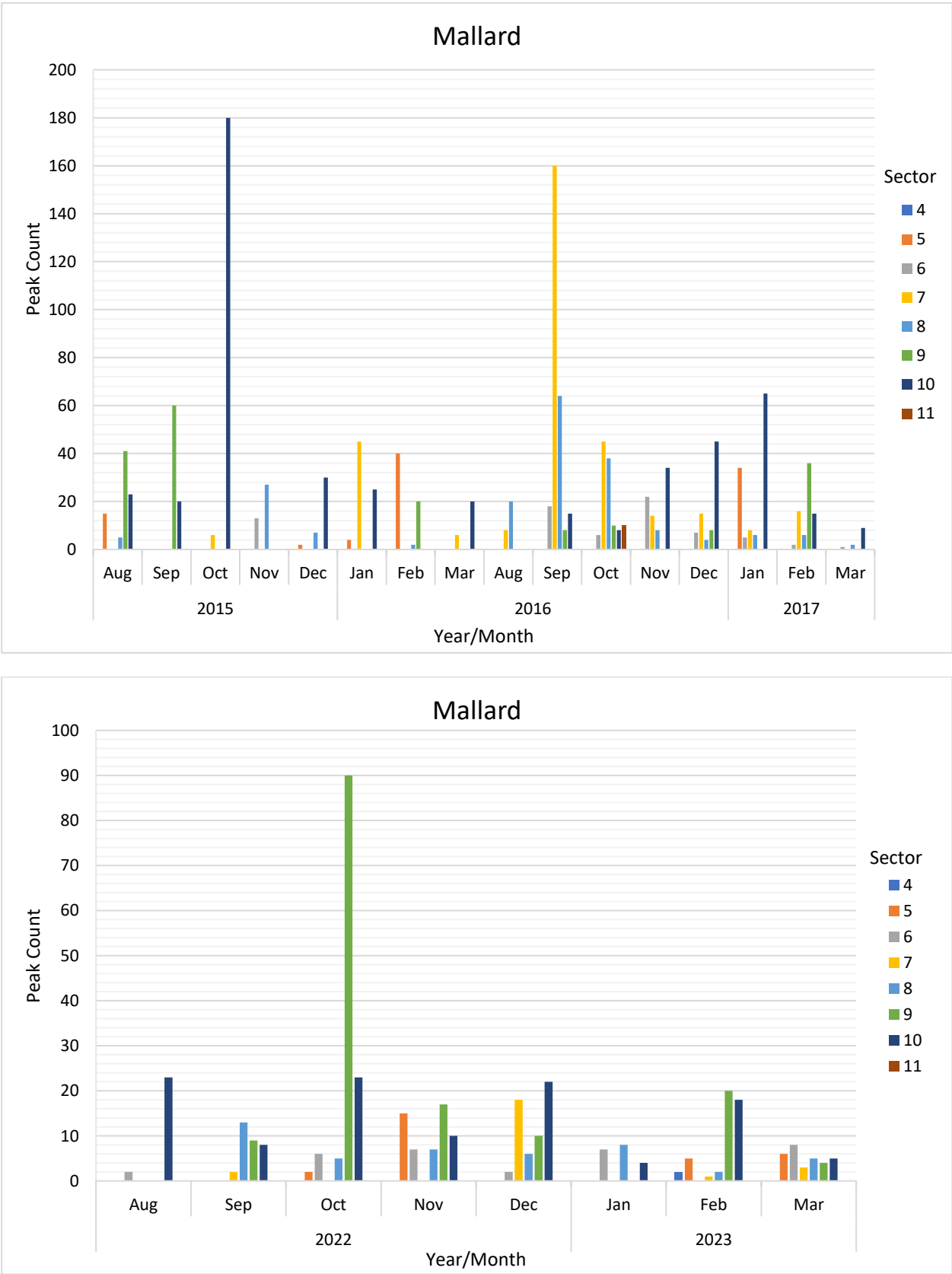


Diagram B12: Peak mallard records within the 300m ZOI

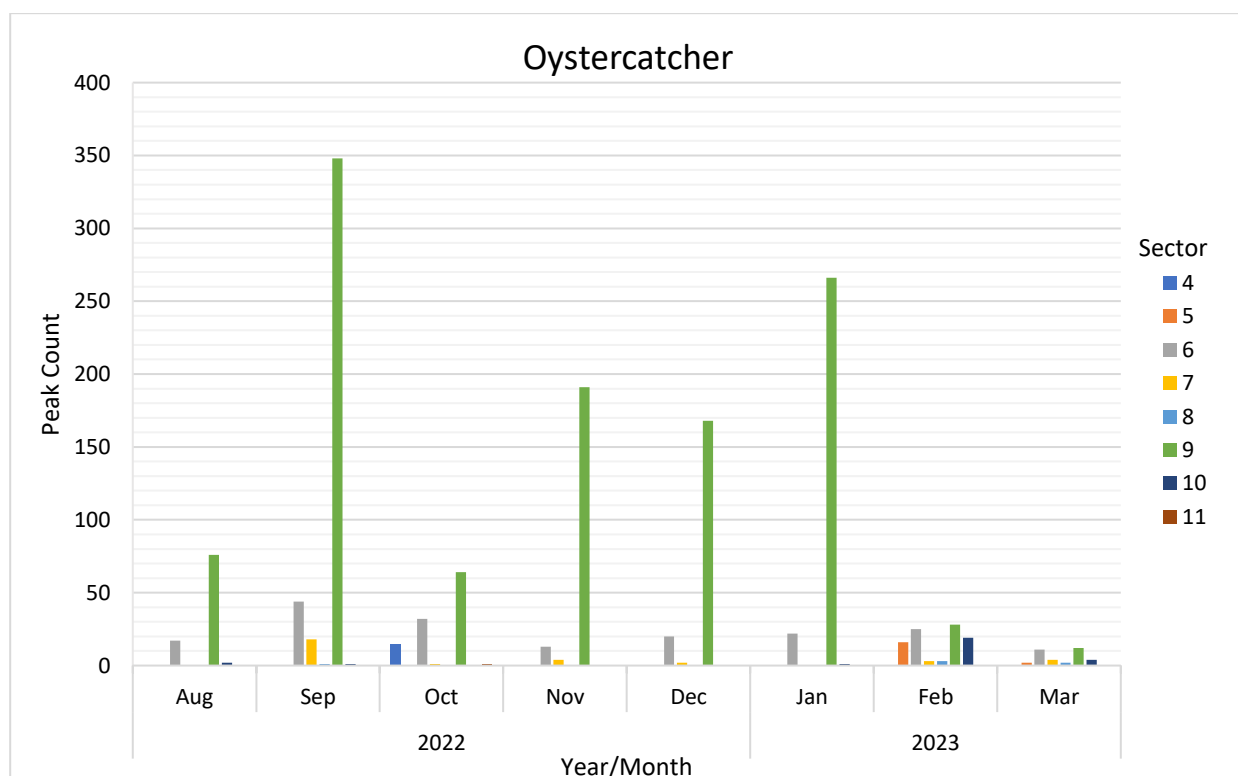
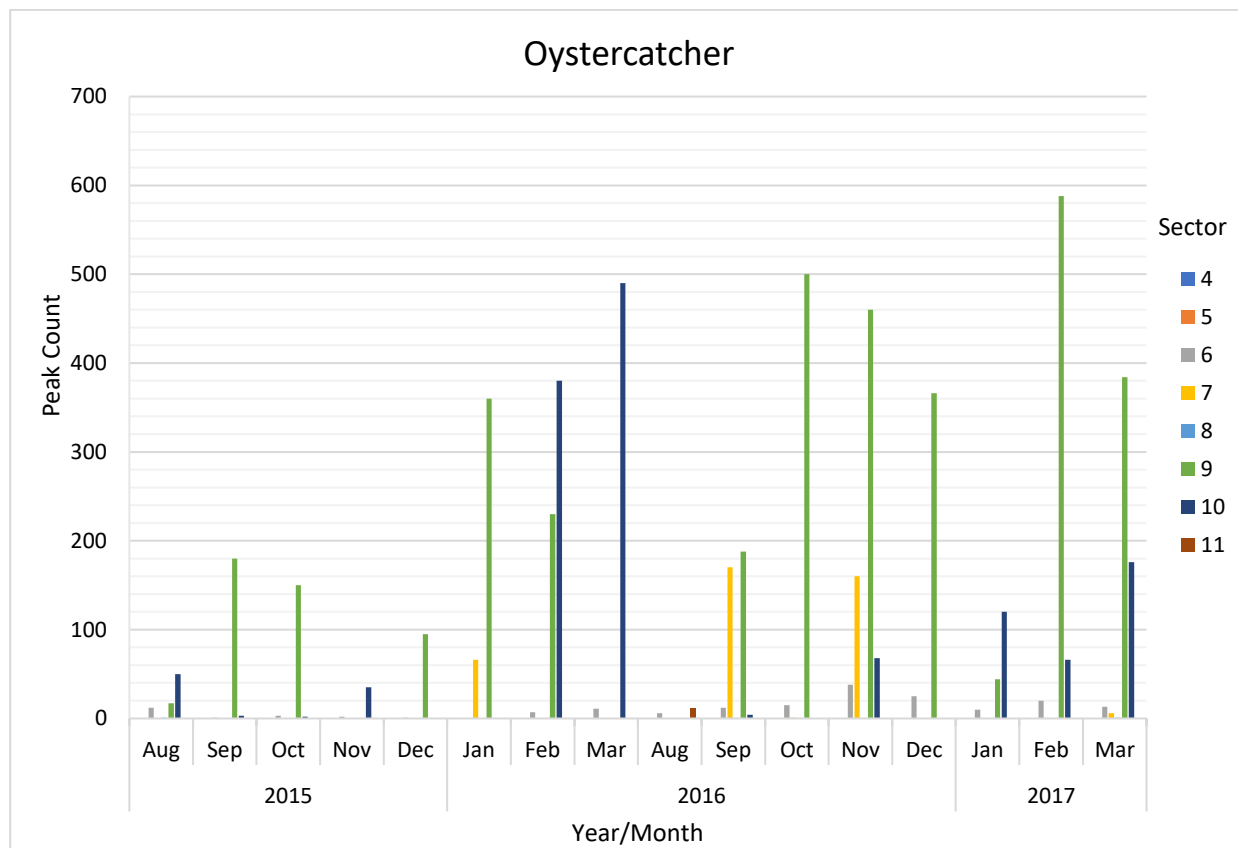


Diagram B13: Peak oystercatcher records within the 300m Zol

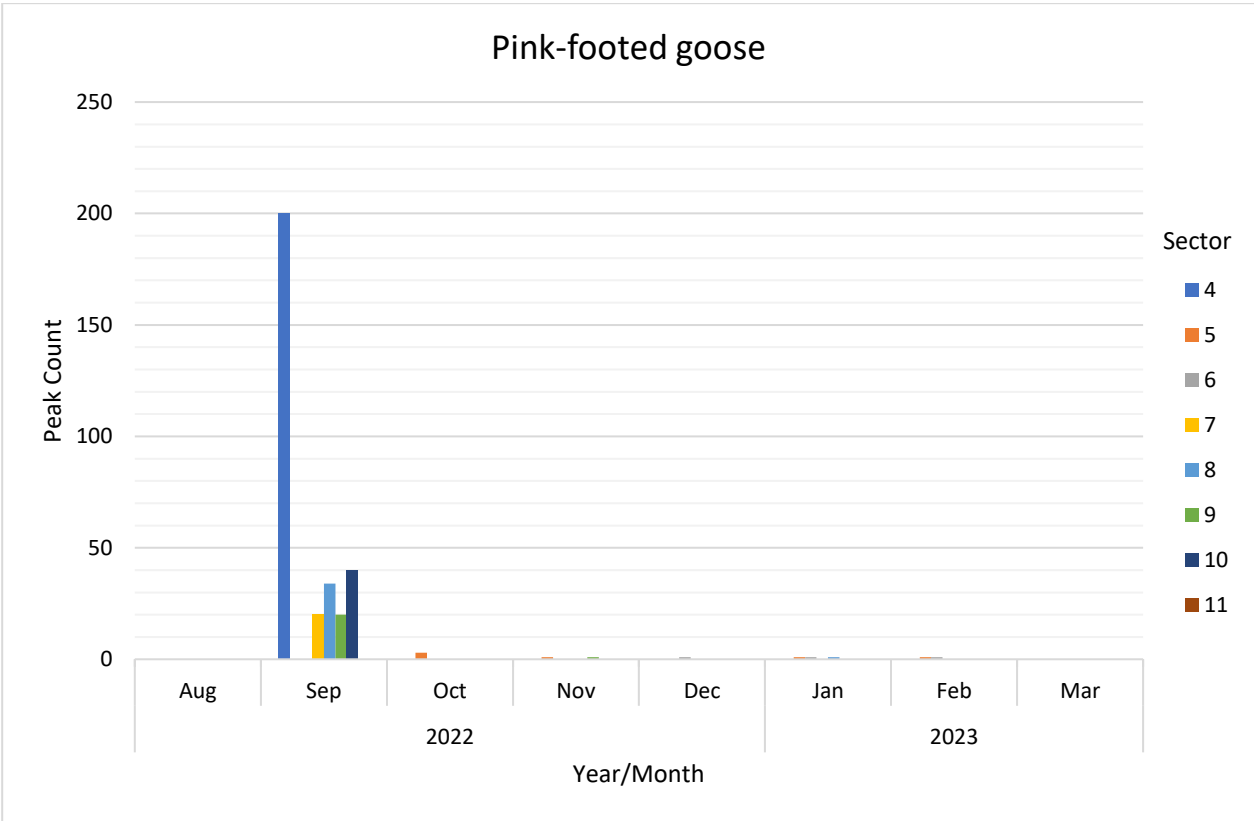
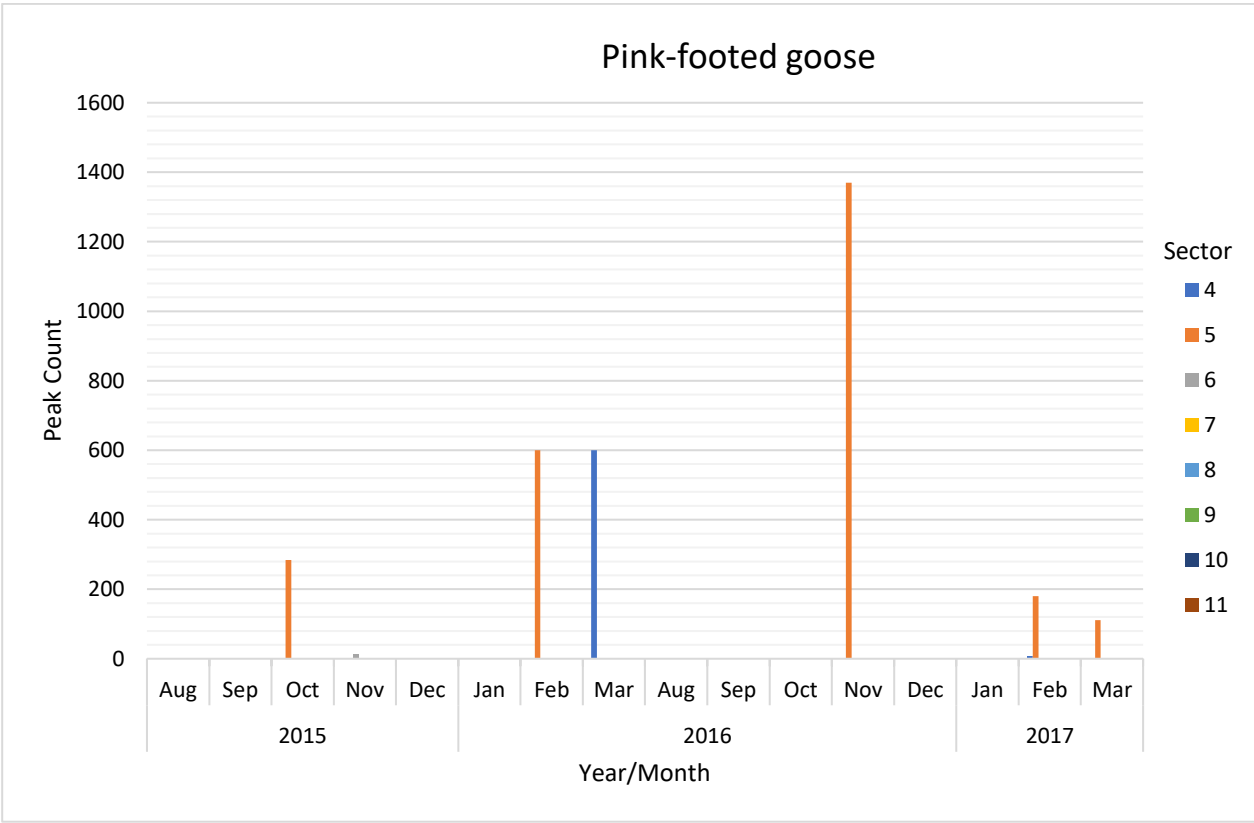


Diagram B14: Peak pink-footed goose records within the 650m Zol

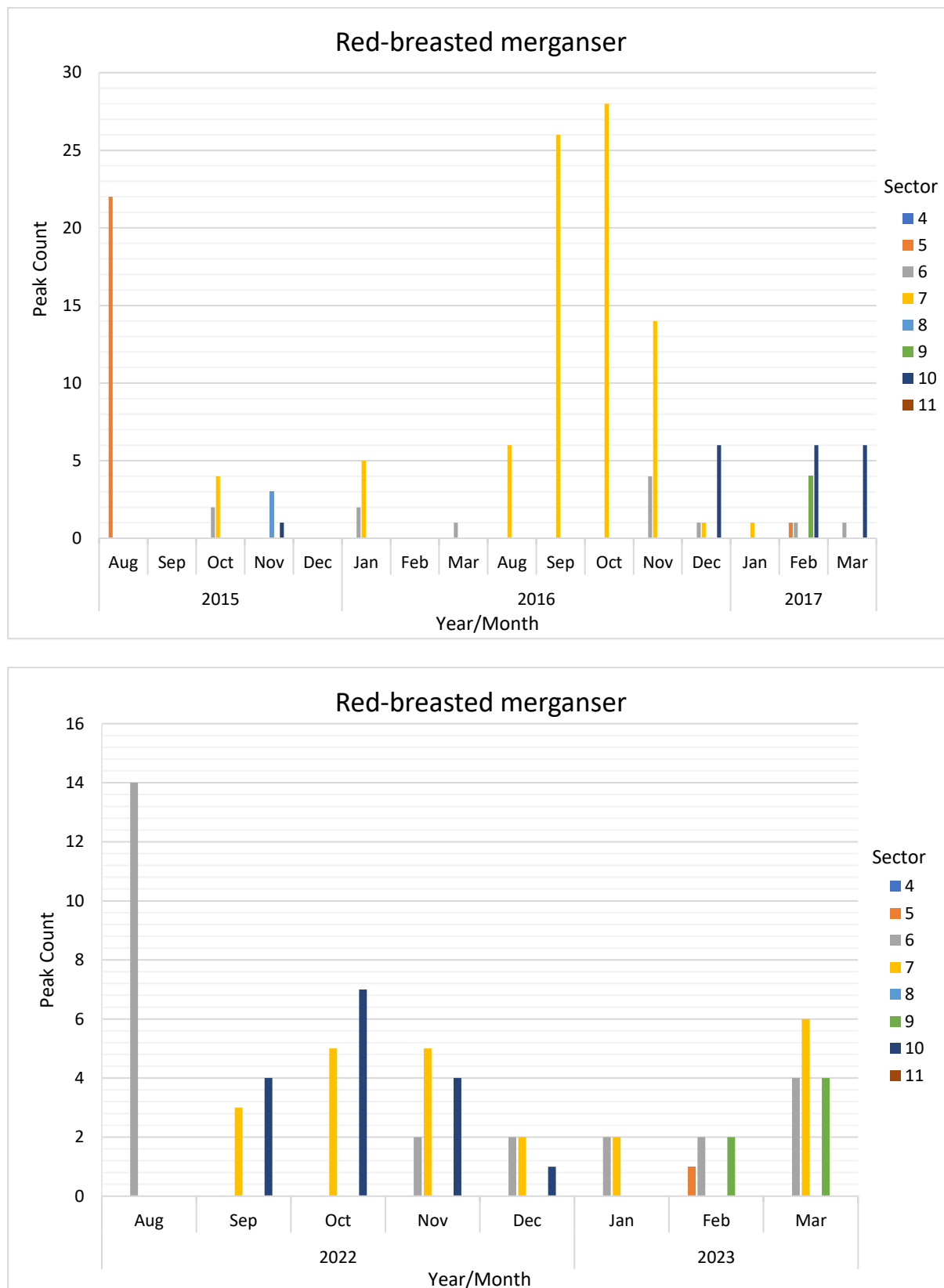


Diagram B15: Peak red-breasted merganser records within the 300m ZoI

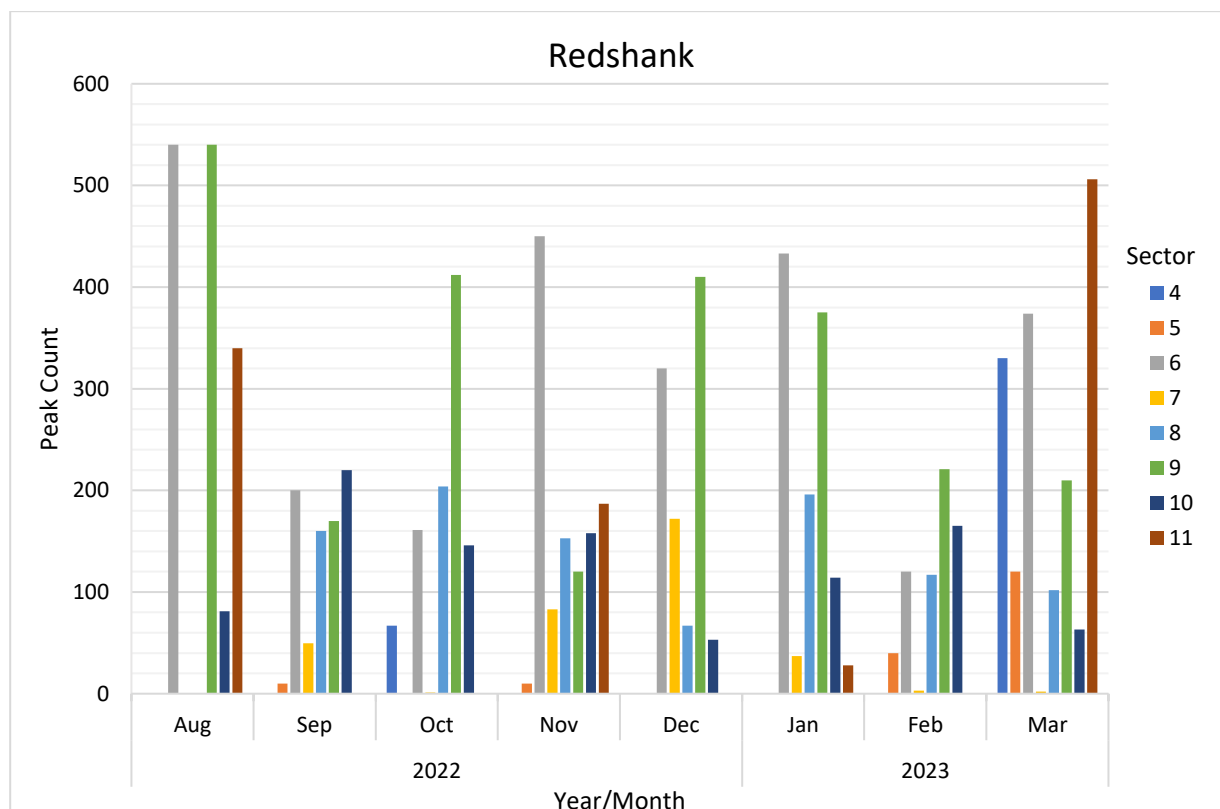
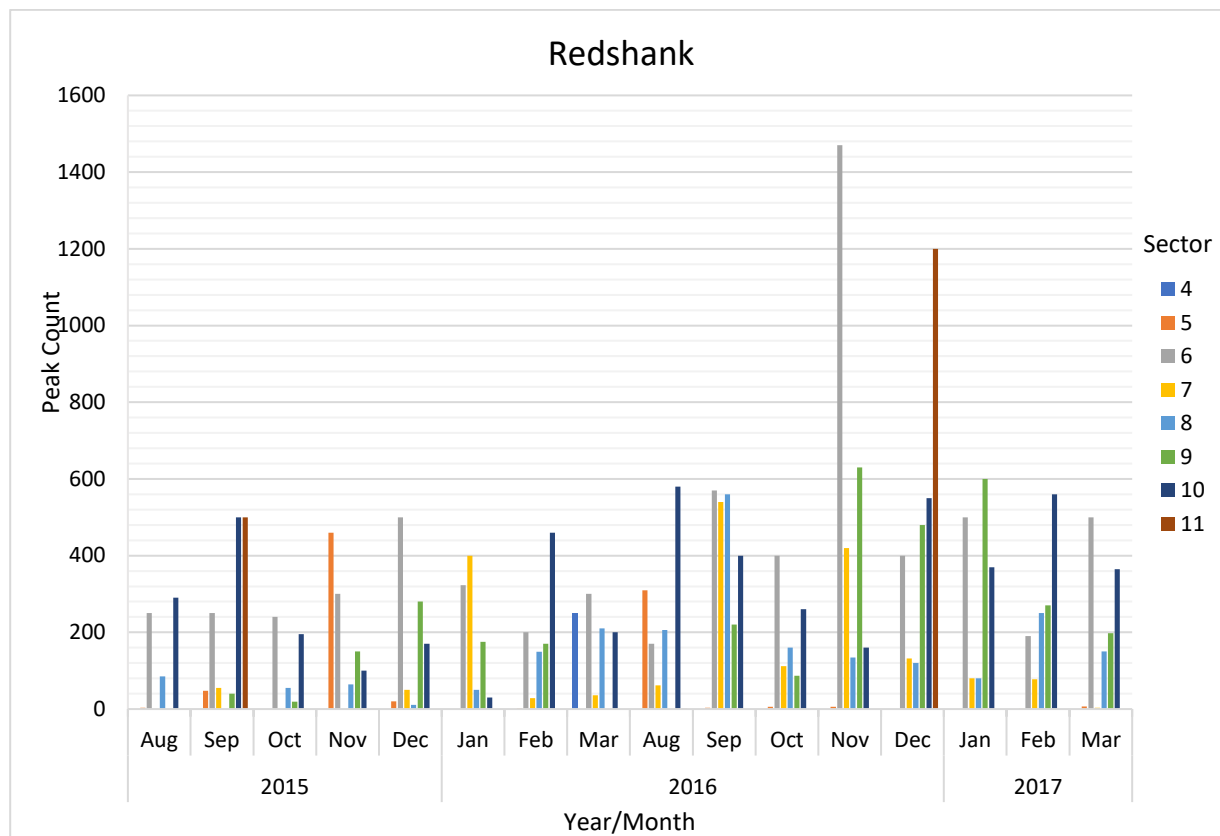


Diagram B16: Peak redshank records within the 300m ZoI

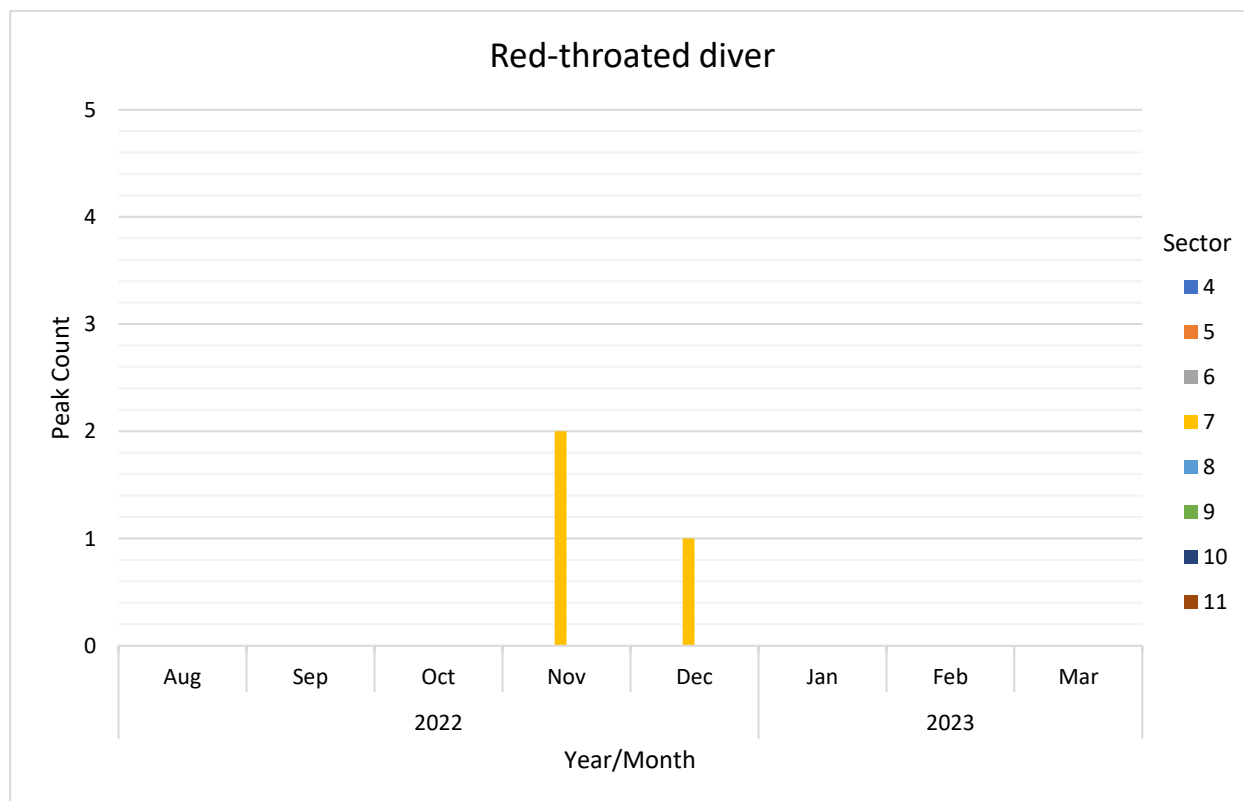
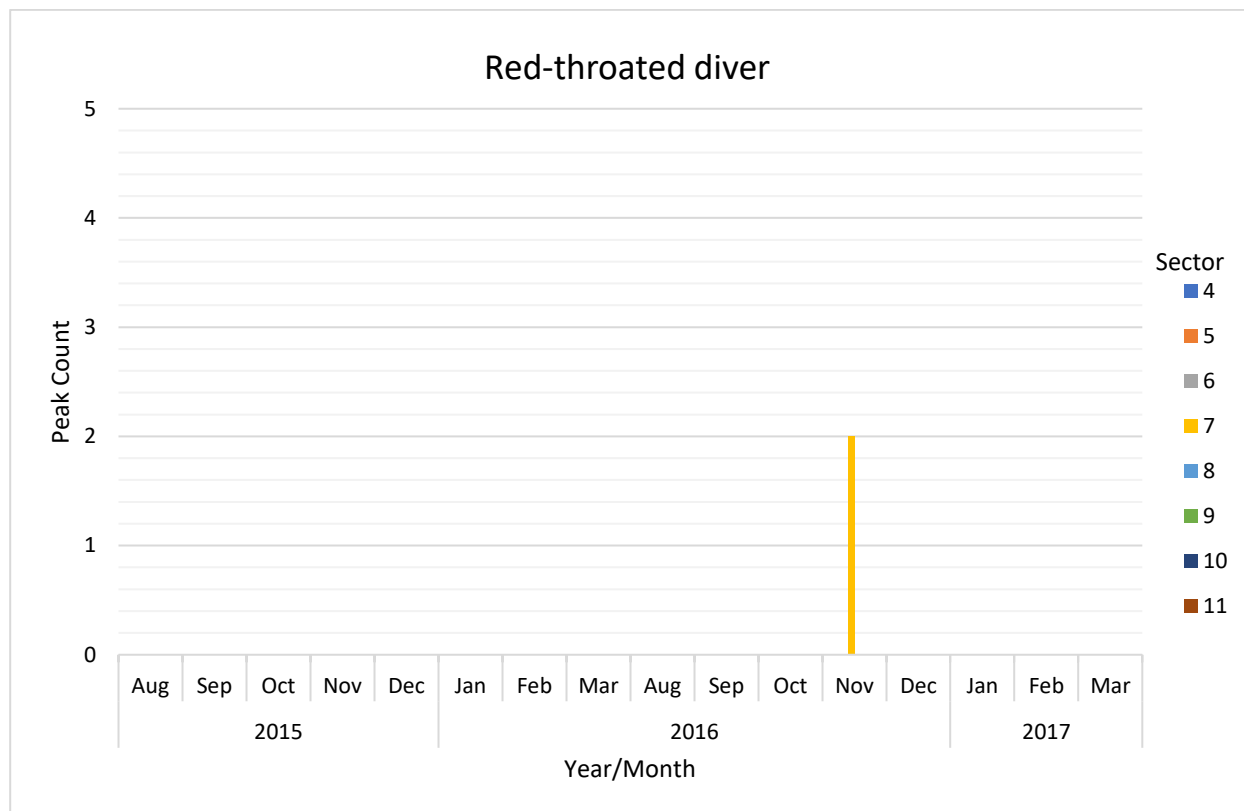


Diagram B17: Peak red-throated diver records within the 650m Zol. There were no red-throated diver recorded within Sectors 4 to 11 during the 2015/16 and 2016/17 surveys.

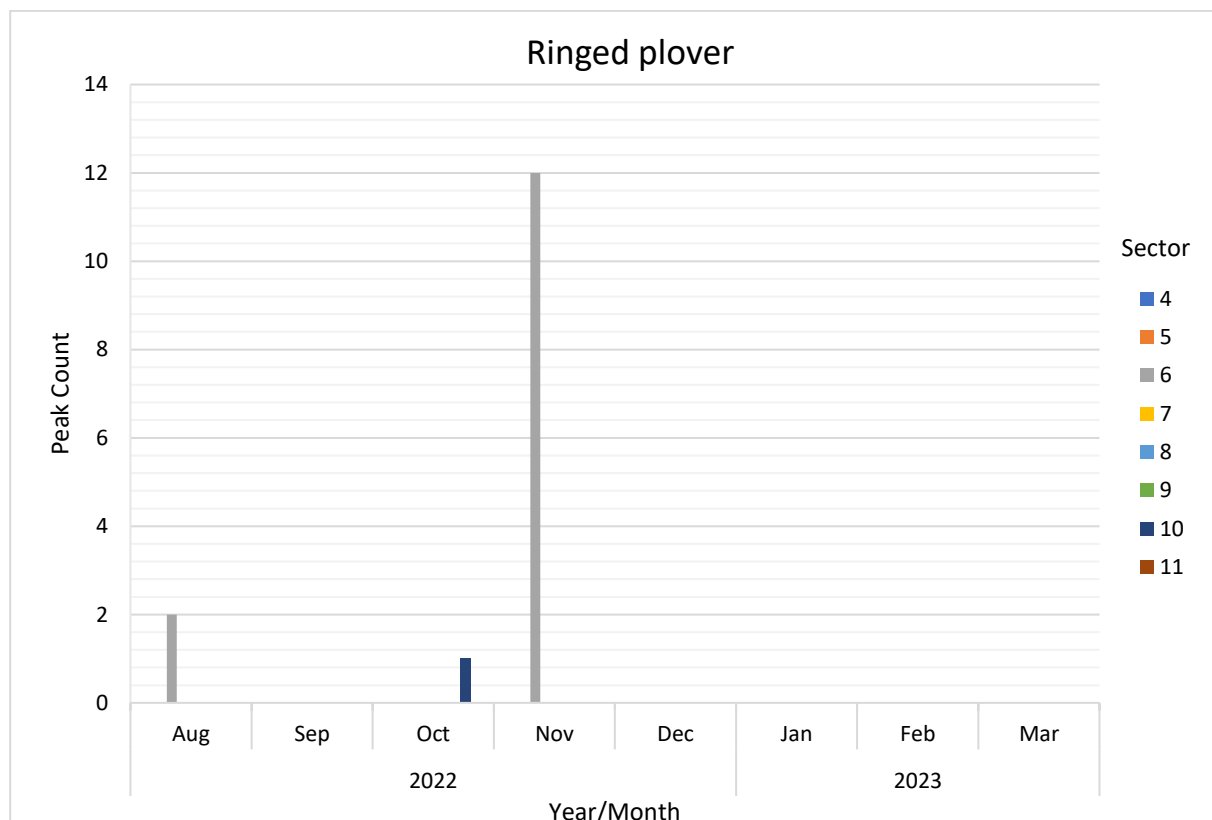
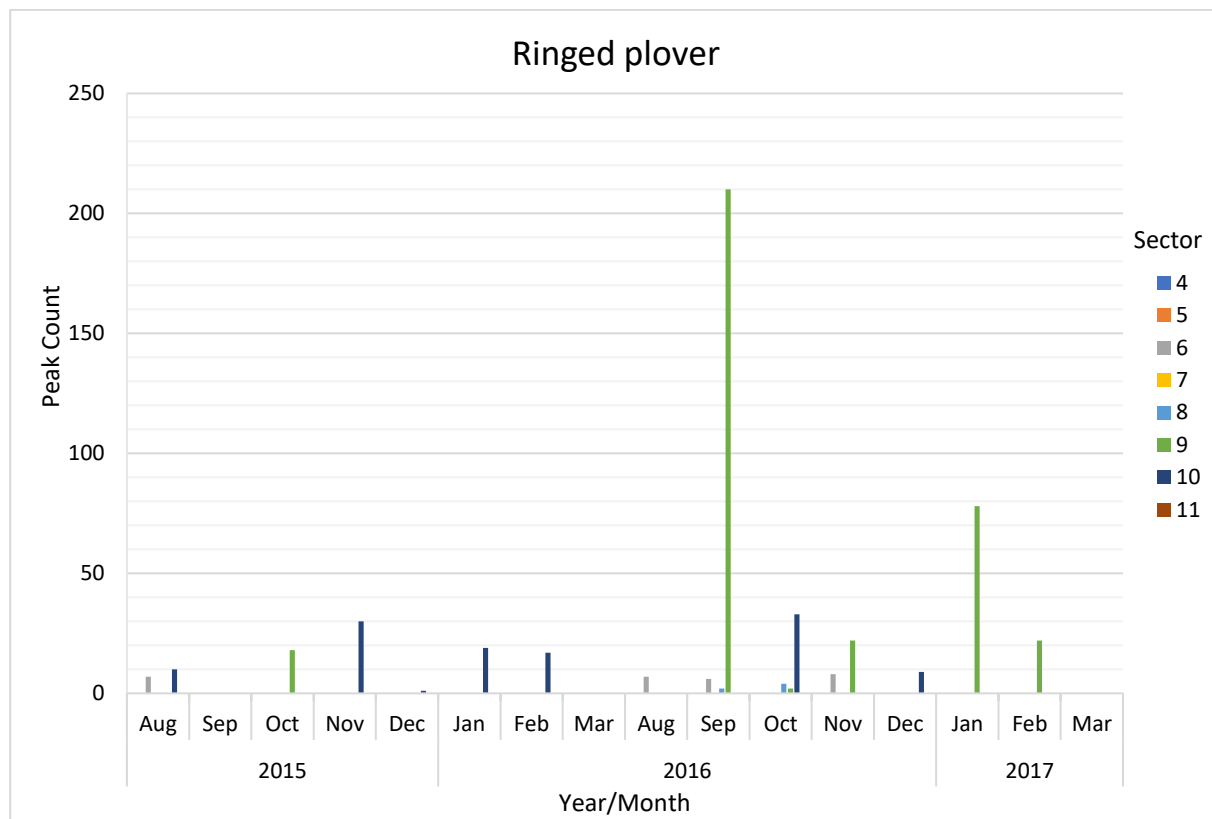


Diagram B18: Peak ringed plover records within the 300m ZoI

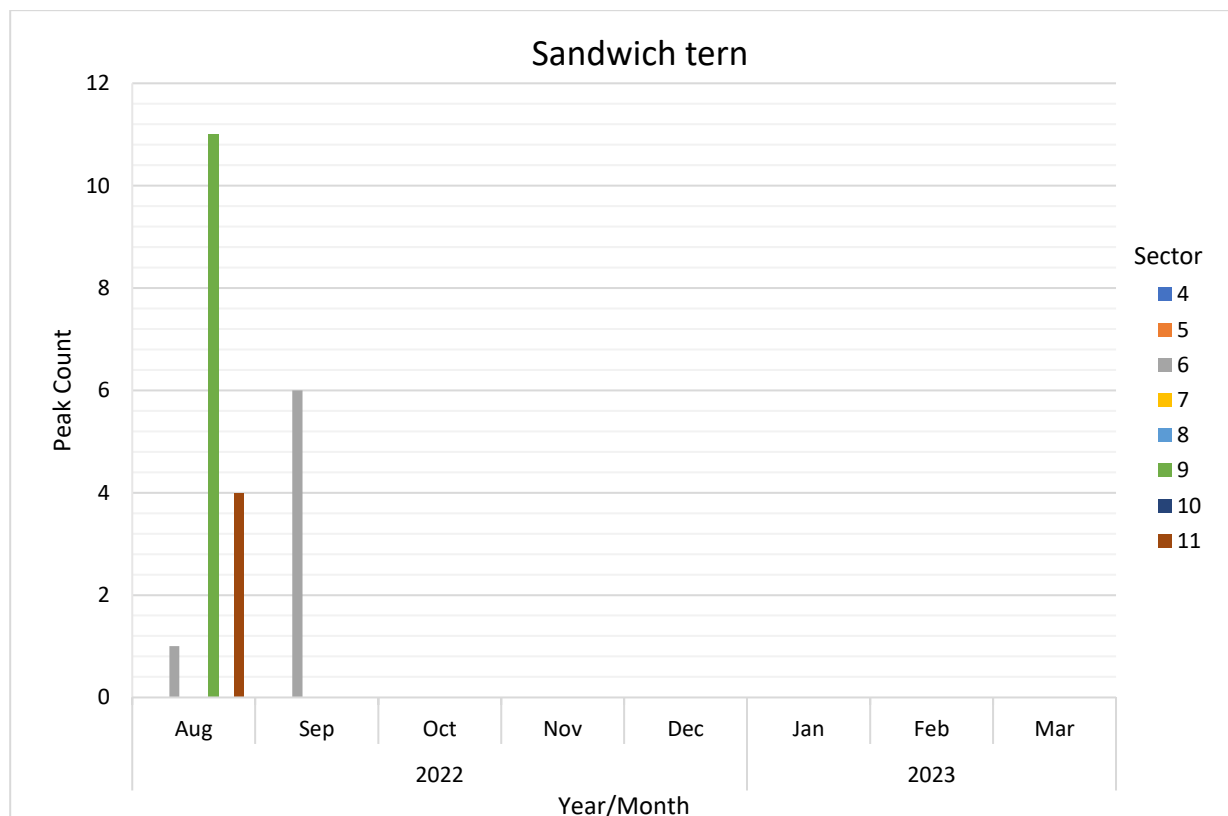
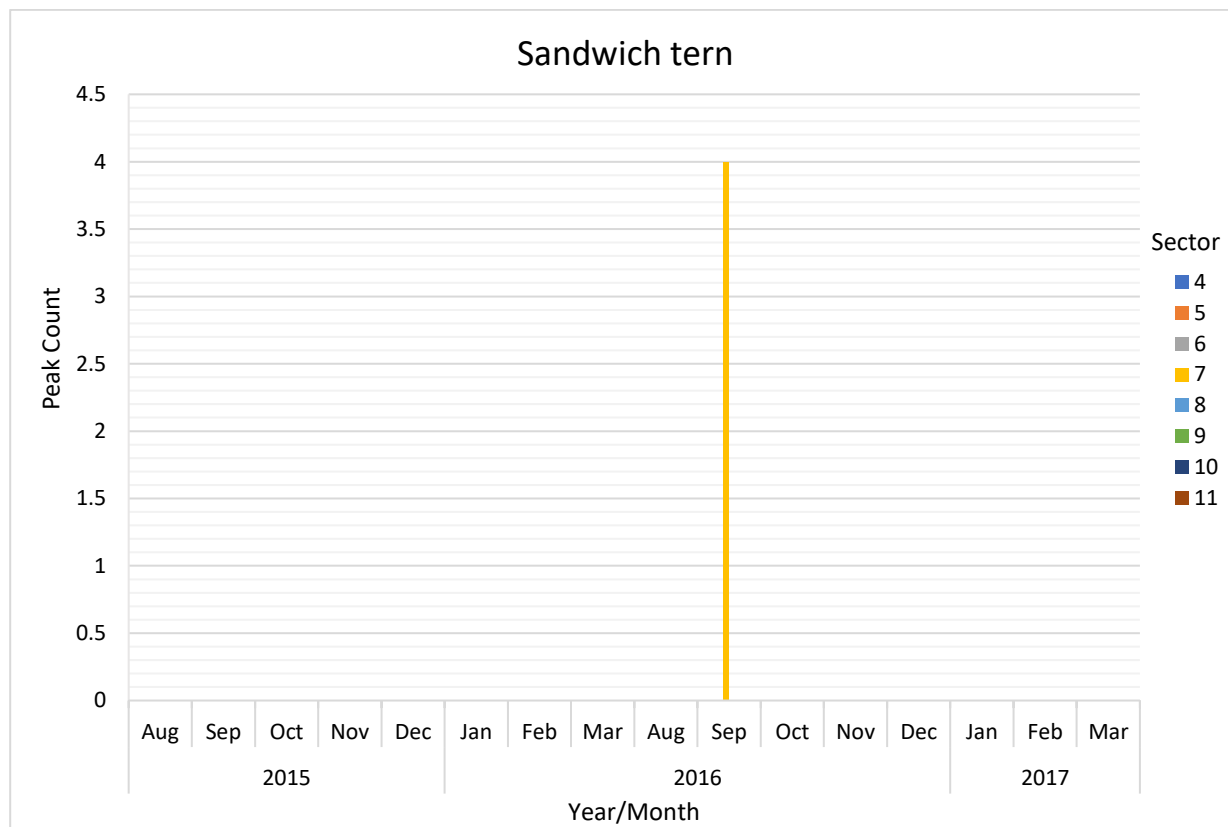


Diagram B19: Peak Sandwich tern records within the 300m Zol

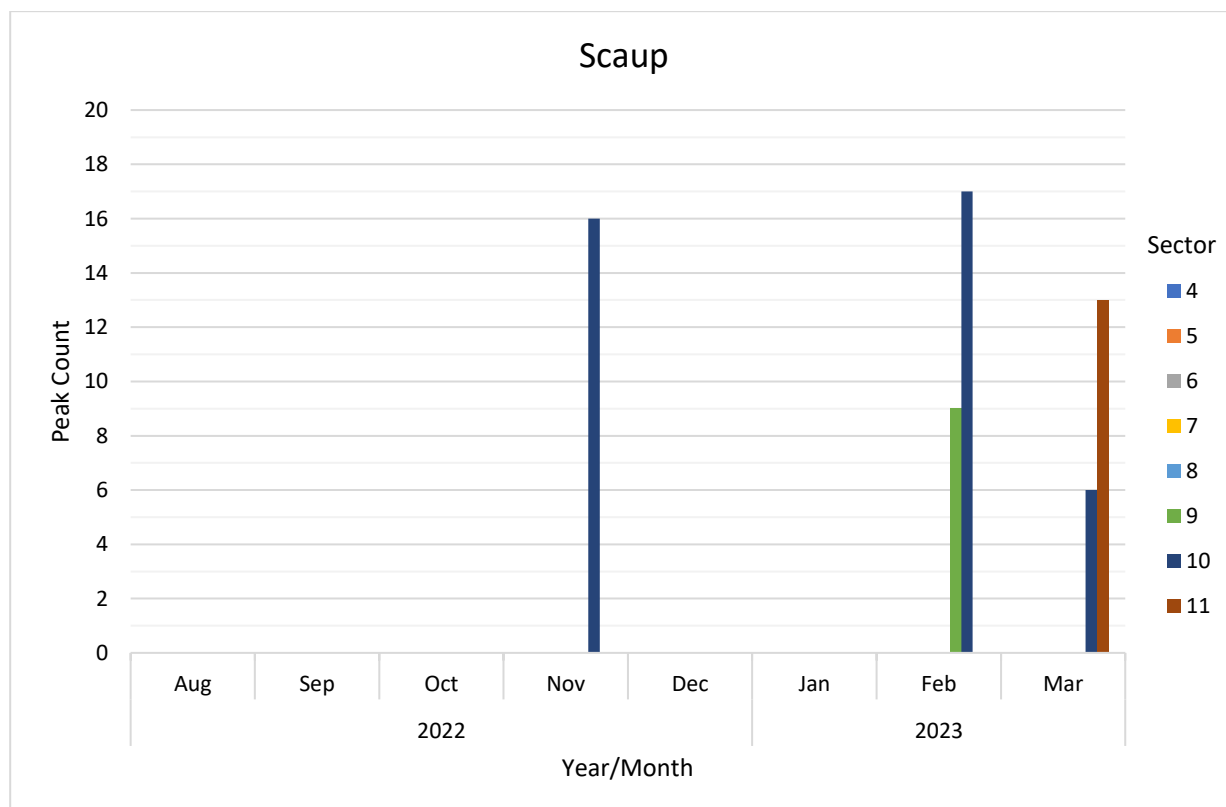
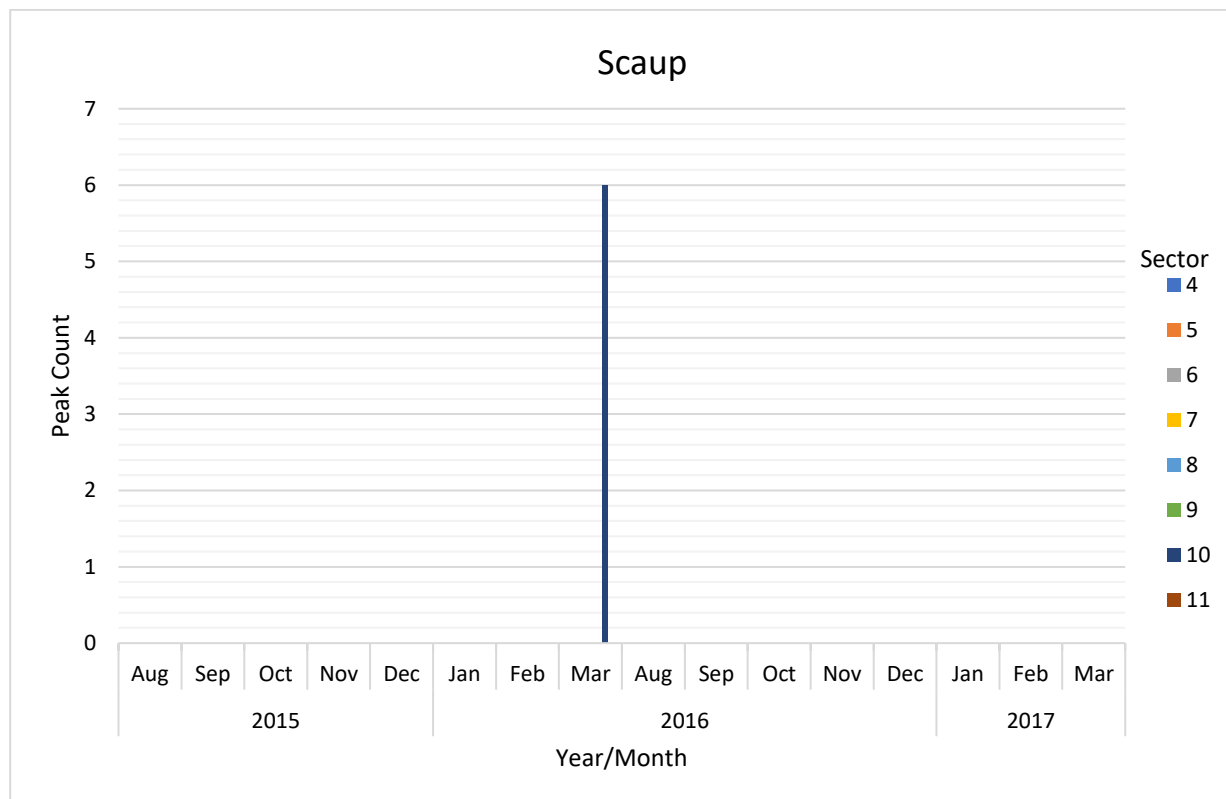


Diagram B20: Peak scaup records within the 650m Zol. There were no scaup recorded within Sectors 4 to 11 during the 2015/16 and 2016/17 surveys.

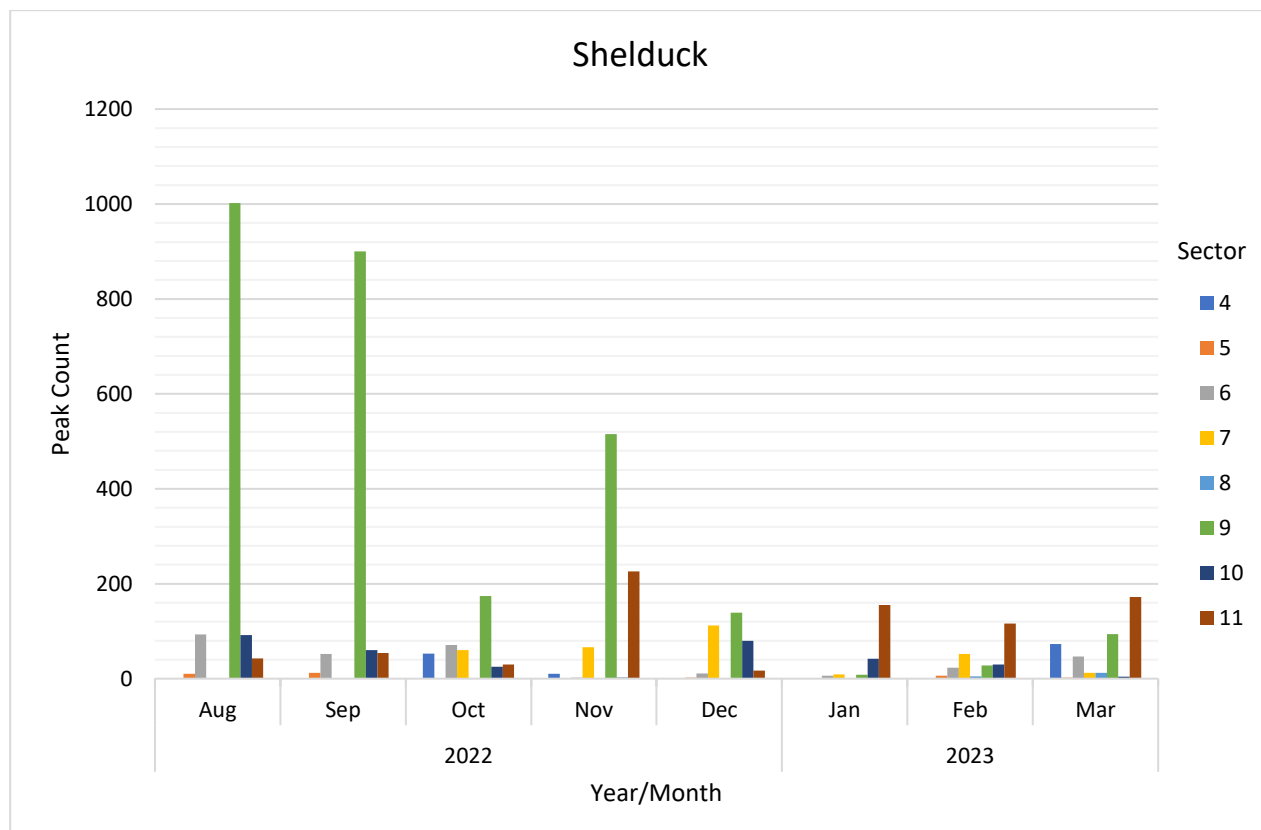
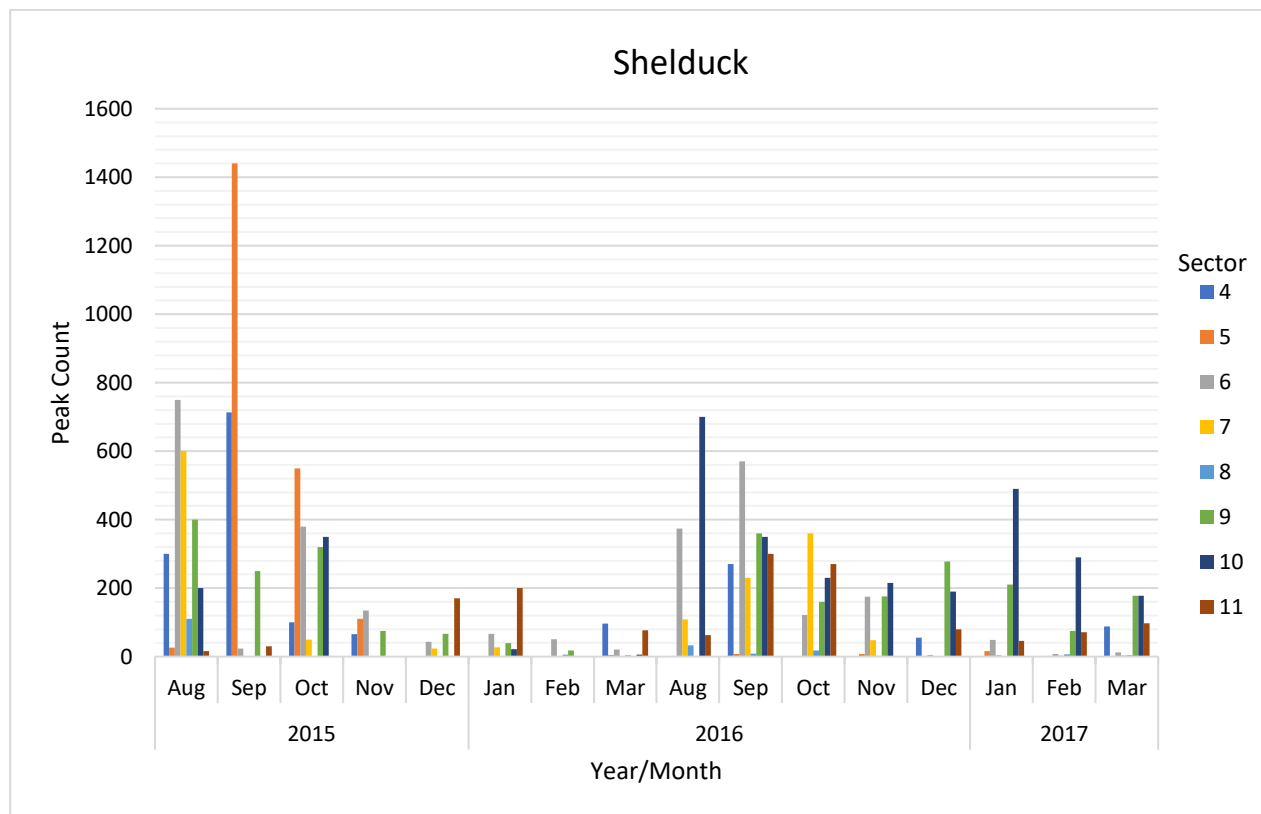


Diagram B21: Peak shelduck records within the 650m Zol

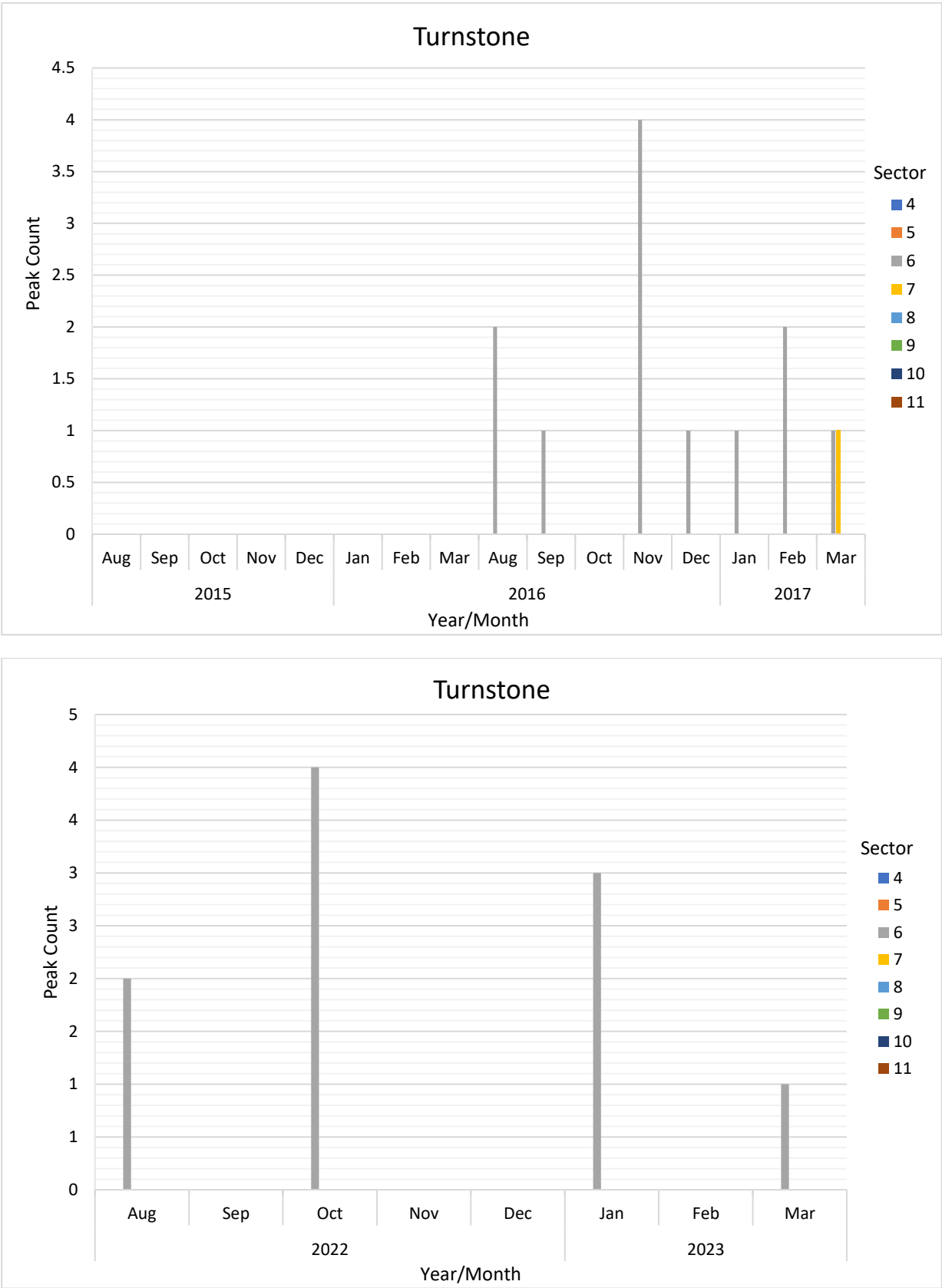


Diagram B22: Peak turnstone records within the 300m ZOI

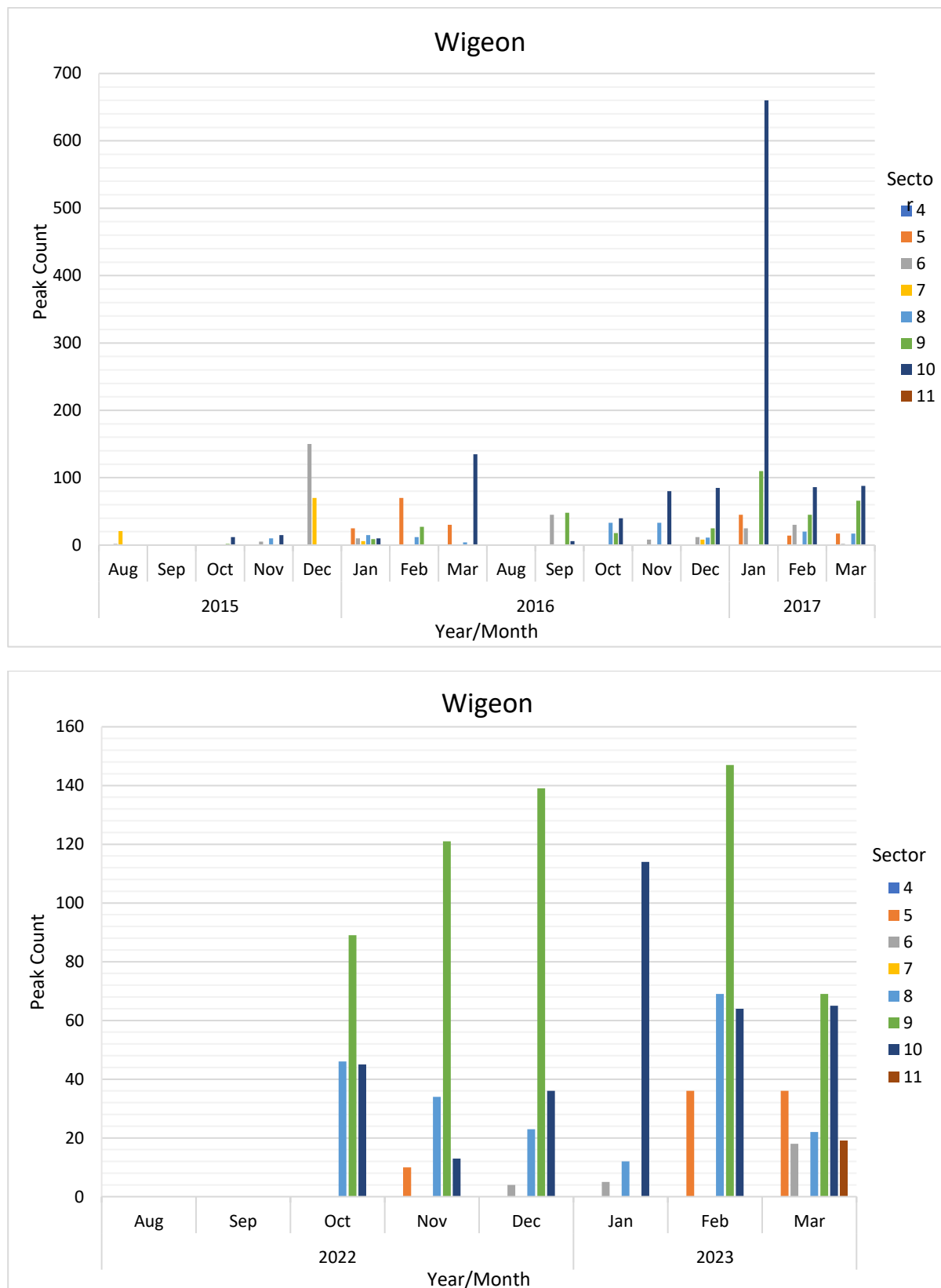


Diagram B23: Peak wigeon records within the 650m Zol

5.4 WeBS Data Results

Table B4: Species recorded within the Forth Grangemouth to Kincardine Bridge (Skinflats) 84405 WeBS count sector from September 2015 to March 2016 and September 2016 to March 2017

Species	2015				2016								2017			WeBS 5yr Average (2014/15- 2018/19)
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Sep	Oct	Nov	Dec	Jan	Feb	Mar		
Bar-tailed godwit	0	0	0	0	0	0	0	1	26	0	0	0	0	0	1	
Common scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cormorant	23	24	14	20	7	17	10	42	38	25	8	21	13	17	24	
Curlew	134	189	316	251	341	586	354	283	291	230	367	312	380	302	315	
Dunlin	7	121	44	495	14	470	102	226	841	928	1480	331	36	45	286	
Eider	0	0	0	0	0	6	0	0	0	0	0	0	0	0	1	
Golden plover	0	1	0	0	0	0	0	2	61	0	0	0	0	0	2	
Goldeneye	0	0	1	4	3	12	8	0	0	0	0	1	0	0	2	
Great crested grebe	0	0	0	0	1	0	2	2	0	0	0	0	1	1	1	
Grey plover	0	0	0	0	0	0	0	0	16	10	0	0	8	4	1	
Knot	0	1	0	0	2	1	3	1	455	0	0	0	0	0	13	
Lapwing	59	143	291	490	6	140	0	241	184	435	320	0	126	3	166	
Long-tailed duck	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0.1	
Mallard	63	27	43	40	107	60	7	102	80	38	67	148	18	35	58	
Oystercatcher	59	59	77	120	92	88	40	59	90	93	89	41	9	136	90	
Pink-footed goose	0	2630	5750	1040	2170	1420	1949	1	3300	0	1720	281	430	480	1042	
Red-breasted merganser	0	0	0	10	17	19	0	0	5	3	20	9	16	10	8	
Redshank	665	942	967	893	880	669	574	955	1068	1155	1210	1124	103 6	1157	1036	
Red-throated diver	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.1	
Ringed plover	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0.1	
Sandwich tern	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
Scaup	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0.9	
Shelduck	958	878	388	173	120	104	218	954	313	89	125	142	101	253	337	
Slavonian grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Turnstone	0	0	0	0	1	0	0	0	0	2	4	0	0	0	0.4	
Wigeon	8	36	133	204	134	100	72	56	99	91	191	196	144	149	108	
Velvet scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table B5: Species recorded within the Forth Grangemouth to Kincardine Bridge (Skinflats) 84405 WeBS count sector from September 2019 to March 2020 and September 2020 to March 2021

Species	2019				2020								2021			WeBS 5yr Average (2016/17 - 2020/21)
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	
Bar-tailed godwit	0	1	0	0	0	1	0	0	5	2	2	0	0	2	0	1
Cormorant	80	48	19	13	30	21	34	62	44	39	48	23	39	8	4	30
Curlew	247	429	340	436	469	386	232	265	264	209	339	166	221	466	463	318
Dunlin	44	80	100	106	290	181	111	129	109	304	129	510	915	976	289	218
Eider (except Shetland)	0	0	6	0	2	2	0	0	1	0	0	0	0	0	0	0
Golden plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Goldeneye	0	0	2	1	1	4	11	0	0	1	2	5	5	2	9	1
Great crested grebe	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1
Grey plover	0	7	0	0	0	0	0	0	0	7	5	0	0	0	0	0
Knot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	161
Lapwing	161	415	94	3	120	58	0	322	304	495	260	121	0	26	0	0
Long-tailed duck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56
Mallard	68	38	27	67	51	46	30	106	67	35	50	47	117	79	27	89
Oystercatcher	3	74	72	20	15	195	52	60	107	167	71	62	116	207	56	875
Pink-footed goose	0	1360	2190	640	6	3800	1740	0	1250	2	1096	2300	810	91	651	11
Red-breasted merganser	1	9	27	6	12	11	25	0	11	13	11	26	7	21	11	1100
Redshank	915	1124	1201	1522	850	964	295	797	903	1030	1345	954	946	1232	1228	0
Red-throated diver	0	0	3	0	0	0	1	0	0	0	5	0	0	0	0	0
Ringed plover	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1
Sandwich tern	13	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1
Scaup	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Shelduck	659	380	102	39	46	124	148	1680	668	213	131	28	26	33	108	289
Slavonian grebe	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turnstone	0	0	1	0	3	5	0	0	0	0	0	0	1	0	0	0
Wigeon	31	58	75	144	225	206	131	5	36	103	105	225	325	444	248	135

Table B6: Species recorded within the Grangepans to Grangemouth 84413 WeBS count sector from September 2015 to March 2016 and September 2016 to March 2017

Species	2015				2016							2017			WeBS 5yr Average (2014/15- 2018/19)
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Sept	Oct	Nov	Dec	Jan	Feb	Mar	
Bar-tailed godwit	3	12	0	190	234	297	47	0	100	84	0	235	87	69	72
Common scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
Cormorant	13	40	5	19	4	3	10	25	22	12	11	11	5	3	13
Curlew	270	267	356	370	215	138	37	375	323	327	235	240	245	201	219
Dunlin	340	1038	1683	3230	3430	2724	288	849	970	1664	3735	5226	2878	2132	2023
Eider	0	2	2	3	0	0	0	0	0	1	0	2	2	5	2
Golden plover	15	192	165	15	5	0	0	12	407	354	22	63	108	0	98
Goldeneye	0	0	0	10	3	0	0	0	0	0	0	3	1	0	2
Great crested grebe	4	51	8	6	5	2	6	8	5	5	4	5	2	2	11
Grey plover	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0.1
Knot	0	440	12	212	3060	1555	516	748	432	521	383	1650	848	510	745
Lapwing	415	415	526	402	1240	297	10	519	654	265	353	58	264	6	285
Long-tailed duck	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mallard	50	59	136	89	73	43	18	68	49	43	117	62	20	14	57
Oystercatcher	138	112	111	44	96	351	69	15	32	91	96	29	206	44	106
Pink-footed goose	0	0	0	32	53	0	0	0	0	0	0	0	0	0	3
Red-breasted merganser	23	43	26	26	7	25	18	18	9	29	9	7	8	18	20
Redshank	1321	2014	1339	1270	825	451	537	828	1814	737	543	802	456	857	938
Red-throated diver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.2
Ringed plover	0	2	0	5	0	0	22	6	0	4	0	72	0	4	9
Sandwich tern	19	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Scaup	0	9	0	0	0	0	6	1	0	0	0	1	0	25	2
Shelduck	1639	2032	1118	202	277	157	110	1509	426	125	175	301	152	593	652
Slavonian grebe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turnstone	0	0	0	2	0	0	9	5	0	0	0	0	0	6	1.5
Wigeon	0	0	68	29	84	51	14	5	5	26	76	75	51	159	47
Velvet scoter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table B7: Species recorded within the Grangepans to Grangemouth 84413 WeBS count sector from September 2019 to March 2020 and September 2020 to March 2021

Species	2019				2020								2021			WeBS 5yr Average (2016/17 – 2020/21)
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	
Bar-tailed godwit	4	10	44	33	78	214	12	2	28	30	49	172	204	67	0	64
Common scoter	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0
Cormorant	8	30	21	4	7	5	4	29	34	51	20	12	11	5	10	14
Curlew	195	106	203	51	337	147	171	100	121	171	272	207	302	220	107	199
Dunlin	109	819	1947	3320	3549	4909	384	185	231	854	2460	2346	4073	2795	41	2089
Eider (except Shetland)	9	0	3	0	1	0	0	5	4	2	0	0	0	0	0	2
Golden plover	27	222	43	0	33	56	0	0	185	234	266	97	0	0	0	68
Goldeneye	0	2	13	26	36	11	54	0	0	3	0	0	0	0	0	6
Great crested grebe	33	25	19	6	6	10	2	81	53	46	26	35	6	5	4	19
Grey plover	0	0	0	0	0	2	0	0	4	0	2	0	2	0	0	0
Knot	126	659	1630	1880	3609	4280	475	164	376	1167	936	2006	4128	1950	93	1075
Lapwing	377	372	272	35	264	449	0	162	380	344	565	415	5	132	0	207
Mallard	39	46	21	47	51	59	21	82	26	27	48	56	95	105	22	43
Oystercatcher	82	57	154	62	43	55	108	112	47	167	67	48	260	168	67	101
Pink-footed goose	18	23	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Red-breasted merganser	26	38	42	22	10	10	23	63	26	43	37	15	18	9	21	22
Redshank	1013	1633	1145	1485	1146	1193	1249	995	1618	825	902	882	946	486	439	985
Red-throated diver	0	0	1	0	0	0	0	0	4	0	2	1	0	0	0	0
Ringed plover	0	0	26	0	0	0	12	31	38	0	0	0	3	0	1	9
Sandwich tern	72	0	0	0	0	0	0	32	6	0	0	0	0	0	0	4
Scaup	0	1	0	0	7	12	18	0	0	1	0	0	0	0	12	3
Shelduck	2595	533	229	219	332	457	621	2144	743	469	522	544	332	416	304	669
Slavonian grebe	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Turnstone	2	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1
Wigeon	0	6	25	72	50	69	30	0	17	17	49	81	26	28	53	40

5.5 Comparison between WeBS and Survey Data

From a visual inspection of the data in Tables B2 to B7, there are strong similarities between the two data sets (i.e., survey results for the Scheme and WeBS data results) in that the same list of species were present during the same months and in similar overall aggregations rising and falling in similar fashions (i.e., the trends are similar). Therefore, using the five years of WeBS data as a comparator, the three years of survey effort for the Scheme is representative of the longer-term dataset and provides a dataset suitable to inform the HRA.

There are some instances where the counts vary, and this is most notable with dunlin: e.g., 11,000 recorded within Sector 9 in January 2017 during surveys for the Scheme, compared to 5,226 birds recorded during the January 2017 WeBS count. Dunlin are known to move between several roost sites (Conklin and Colwell, 2007), as is evident in the survey findings for the Scheme in that roosting dunlin numbers were observed to fluctuate greatly between Sectors and between months. It is therefore likely that differing counts can be expected on different days.

5.6 Density Mapping – Heat Maps

Density/heat maps have been produced for qualifying species of the Firth of Forth SPA/Ramsar site that were recorded in significant numbers within the study area during bird surveys for the Scheme. These maps include the relevant ZOI for each species and show the location of hotspots for foraging at low tide, roosting at high tide and aggregations during rising and lowering tides, as well as the months in which the significant aggregations occur.

The maps show the relative abundance and distribution of each species during each stage of the tidal cycle, facilitating an easy-to-use visual tool useful for identifying hotspots and aggregations of birds. The heat density maps can be viewed using the following link:

<https://emeagis.jacobs.com/portal/apps/experiencebuilder/experience/?id=26850fc7c1ec4522897ee0b6a09c2744>

All other species recorded either infrequently or in low aggregations are shown in Figures 22 to 32 of the HRA.

5.6.1 What the Heat Maps Show

A heat map represents the density (number per unit area) of selected features on a map. Point data is analysed to create an interpolated representative surface showing the relative density of occurrence. Heat map symbology displays the relative density of points as a dynamic raster visualization using a colour scheme to indicate density values. The colour scheme is a smoothly varying set of colours, ranging from cool (sparse density of points) to hot (high density of points). The density definition, and therefore the colour values, change as the user zooms in and out. The density is calculated using the kernel density method, the same algorithm used by the Kernel Density geoprocessing tool in ArcPro.

5.6.2 How the Heat Maps were Developed

A weighted measure heat map was used to create the maps for the bird species. This was calculated based on the species count for each species and displayed as a smoothly varying set of colours ranging from cool (low number of species counts) in a light blue colour to hot (high number of species counts) in a yellow colour.

Note: The colours shown on the heat maps are not comparable in terms of absolute density values between heatmaps and should be viewed separately. Therefore, what shows as a yellow hot spot in terms of density for one species, such as 5000 dunlin, could represent a much smaller number of birds on the heat map for another species (e.g. 100 mallard).

5.6.3 Using the Heat Maps

The user is linked to a webpage that contains maps for 12 qualifying species of the SPA/Ramsar site that were recorded in significant numbers within the Zol. The landing page contains selectable images for each of these species. When a species is selected, a new webpage is opened and the user can click into either of two tabs that are available (Time Series map or Survey Comparison map).

For both maps, the user can scroll with the mouse wheel to zoom in or out. The overall hotspots are visible when fully zoomed out: these are a combination of multiple recordings at the one location or contain the largest count for that species during the surveys. Given the scale of the site, the colour variation that defines the density appears larger than the actual location of the species records when zoomed out to allow a clear visual representation of site usage at that scale. However, when zoomed in the colour variation is more refined to the location of the species record.

Time Series Map

The first tab (e.g., Redshank – Time Series) contains all the data for a specific species, split by year, month, and tidal state. The user can select what tidal state to view within a survey season from the panel on the right side of the map. As this tab is time enabled and contains a time slider at the bottom of the map, the user has the option to either play the time series to view bird usage within the Zol throughout the survey season or alternatively pause the time slider and manually scroll through each month. The months are shown as numbers on the slider (i.e. February is 2), but due to the label limitations of the slider, January is shown as the year (e.g. for the 2015/2016 data, January is shown as 2016). There is an additional option to view the records for multiple months by expanding the time slider i.e., October – December records only. If the user wants to know more information about a particular record, they can click on the exact location of the record with the cursor and this will display an information box with all available metadata including date, tide, species count and location co-ordinates.

Comparison Map

The second tab (e.g., Redshank - Survey Comparison) includes maps for each of the three survey seasons conducted (2015/2016, 2016/2017 and 2022/2023). For each map, the tidal states (Rising, High, Lowering or Low) can be selected and multiple tidal states can be presented at the same time. The user can make a visual comparison of bird usage within the Zol during different tidal states within the same survey season and also during the other two survey seasons conducted. This can help identify the areas within the Zol which are particularly important (i.e., the hotspots). On the top left of each map there are zoom options, a selection tool, and a home button which returns the map to the original scale.

5.7 Key Points from Bird Survey Results

The bird surveys recorded the largest numbers of roosting waders within the 300m and 650m Zol between December and March in Sectors 6, 9 and 10, with particularly high numbers in January 2017 and September 2022.

The survey sectors and WeBS survey sectors, along with the 300m and 650m Zol are shown in Figure 10, and a summary is presented for each species below.

- Bar-tailed godwit was recorded primarily to the east of the Scheme within the Zol. As is evident from the heat maps, the main roosting areas are in the sheltered bay at the petrochemical plant, along the mouth of the River Avon, and in Kinneil Lagoons. A peak count of 480 birds (24.3% of the cited SPA population) was recorded in Sector 11, Kinneil Lagoons in January 2017. Birds were also recorded roosting at Skinflats Bay.
- Curlew was found to be widespread throughout the Zol, feeding and roosting in large numbers through the tidal cycle and along the tideline. A peak count of 430 foraging birds (22.3% of the SPA population) was recorded in Sector 11 in December 2016, east of the petrochemical plant. As can be seen in the heat maps, high tide roosts were encountered across the study area, with a particularly important roost located east of the petrochemical plant. Birds fed extensively on the mudflats around Skinflats. Curlew numbers consistently appear to be important within an estuary context.
- Dunlin was the most abundant species recorded during the surveys with birds recorded across most of the Zol through all tidal states (see heat maps). The highest numbers were recorded along the breakwater west of the Port of Grangemouth, in the sheltered bay north of the petrochemical plant, at the mouth of the River Avon and in the Kinneil Lagoons. A peak count of 11,000 birds (115% of the cited SPA population) was recorded in January 2017 roosting at high tide in the sheltered bay. Several other notable counts of dunlin were recorded across the Zol ranging from between 6,000 and 9,000 roosting birds. Birds also fed extensively across mudflats to the north of the petrochemical plant.
- Golden plover distribution within the Zol was mainly restricted to a small number of locations – within Skinflats Bay, in the sheltered bay north of the petrochemical plant, at the mouth of the River Avon and in the lagoons at Kinneil where birds roosted at high tide. A peak count of 436 birds (14.8% of the cited SPA population) was recorded at Kinneil Lagoons.
- Knot was recorded in large numbers within the Zol primarily around the sheltered bay north of the petrochemical plant and at the mouth of the River Avon (see heat maps). A peak count of 7,300 birds (78.9% of the cited SPA population) was recorded at the mouth of the River Avon foraging/roosting in January 2017. The majority of knot were recorded in Sectors 9, 10 and 11 during the 2015 – 2017 and 2022/23 surveys.
- Lapwing was recorded frequently within the Zol throughout the survey period, through the tidal cycle and along the tideline and nearby fields. However, numbers varied throughout the study area over the three years. The primary areas of roosting and foraging were at the breakwater, north of the petrochemical plant, at the mouth of the River Avon and in the Kinneil Lagoons. A peak count of 548 birds (13.2% of the cited SPA population) was recorded within Sector 11 in December 2016, with a peak count of 404 birds (9.7% of the cited SPA population) recorded in September 2022 also in Sector 11. As is evident from the heat maps, at mid to high tide, the sheltered bay area next to petrochemical plant is particularly important for roosting lapwing.
- Redshank was the most frequently recorded species, occurring widely throughout the Zol (both roosting and foraging). A peak count of 1,470 birds (33.8% of the cited SPA population) was recorded foraging/ roosting along the breakwater in Sector 6, in November 2016. As is evident from the heat maps, the largest flock sizes were recorded around the Port of Grangemouth and the petrochemical plant, particularly along the breakwater, along the sheltered bay north of the petrochemical plant, at the mouth of the River Avon, and in the lagoons at Kinneil.

- Ringed plover was recorded primarily in the sheltered bay north of the petrochemical plant and at the mouth of the River Avon. A peak count of 210 birds (64% of the cited SPA population) was recorded foraging/roosting near the sheltered bay in September 2016. Birds were generally recorded foraging in the upper shore area.
- Shelduck was recorded throughout the Zol, primarily foraging and roosting on the water and mudflats. A peak high/rising count of 1,440 (20% of the cited SPA population) roosting/foraging birds was recorded in Sector 9 in September 2015. This is likely to include a proportion of the annual moulting flock present within the Forth Estuary each year from July until September (see heatmaps). The 2022/23 survey data also identified peak shelduck counts during this period (peak count of 1,002 in August 2022) in Sector 9. Large numbers of roosting birds were recorded around the Port of Grangemouth and petrochemical plant and on the mudflats at Kinneil. Birds were recorded roosting mainly on land, but occasionally also on the water. In addition, 4,700 birds (104% of the cited SPA population) were recorded within the 650m visual Zol at low tide roosting, loafing, and foraging within Sector 10 in August 2016. Again, this is likely to include a large proportion of the annual moulting flock.
- Wigeon was recorded throughout the Zol, as can be seen from the heat maps, in numbers ranging from 1 to 660 birds (up to 30.9% of the cited SPA population). Birds were primarily foraging during the surveys.
- Cormorant is widespread and common in the Firth of Forth and was recorded frequently throughout the study area, with a peak count of 110 (16.13% of the cited SPA population) in Sector 4 in August 2022. They tolerate high levels of human activity and the presence of artificial structures (McKay et al., 1999; Dierschke et al., 2016), so are less vulnerable to disturbance (i.e., noise, visual). Cormorant feed in open water and can rest on structures such as buoys, breakwaters, walls, and rocks. They can be highly mobile during the non-breeding season, with tracked individuals making extensive movements (up to 45 km) between sites throughout Scotland depending on food availability (Forrester et al., 2007), moving not only between estuaries but also between coastal and inland feeding sites. Tracking showed that many cormorant wintering on the Firth of Forth roost at Loch Leven but can forage up to 50 km from that site, including the Firth of Forth and many other sites (Wright, 2003).
- Great crested grebe was recorded on eight occasions within the Zol during the 2015–2017 surveys, and only once during the 2022/23 surveys. These records were primarily to the east and northeast of the Scheme in open water near Kinneil Kerse during high tides. A peak count of 11 birds (1.5% of the cited SPA population) was recorded northeast of the docks in November 2016. Bothkennar Pools have been identified as important for foraging.
- Grey plover was recorded on two occasions within the Zol, with a peak count of two birds (0.3% of the cited SPA population) recorded in Bothkennar Pools during the 2015 – 2017 surveys. During the 2022/23 surveys, a peak count of seven birds (0.9% of the cited SPA population) was recorded during February 2023 also in Bothkennar Pools.
- Mallard was recorded throughout the Zol. A peak count of 180 birds (7% of the cited SPA population) was recorded in October 2015 on mudflats at the mouth of the River Avon in Sector 10.
- Oystercatcher was recorded roosting and feeding across the Zol, particularly around the Port of Grangemouth and Grangemouth Port Locks. In February 2017, a peak count of 588 birds (7.5% of the cited SPA population) was recorded on the mudflats north of petrochemical plant in Sector 9.
- A peak count of 1,370 (12.6% of the cited SPA population) pink-footed goose was recorded in November 2016, within the Zol in Sector 5. During the 2022/2023 surveys, records ranged from 1 to 200 individual birds in all sectors excluding Sector 11.
- Red-breasted merganser was recorded on water within the Zol around the breakwater, northeast of the dock entrance and at the mouth of the River Avon. A peak count of 28 birds (4.18% of the cited SPA population) was recorded in October 2016, east of the dock entrance in Sector 7. At low tide birds remained below the low tide line, in the water.
- Scaup was recorded infrequently and in low numbers during the surveys. A peak count of 17 birds (3.8% of the cited SPA population) was recorded in February 2023, at the mouth of the River Avon in Sector 10. Scaup was recorded once during the 2015 – 2017 surveys, with a peak count of 6 birds in March 2016 in Sector 10. The

substantial declines in scaup occurring on the Firth of Forth were historically linked directly to sewage treatment improvement works (reduced sewage outputs leading to reduced mollusc abundance which supported less scaup) (Campbell, 1984). Scaup is now only recorded in very low numbers in winter (Cook et al., 2013).

- Eider was recorded infrequently within the study area during the winter bird surveys and is mostly associated with the outer Forth rather than the inner Forth (Bryant, 1987; Forrester et al., 2007). A peak count of 5 birds within the Zol was recorded in October 2016 in Sector 10 at the mouth of the River Avon, with other infrequent records in November 2016, and January 2017. No eider were recorded within the Zol at high or rising tide within the 2022/23 surveys. As numbers nationally have remained relatively stable, declines in the Forth are thought to be attributable, at least partially, to local pressures.
- Goldeneye was recorded in low numbers within the study area during the winter bird surveys. During the 2015 – 2017 surveys, goldeneye was recorded within the Zol on six occasions with a peak count of 23 birds (0.76% of cited SPA population) near the mouth of the River Avon in January 2017. Similarly, goldeneye was recorded on six occasions with a peak count of eight birds (0.27% of the cited SPA population) in September and January during the 2022/23 surveys. Goldeneye are associated predominantly with the sub-tidal area and outer Forth and rarely come ashore during the winter months (Bryant, 1987 and Forrester et al., 2007). The declines in numbers of goldeneye on the Forth have been linked to improvements in sewage treatment, as feeding flocks were only recorded at outfalls where sewage continued to be discharged in large quantities (Campbell, 1984). This has resulted in a trend suggesting that declining numbers are possibly due to site-specific pressures as they do not correlate with the regional and British trends.
- The Firth of Forth is recognised as an important area for large numbers of Sandwich tern that congregate in the Forth post-breeding. Sandwich tern were recorded in flight in low numbers during the surveys in August and September. One small flock (four birds, <1% of the cited SPA population) was recorded roosting within the study area in September 2016, roosting on mud at low tide approximately 300m from the foreshore at the petrochemical plant. During the 2022/23 surveys, 11 birds (<1% of the cited SPA population) were recorded loafing north-west of the mouth of the River Avon. All other records were of birds in flight and foraging. The immediate area surrounding the Scheme is not an important area for roosting terns and any terns recorded were infrequent and at a distance from the works area. Greater numbers were recorded east of the Scheme, particularly at Carriden. Large roosts are also found between Musselburgh and Aberlady Bay, and in Tynninghame Bay towards the outer Forth.
- Turnstone were recorded in low numbers, with a peak count of four birds (0.5% of the cited SPA population) recorded along the breakwater in November 2016 and October 2022. Turnstone rely on rocky/stony shores (SNH, 2016) and therefore tend to occur in greater numbers in the outer Forth.
- Surveys did not record Slavonian grebe, long-tailed duck, or velvet scoter within survey Sectors adjacent to the Scheme. Slavonian grebe was recorded on three occasions outside of the study area east of Bo'ness. The presence of Slavonian grebe within the inner Forth is considered to be rare (SNH, 2016). Long-tailed duck and velvet scoter were not recorded at all during the surveys. The absence of both species during the surveys is reflective of the fact these species favour other areas within the SPA.
- Red-throated diver was recorded once in the 2015 - 2017 surveys, with a peak count of two birds in November 2016 in Sector 7. They were also recorded once with two birds (2% of the cited SPA population) in November 2022, feeding in deeper waters north of the port entrance (two individuals) in Sector 7; a single record from December 2022 is present in the same location.
- Common scoter was recorded on three occasions within the study area: in December 2015 (four birds), December 2016 (one bird) and March 2017 (four birds). However, no birds were recorded within the Zol. Scoters are mostly found in the outer Forth rather than the inner Forth.

6. Bird Monitoring Weather Conditions during Ground Investigation

To inform the design and construction of the Scheme, multiple phases of Ground Investigation (GI) works have been conducted. Monitoring during GI works was undertaken by two competent ecologists to account for differing use of the site by birds through the period and during all tidal states (high, mid, and low). Also, monitoring was undertaken during a range of ground investigation types: cable percussive drilling at boreholes; rotary drilling at boreholes, and cone penetration tests, and at locations both adjacent to and more distant from the SPA boundary.

Bird monitoring took place during whilst noise measurements were being taken. Weather conditions during each monitoring period are detailed in Table B8; the observations recorded during monitoring can be found in Section 4.4 of the HRA.

Table B8: Weather conditions during bird monitoring

Location	Date and Time	Temperature (°C)	Wind (direction)	Precipitation	Cloud Cover	Visibility
<i>GI Works</i>						
BHFP04	24 September 2019, 08:10-09:40	14	Light breeze (E)	None	87%	Good (>2km)
BHFP07	11 December 2019, 10:10-12:00	4	Moderate breeze (SW)	Light showers	75-87%	Good (>2km)
BHFP08	22 October 2019, 08:15-12:25	9-10	Gentle breeze (SW) Moderate breeze (WSW)	None	100%	Good (>2km)
	31 October 2019, 09:15-11:40	5	Calm	None	12%	Good (>2km)
BHFP09	23 September 2019, 09:45-13:15	15-16	Light air (SSE) Light breeze (S)	None	62-87%	Good (>2km)
BHFP10	11 October 2019, 09:00-10:45	8-11	Moderate breeze (SW) Light air (NNW)	None	37-62%	Good (>2km)
BHFP11	11 September 2019, 08:15-10:00	14	Gentle-moderate breeze (WSW)	None	50%	Good (>2km)
	19 September 2019, 08:30-10:00	13	Gentle breeze (WSW)	None	100%	Good (>2km)
BHFP12	22 August 2019, 08:10-12:14	13-15	Gentle-moderate breeze (SW)	None	25-37%	Good (>2km)
	05 September 2019, 08:30-13:00	9-14	Gentle breeze (WSW) Moderate breeze (W)	None	62-87%	Good (>2km)
BHFP15	05 August 2019, 10:50-12:50	16-17	Gentle breeze (SSW-SW)	None	100%	Good (>2km)
	05 August 2019, 14:00-16:05	19	Moderate breeze (WSW)	None	37-50%	Good (>2km)
	08 August 2019, 08:45-12:15	14-16	Light air (WSW-NNE)	None	25-87%	Good (>2km)
	14 August 2019, 08:00-10:00	10-11	Light breeze (E)	None	62-100%	Good (>2km)
	23 August 2019, 08:00-10:05	16-17	Gentle-moderate breeze (WSW)	None	87%	Good (>2km)

Location	Date and Time	Temperature (°C)	Wind (direction)	Precipitation	Cloud Cover	Visibility
CPTFP05	01 October 2019, 08:45-11:15	7-8	Light-gentle breeze (NE)	None	62-75%	Good (>2km)
CPTFP11	08 January 2020, 08:30-11:30	4-5	Light breeze (W-WSW)	Heavy showers	50-100%	Moderate (1-2km - Good (>2km)
Noise Measurements						
A – North Shore Road	29 October 2019, 14:12-16:12	9	Light breeze (ENE - NE)	None	50-75%	Good (>2km)
B – North Shore Road	31 October 2019, 12:44-14:44	8-9	Light breeze (E-ESE)	None	12-50%	Good (>2km)
C – South Shore Road	31 October 2019, 09:22-11:24	2-6	Light air-light breeze (ESE)	None	0%	Good (>2km)
D – petrochemical plant	30 October 2019, 11:19-13:15	6-8	Light breeze (NE-ENE-E)	None	25-37%	Good (>2km)
BHFP08 – North Shore Road	30 October 2019, 15:00-15:15	9	Light breeze (ESE)	None	100%	Good (>2km)

7. References

- Berg, A. (1993). Food resources and foraging success of Curlews *Numenius arquata* in different farmland habitats. *Ornis Fennica*. 70. 22-31.
- BirdLife International (2015b). *Anas platyrhynchos* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22680186A119275821. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22680186A119275821.en> [Accessed July 2019]
- BirdLife International (2016a). *Pluvialis apricaria*. The IUCN Red List of Threatened Species 2016: e.T22693727A86551440. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693727A86551440.en> [Accessed July 2019]
- BirdLife International (2016b). *Anser brachyrhynchus*. The IUCN Red List of Threatened Species 2016: e.T22679872A85978254. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22679872A85978254.en> [Accessed July 2019]
- BirdLife International (2016c). *Tringa totanus*. The IUCN Red List of Threatened Species 2016: e.T22693211A86687799. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693211A86687799.en> [Accessed July 2019]
- BirdLife International (2016d). *Charadrius hiaticula*. The IUCN Red List of Threatened Species 2016: e.T22693759A86575756. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693759A86575756.en>. [Accessed July 2019]
- BirdLife International (2016e). *Tadorna tadorna*. The IUCN Red List of Threatened Species 2016: e.T22680024A86009950. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22680024A86009950.en>. [Accessed July 2019]
- BirdLife International (2016f). *Arenaria interpres*. The IUCN Red List of Threatened Species 2016: e.T22693336A86589171. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22693336A86589171.en>. [Accessed August 2019]
- BirdLife International (2017). European birds of conservation concern: populations, trends and national responsibilities Cambridge, UK: BirdLife International.
- BirdLife International (2017a). *Limosa lapponica* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22693158A111221714. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22693158A111221714.en>. [Accessed July 2019]
- BirdLife International (2017b). *Numenius arquata*. The IUCN Red List of Threatened Species 2017: e.T22693190A117917038. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22693190A117917038.en>. [Accessed July 2019]
- BirdLife International (2017c). *Calidris alpina* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22693427A111785607. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22693427A111785607.en>. [Accessed July 2019]
- BirdLife International (2017d). *Pluvialis squatarola* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22693749A111753197. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22693749A111753197.en>. [Accessed July 2019]

BirdLife International (2017e). *Vanellus vanellus* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22693949A111044786. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22693949A111044786.en>. [Accessed July 2019]

BirdLife International (2017f). *Haematopus ostralegus* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22733462A117739875. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22733462A117739875.en>. [Accessed July 2019]

BirdLife International (2017g). *Mareca penelope* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22680157A111892532. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22680157A111892532.en>. [Accessed July 2019]

BirdLife International (2018a). *Podiceps cristatus*. The IUCN Red List of Threatened Species 2018: e.T22696602A132583378. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22696602A132583378.en>. [Accessed July 2019]

BirdLife International (2018b). *Calidris canutus*. The IUCN Red List of Threatened Species 2018: e.T22693363A132285482. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22693363A132285482.en>. [Accessed August 2019]

BirdLife International (2018c). *Mergus serrator*. The IUCN Red List of Threatened Species 2018: e.T22680485A132053220. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22680485A132053220.en> [Accessed July 2019]

BirdLife International (2018d). *Gavia stellata*. The IUCN Red List of Threatened Species 2018: e.T22697829A131942584. Available at: <https://www.iucnredlist.org/species/22697829/60168888> [Accessed August 2019]

BirdLife International, (2018e). *Thalasseus sandvicensis*. The IUCN Red List of Threatened Species 2018: e.T22694591A132063997. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22694591A132063997.en>. [Accessed August 2019]

BirdLife International (2018f). *Melanitta nigra*. The IUCN Red List of Threatened Species 2018: e.T22724879A132257623. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22724879A132257623.en>. [Accessed August 2019]

BirdLife International (2018g). *Phalacrocorax carbo*. The IUCN Red List of Threatened Species 2018: e.T22696792A132592923. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22696792A132592923.en>. [Accessed August 2019]

BirdLife International (2018h). *Bucephala clangula*. The IUCN Red List of Threatened Species 2018: e.T22680455A132529366. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22680455A132529366.en>. [Accessed August 2019]

BirdLife International (2018i). *Aythya marila*. The IUCN Red List of Threatened Species 2018: e.T22680398A132525108. Available at: <http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22680398A132525108.en>. [Accessed August 2019]

BirdLife International (2021). European Red List of Birds. Luxembourg: Publications Office of the European Union.

Bos, J. (2008). Post breeding movements of sandwich tern in the Firth of Forth. Available at: <http://www.let.rug.nl/bos/pubs/Bos2008SB.pdf> [Accessed August 2019]

Boyd, H. (1992). Arctic summer conditions and British Knot numbers: an exploratory analysis. Wader Study Group Bull. 64, Suppl: 144-152.

Brides, K., Mitchell, C. Auhage, and S. N.V. (2020). Status and distribution of Icelandic-breeding geese: results of the 2019 international census. Wildfowl & Wetlands Trust Report, Slimbridge.19 pp.

Bryant, D.M. (1987). Wading birds and wildfowl of the estuary and Firth of Forth, Scotland. Volume 93, Issue 3-4 (The Natural Environment of the Estuary and Firth of Forth)1987, pp. 509-520.

BTO (2010). Redshank. Available at: https://www.bto.org/sites/default/files/u18/downloads/publications/wituk200708_9.pdf [Accessed August 2019]

Burns, F., Eaton, M.A., Balmer, D.E., Banks, A., Caldow, R., Donelan, J.L., Douse, A., Duigan, C., Foster, S., Frost, T., Grice, P.V., Hall, C., Hanmer, H.J., Harris, S.J., Johnstone, I., Lindley, P., McCulloch, N., Noble, D.G., Risely, K., Robinson, R.A., Wotton, S. (2020). The state of the UK's birds 2020. The RSPB, BTO, WWT, DAERA, JNCC, NatureScot, NE and NRW, Sandy, Bedfordshire.

Burton, N.H.K. (2006). The impact of the Cardiff Bay barrage on wintering waterbirds. In: Boere, G.; Galbraith, C., Stroud, D. (ed.), Waterbirds around the world, pp. 805. The Stationary Office, Edinburgh, UK.

Burton, N.H.K., Rehfisch, M.M. and Clark, N.A. (2002). Impacts of disturbance from construction work on the densities and feeding behaviour of waterbirds using the intertidal mudflats of Cardiff Bay, UK. Environ. Manage. 30: 865–871.

Campbell, L.H. (1984). The impact of changes in sewage treatment on seaducks wintering in the Firth of Forth, Scotland. Biological Conservation 28: 173-180.

Campbell, L.H., Standring, K.T. and Cadbury, C.J. (1978). Firth of Forth oil pollution incident, February 1978. Marine Pollution Bulletin. 9. 335-339. 10.1016/0025-326X(78)90244-8.

Carroll, M.J., Williams, M.A. and Bradbury, R.B. (2015). The Nature of Climate Change: Europe's Wildlife at Risk. Research Report 55. RSPB Centre for Conservation Science, Sandy.

Cayford, J.T. and Waters, R.J. (1996). Population estimates for waders Charadrii wintering in Great Britain, 1987/77 – 1991/92. Biological Conservation 77:7-17.

Conklin, J.R. and Battley, P.F. (2011). Impacts of wind on individual migration schedules of New Zealand bar-tailed godwits, Behavioural Ecology, Volume 22, Issue 4, July-August 2011, Pages 854–861.

Conklin J.R and Colwell, M.A (2007). Interaction of predators and manmade object causes potentially significant mortality in a wintering shorebird population. Wader Study Group Bull. 112: 57-59

Cook, A.S.C.P., Barimore, C., Holt, C.A., Read, W.J. and Austin, G.E. (2013). Wetland Bird Survey Alerts 2009/2010: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs). BTO Research Report 641. BTO, Thetford.

- Cutts, N., Hemingway, K. and Spencer, J. (2013). Waterbird disturbance mitigation toolkit. Institute of Estuarine and Coastal Studies, University of Hull.
- Davidson, N. and Rothwell, P.I. (1993). Human disturbance to waterfowl on estuaries: Conservation and coastal management implications of current knowledge. Wader Study Group Bulletin. 68. 97-105.
- Del Hoyo, J., Elliott, A. and Sargatal, J. (1992). Handbook of the birds of the world. Barcelona: Lynx Editions. Vol. 1-10.
- Delany, S., Scott, D., Dodman, T. and Stroud, D. (2009). (eds) An atlas of wader populations in Africa and Western Eurasia. Wetlands International, Wageningen, The Netherlands.
- Dierschke, V., Furness, R. and Garthe, S. (2016). Seabirds and offshore wind farms in European waters: Avoidance and attraction. Biological Conservation. 202. 59-68. 10.1016/j.biocon.2016.08.016.
- European Commission (2016a). Wild Birds – Threatened Birds: Bar-tailed Godwit. Available at: http://ec.europa.eu/environment/nature/conservation/wildbirds/threatened/l/limosa_lapponica_en.htm. [Accessed August 2019]
- European Commission (2016b). Wild Birds – Threatened Birds: Golden Plover. Available at: http://ec.europa.eu/environment/nature/conservation/wildbirds/threatened/p/pluvialis_apricaria_en.htm. [Accessed August 2019]
- European Commission (2016c). Wild Birds – Threatened Birds: Red Throated Diver. Available at: https://ec.europa.eu/environment/nature/conservation/wildbirds/threatened/g/gavia_stellata_en.htm. [Accessed August 2019]
- European Commission (2019). Wild Birds: Threatened bird species in Annex I. Available at: https://ec.europa.eu/environment/nature/conservation/wildbirds/threatened/index_en.htm [Accessed August 2019]
- Forrester, R.W., Andrews, I.J., McInerny, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. and Grundy, D.S. (eds) (2007). The Birds of Scotland. The Scottish Ornithologists' Club, Aberlady.
- Franks, S.E., Douglas, D.J.T., Gillings, S., and Pearce-Higgins, J.W. (2017). Environmental correlates of breeding abundance and population change of Eurasian Curlew *Numenius arquata* in Britain. Bird Study 64: 1-17, <http://dx.doi.org/10.1080/00063657.2017.1359233>.
- Frost, T.M., Austin, G.E., Calbrade, N.A., Mellan, H.J., Hearn, R.D., Robinson, A.E., Stroud, D.A., Wotton, S.R. and Balmer, D.E. (2019). Waterbirds in the UK 2017/18: The Wetland Bird Survey. BTO, RSPB and JNCC, in association with WWT. British Trust for Ornithology, Thetford.
- Frost, T.M., Calbrade, N.A., Birtles, G.A., Mellan, H.J., Hall, C., Robinson, A.E., Wotton, S.R., Balmer, D.E., and Austin, G.E. (2020). Waterbirds in the UK 2018/19: The Wetland Bird Survey. BTO, RSPB and JNCC, in association with WWT. British Trust for Ornithology, Thetford.
- Frost, T.M., Calbrade, N.A., Birtles, G.A., Hall, C., Robinson, A.E., Wotton, S.R., Balmer, D.E. and Austin, G.E. (2021). Waterbirds in the UK 2019/20: The Wetland Bird Survey. BTO, RSPB and JNCC, in association with WWT. British Trust for Ornithology, Thetford.
- Gillings, S. and Fuller, R. J. (1999). Winter Ecology of Golden Plovers and Lapwings: a review and Consideration of Extensive Survey Methods. British Trust for Ornithology, Thetford.

- Gillingwater, L. (2018). East Lothian Local Development Plan 2018: Update on Habitats Regulations Appraisal.
- Gittings, T. (2018). Nocturnal communal roosting behaviour in Great Crested Grebes *Podiceps cristatus*.
- Goodship, N.M. and Furness, R.W. (2022). Disturbance Distances Review: An updated literature review of disturbance distances of selected bird species. NatureScot Research Report 1283
- Gray, C.E., Dierschke, V., Furness, R.W., Petersen, I.K., Schmutz, J., Zydels, R. and Daunt, F. (2017). Possible Behavioural, Energetic and Demographic Effects of Displacement of Red-throated Divers (Revised December 2017). JNCC Report No. 605. JNCC, Peterborough. ISSN 0963-8091.
- Hayhow, D.B., Ausden, M.A., Bradbury, R.B., Burnell, D., Copeland, A.I., Crick, H.Q.P., Eaton, M.A., Frost, T., Grice, P.V., Hall, C., Harris, S.J., Morecroft, M.D., Noble, D.G., Pearce-Higgins, J.W., Watts, O. and Williams, J.M. (2017). The state of the UK's birds 2017. The RSPB, BTO, WWT, DAERA, JNCC, NE and NRW, Sandy, Bedfordshire.
- Hustings, F., Koffijberg, K., Van Winden, E., Van Roomen, M., SOVON Ganzen- en Zwanenwerkgroep and Soldaat, L. (2009). Water birds in the Netherlands in 2007/2008. SOVON-monitoringrapport 2009/02, Waterdienst-rapport SOVON Vogelonderzoek Nederland, Beek-Ubbergen.
- IUCN (2019). The IUCN Red List of Threatened Species. Version 2019-2. Available at: <http://www.iucnredlist.org>. [Accessed November 2019]
- JNCC (2001). Firth of Forth SPA Description. Available at: <https://sitelink.nature.scot/site/8499> [Accessed February 2024]
- JNCC (2008). Information Sheet on Ramsar Wetlands: Firth of Forth. Available at: <https://sitelink.nature.scot/site/8424> [Accessed February 2024]
- JNCC (2012). SPA Species Account – Species List. Available at: <https://jncc.gov.uk/jncc-assets/SPA-N2K/UK9004411.pdf> [Accessed February 2024]
- JNCC (2019a) Eleventh Article 12 UK Birds Directive Report (2019): Annex B – Species' status and trends 2019.
- JNCC (2019b) Eleventh Article 12 UK Birds Directive Report (2019): Annex A – General Report 2019.
- Johnston, A., Ausden, M., Dodd, A.M., Bradbury, R.B., Chamberlain, D.E., Jiguet, F. and Pearce-Higgins, J.W. (2013). Observed and predicted effects of climate change on species abundance in protected areas. *Nature Climate Change*, 3, 1055– 1061.
- Kear, J. (2005). Ducks, geese and swans volume 1: general chapters; species accounts (Anhimas to Salvadorina). Oxford University Press, Oxford, U.K.
- Lack, P. (1986). The Atlas of Wintering Birds in Britain and Ireland. T. and A.D. Poyser
- Leech, D.I., Crick, H.Q.P., and Rehfisch, M.M. (2004). The effect of climate change on bird species in the UK. BTO Research Report No. 369. Available at: https://www.bto.org/sites/default/files/shared_documents/publications/research-reports/2004/rr369.pdf [Accessed July 2019]

MacArthur Green (2017). Grangemouth Flood Alleviation Scheme - Ornithology Survey Report 2015-2017.

Maclean, I. M.D., Austin, G.E., Rehfish, M. M., Blew, J., Crowe, O., Delany, S., Devos, K., Deceuninck, B., Gunther, K., Laursen, K., Van Roomen, M. and Wahl, J. (2008). Climate change causes rapid changes in the distribution and site abundance of birds in winter. Blackwell Publishing Ltd.

Marchowski, D., Jankowiak, Ł., Ławicki, Ł., Wysocki, D., and Chylarecki, P. (2019). Fishery bycatch is among the most important threats to the European population of Greater Scaup *Aythya marila*. *Bird Conservation International* 30:1–18.

Marchowski, D., Jankowiak, Ł., Ławicki, Ł., Wysocki, D., Calbrade, N.A. and 15 others. (2020). Effectiveness of the European Natura 2000 network to sustain a specialist wintering waterbird population in the face of climate change. *Scientific Reports* 10: 20286.

McKay, H., Furness, R., Russell, L. I., Parrott, D., Rehfish, M., Watola, G., Packer, J., Armitage, M., Gill, E. and Robertson, P. (1999). The assessment of the effectiveness of management measures to control change by fish-eating birds to inland fisheries in England and Wales. York: MAFF.

Mitchell, C. (2012). Mapping the distribution of feeding Pink-footed and Iceland Greylag Geese in Scotland. Wildfowl & Wetlands Trust / Scottish Natural Heritage Report, Slimbridge. 108pp.

Myrfyn, O and Thomas, J. G. (1979). The Feeding Ecology and Conservation of Wigeon Wintering at the Ouse Washes, England. *The Journal of Applied Ecology*. 16. 795. 10.2307/2402854.

NatureScot (2019a). Firth of Forth SPA. Available at: <https://sitelink.nature.scot/site/8499> [Accessed February 2024]

NatureScot (2019b). Firth of Forth Ramsar. Available at: <https://sitelink.nature.scot/site/8424> [Accessed February 2024]

O'Brien, S.H., Wilson, L.J., Webb, A. and Cranswick, P.A. (2008). Revised estimate of numbers of wintering Red-throated Divers *Gavia stellata* in Great Britain, *Bird Study*, 55:2, 152–160, DOI: 10.1080/00063650809461517.

Piersma, T., Verkuil, Y. and Tulp, I. (1994). Resources for Long-Distance Migration of Knots *Calidris canutus islandica* and *C. c. canutus*: How Broad Is the Temporal Exploitation Window of Benthic Prey in the Western and Eastern Wadden Sea? *Oikos* 71: 393 – 407.

Pollitt, M.S., Cranswick, P.A., Musgrove, A.J., Hall, C., Hearn, R.D., Robinson, J.A. and Holloway, S.J. (2000). The Wetland Bird Survey 1998/99: Wildfowl and wader counts. Slimbridge: BTO/WWT/RSPB/JNCC.

Pollitt, M.S., Hall, C., Holloway, S.J., Hearn, R.D., Marshall, P.E., Musgrove, A.J., Robinson, J.A. and Cranswick, P.A. (2003). The Wetland Bird Survey 2000–01: Wildfowl and Wader Counts. BTO/WWT/RSPB/JNCC, Slimbridge.

Ratcliffe, D.A. (Ed) (1977). *A Nature Conservation Review*. 2 vols. Cambridge University Press.

Rose, P.M. and Scott, D.A. (1997). Waterfowl population estimates. Wetlands International Publication 44. Wetlands International, Wageningen, The Netherlands.

Scotland's Environment (2019). Protected Nature Sites. Available at: <https://www.environment.gov.scot/data/data-analysis/protected-nature-sites/?pagenumber=1&resetmap=true&siteid=8499> [Accessed February 2024]

Skov, H., Heinänen, S., Žydelis, R., Bellebaum, J., Bzoma, S., Dagys, M., Durinck, J., Garthe, S., Grishanov, G., Hario, M., Kieckbusch, J.J., Kube, J., Kuresoo, A., Lasson, K., Luigujoe, L., Meissner, W., Nehls, H.W., Nilsson, L., Petersen, I.K., Roos, M.M., Pihl, S., Sonntag, N., Stock, A., Stipniece, A. and Wahl, J. (2011). Waterbird populations and pressures in the Baltic Sea. Copenhagen: Nordic Council of Ministers.

Smit, C.J. and Piersma, T. (1989). Numbers, midwinter distribution, and migration of wader populations using the East Atlantic Flyway. — IWRB spec. Publ.9, 24–63.

SNH (2016). Habitats Regulations Appraisal (HRA) on the Firth of Forth: A Guide for developers and regulators. Available at: https://www.nature.scot/sites/default/files/2019-07/Habitats%20Regulations%20Appraisal%20%28HRA%29%20on%20the%20Firth%20of%20Forth%20-%20A%20Guide%20for%20developers%20and%20regulators_1.pdf [Accessed February 2024]

SNH (2018). Biodiversity Indicator – Abundance of wintering waterbirds. Available from: <https://marine.gov.scot/sma/assessment/abundance-wintering-waterbirds#:~:text=By%202018%2C%20wintering%20numbers%20were,in%20the%20wintering%20waterfowl%20index>. [Accessed February 2024]

Stanbury, A., Eaton, M., Aebischer, N., Balmer, D., Brown, A., Douse, A., Lindley, P., McCulloch, N., Noble, D., and Win I. (2021). The status of our bird populations: the fifth Birds of Conservation Concern in the United Kingdom, Channel Islands and Isle of Man and second IUCN Red List assessment of extinction risk for Great Britain. British Birds 114: 723-747. Available at: <https://britishbirds.co.uk/content/status-our-bird-populations> [Accessed February 2024]

Swann, R.L. and Etheridge, B. (1996). Movements of waders to and from the Moray Firth, Ringing & Migration, 17:2, 111-121, DOI: 10.1080/03078698.1996.9674126

Symonds, F.L., Langslow, D.R. and Pienkowski, M.W. (1984). Geographical origins and movements of shorebirds using the Firth of Forth. Ringing and Migration 5: 145-152.

Tucker, G.M. and Heath M.F. (1994). BirdLife International (Conservation Series No. 3). Cambridge, United Kingdom.

Wetlands International (2015). Waterbird Population Estimates. Available at: wpe.wetlands.org. [Accessed November 2019]

Wetlands International (2021). Waterbird Population Estimates. Available at: wpe.wetlands.org [Accessed July 2023]

Woodward, I., Bray, J., Marchant, J., Austin, J. and Calladine, J. (2015). A review of literature on the qualifying interest species of Special Protection Areas (SPAs) in the Firth of Forth and development related influences. Scottish Natural Heritage Commissioned Report No. 804.

Woodward, I.D., Frost, T.M., Hammond, M.J., and Austin, G.E. (2019). Wetland Bird Survey Alerts 2016/2017: Changes in numbers of wintering waterbirds in the Constituent Countries of the United Kingdom, Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Areas of Special Scientific interest (ASSIs). BTO Research Report 721. BTO, Thetford.

Wright, G.A. (2003). Impact of cormorants on the Loch Leven trout fishery and the effectiveness of shooting as mitigation. In: I.G. Cowx (editor) *Interactions between Fish and Birds: Implications for Management*. Oxford: Fishing News Books, Blackwell Science.

CONSTRUCTION METHODOLOGY REPORT

Document no: B2386100-JEC-S4-XXX-XXX-RE-C0007
Revision no: 9

Falkirk Council
B2386100

Grangemouth Flood Protection Scheme
6 September 2024



CONSTRUCTION METHODOLOGY REPORT

Client name: Falkirk Council
Project name: Grangemouth Flood Protection Scheme
Client reference: B2386100 **Project no:** B2386100
Document no: B2386100-JEC-S4-XXX-XXX-RE-C0007 **Project manager:** Alan McGowan
Revision no: 9 **Prepared by:** Richard Meeson
Date: 6 September 2024 **File name:** B2386100-JEC-S4-XXX-XXX-RE-C0007 – Construction Methodology Report
Doc status: FINAL

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1.0	03/05/2019	Draft for internal report	Adele Jaccon	Richard Meeson	Alan McGowan	Alan McGowan
1.1	13/05/2019	Updated table 1; amended cell names in table 2; updated sections titles on p. 7-14 & 7-15	Adele Jaccon	Richard Meeson	Alan McGowan	Alan McGowan
1.2	20/05/2019	Updated cell names in tables 1 and 2; corrected a few typos	Adele Jaccon	Richard Meeson	Alan McGowan	Alan McGowan
1.3	17/10/2019	Added coastal revetment to table 1, on p. 9 & 10	Adele Jaccon	Richard Meeson	Alan McGowan	Alan McGowan
2.0	13/03/2020	Design Freeze	Adele Jaccon	Richard Meeson	Alan McGowan	Alan McGowan
3.0	11/11/2022	Updated to reflect October 2022 Design	Steven Frater	Adele Jaccon	Richard Meeson	Alan McGowan
4.0	29/11/2022	Added Section – ProjectMapper Layer table	Richard Meeson	Adele Jaccon	Alan McGowan	Alan McGowan
5.0	13/01/2023	Car vehicle estimate amended	Alan McGowan	-	-	Alan McGowan
6.0	19/09/2023	Updated figures for issue of EIAR to statutory consultees	Robert Fergusson	Richard Meeson	Alan McGowan	Alan McGowan
7.0	06/12/2023	Updated following final design	Richard Meeson	Alan McGowan	Alan McGowan	Alan McGowan
8.0	21/03/24	Updated site compounds and flood defence lengths	Richard Meeson	Alan McGowan	Alan McGowan	Alan McGowan

CH2ML

95 Bothwell Street
Glasgow, Scotland G2 7HX
United Kingdom

T +44 (0)141 243 8000
F +44 (0)141 226 3109
www.jacobs.com

Copyright CH2ML © 2025.

All rights reserved. The concepts and information contained in this document are the property of the Jacobs group of companies. Use or copying of this document in whole or in part without the written permission of Jacobs constitutes an infringement of copyright. Jacobs, the Jacobs logo, and all other Jacobs trademarks are the property of Jacobs.

NOTICE: This document has been prepared exclusively for the use and benefit of Jacobs' client. Jacobs accepts no liability or responsibility for any use or reliance upon this document by any third party.

9.0	04/09/2024	Updated Programme, removed section 7.	Richard Meeson	Alan McGowan	Alan McGowan	Alan McGowan

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
3.0	11/11/22	21/11/22	EIA Team	For EAI update
4.0	12/12/22	12/12/22	EIA Team	For EIA update
5.0	13/01/2023	13/01/2023	EIA Team	For EIA Update
6.0	19/09/2023	01/09/2023	EIA Team	For EIA Update
7.0	06/12/23	06/12/2023	EIA Team	For EIA Update
8.0	21/03/24	21/03/24	EIA Team	For finalisation of the EIAR
9.0	05/09/24	06/09/24	HRA Team	For finalisation of the HRA

Contents

Acronyms and abbreviations.....	i
1. Introduction.....	1
1.1 Purpose	1
1.2 Background to the Scheme	1
2. Summary of Construction Areas.....	2
3. Advanced Works	5
3.1 Tree Felling	5
3.2 Service Diversions	5
3.3 Traffic Management Preparatory Works	6
4. Site Compounds	8
5. Construction Access.....	9
5.1 General	9
5.2 Cofferdams	9
5.3 Raised Platforms.....	10
5.4 Crossing Points.....	11
5.5 Dewatering of Excavations	13
5.6 Temporary Culverting a Channel	13
6. Outline Construction Methods.....	14
6.1 General	14
6.2 Embankments.....	16
6.3 Sheet Pile Walls (top of riverbank).....	17
6.4 Reinforced Concrete Cantilevers Walls.....	19
6.5 Bare Sheet Pile	20
6.6 Bare Sheet Pile with granular shoulders	21
6.7 Augured (continuous flight augured) piles.....	22
6.8 Coastal Structures	22
6.9 Ground Improvements.....	26
6.10 New Culverts.....	27
6.11 Riverbank (fluvial) Erosion Protection	27
6.12 Bridge Modification	28
6.13 Bridge Replacement.....	28
6.14 Flow Control Structures	28
6.15 Flood Relief Channel Relining.....	28
6.16 Demolished Structures.....	28
6.17 Other Works to be Undertaken	29
6.18 Access for Construction/Working in the Channel.....	29
7. Impact of Construction Sequence and Timing.....	33
7.1 Sequence/Phasing	33
7.2 Timing	34
7.3 Transport Planning	38

7.4	Contract Constraints	40
7.5	Temporary Flood Protection.....	41
8.	Reinstatement.....	42
8.1	Residential Gardens	42
8.2	Amenity Areas	42
8.3	Roads and Footpaths.....	42
8.4	Existing Structures	42
9.	Recommendations.....	44

Tables

Table 1: Summary of Work Areas

Table 2: Estimated construction durations for work areas

Table 3: Estimates the duration of construction works

Table 4: Estimates HGV construction vehicle movements

Table 5: Estimates car movements

Figures

Figure 1: Example of a cofferdam, White Cart Water FPS, Glasgow, 2009	10
Figure 2: Example of a raised platform	11
Figure 3: Pipe bridge under construction	12
Figure 4: Example of a Bailey bridge in use	13
Figure 5: Schematic of Embankment with steel sheet pile core	16
Figure 6: Schematic of Sheet Pile Wall with reinforced concrete stem (at top of riverbank)	17
Figure 7: Schematic of Reinforced Concrete Cantilever Wall with steel sheet pile seepage cut-off	19
Figure 8A: Bare sheet pile wall	20
Figure 9: Schematic of Bored pile with reinforced concrete stem	22
Figure 10: Location of coastal structures	23
Figure 11: Schematic of rock revetment along the estuary frontage	23
Figure 12: Typical cross-section steel sheet piled wall with capping beam/plate and rock armour revetment	24
Figure 13: Typical cross-section bare steel sheet piled wall with scour protection	25
Figure 14: Typical x-section of the ground improvement work with flood wall and rock revetment	26
Figure 15: Estimated phasing of construction work	33

Acronyms and abbreviations

BCR	Benefit Cost Ratio
RC	Reinforced Concrete
SEPA	Scottish Environment Protection Agency
FC	Falkirk Council
FPS	Flood Protection Scheme

1. Introduction

1.1 Purpose

The purpose of this report is to discuss a possible outline construction methodology for Grangemouth Flood Protection Scheme (FPS). This has been done in the context of risk management with respect to the anticipated social and environmental impacts resulting from the construction process. It is considered necessary to discuss different possibilities at this stage such that the Project Team are comfortable that the outline design could be constructed safely and in a pragmatic and logistical manner.

Notwithstanding this, it is not possible for FC or Jacobs to determine or prescribe exactly which methods of construction the contractor will select, or in which sequence they will construct the works. The contractor will be solely responsible for exercising their experience and professional judgement to construct the works in a manner which complies with the construction contract and all applicable laws and regulations. In doing so, the contractor may choose to use methods not considered or discussed in this report, subject to complying with any constraints imposed through contract specifications and requirements.

This outline construction methodology has been carried out with a view to informing the:

- Scheme application (including scheme cost estimate) under the Flood Risk Management (Scotland) Act 2009;
- Environmental Impact Assessment under the Flood Risk Management (Flood Protection Schemes, Potential Vulnerable Areas and Local Plan Districts) (Scotland) Regulations 2010;
- Habitat Regulations Assessment/ Appropriate Assessment under the Conservation (Natural Habitats & c.) Regulations 1994; and
- CAR application under the Water Environment (Controlled Activities) (Scotland) Regulations 2011.
- Marine Licence, under the Marine (Scotland) Act 2010.

It should be noted the outline design has not been completely finalised, at the time this report was prepared, and some assumptions have had to be made regarding the scheme design.

1.2 Background to the Scheme

Grangemouth is a coastal town located on the Firth of Forth, approximately three miles east of Falkirk. The port of Grangemouth is the largest container terminal in Scotland, and intrinsically linked to the petrochemical plant, which is classified as nationally important infrastructure.

Large parts of Grangemouth are at risk from fluvial and tidal flooding; in late 2011 Falkirk Council instructed Jacobs to undertake a detailed flood risk mapping study. This investigation showed extensive inundation during a 1 in 200-year return period event, for both tidal and fluvial events. This included extensive flooding to the port and petrochemical plant, predominantly caused by elevated water levels in the Firth of Forth caused by high tides, surge events and wave overtopping.

Following the outcome of this study, in 2015 Jacobs were appointed by Falkirk Council to undertake the option appraisal and identify a preferred scheme option which was to be taken forward to the outline design stage for the Grangemouth Flood Protection Scheme.

2. Summary of Construction Areas

The proposed scheme has been divided into six Flood Cells, see Appendix A for plan outlining the six Cells. Each Flood Cell has been sub-divided in Working Areas. The Working Areas are based on form of construction, geographic divisions, source of flooding and sensible breaks within the Flood Cell. It is anticipated that the contractor will develop their programme and sequence of construction based on the Flood Cells or Working Areas. Details are as follows:

Cell no.	Working Areas	Location	Estimated overall length of flood defences in metres	Anticipated Form of Construction
1	1-1	Stirling Road	1611	Formed Concrete Wall, Brick Clad Wall, Seepage Only, Embankment
	1-2	Carron Bridges	1045	Brick Clad Wall, Stone Clad Wall, Stone Clad Wall with Glass Panels, Formed Concrete Wall, Embankment, Replacement Bridge (B902)
	1-3	Chapel Burn	685	Brick Clad Wall, Stone Clad Wall
	1-4	Dock Street	557	Formed Concrete Wall
2	2-1	Forth and Clyde Canal Lock	662	Embankment, Sheet Pile Wall
	2-2	Jarvie Plant/Rossco Properties	840	Sheet Pile Wall
3	3-1	Mouth of the River Carron	920	Sheet Pile Wall & revetment
	3-2	West Coast of the Port	965	Sheet Pile Wall & revetment
	3-3	West Gate to the Port	1167	Sheet Pile Wall & revetment
	3-4	East Gate to the Port	992	Sheet Pile Wall, Plain Concrete Wall, Formed Concrete Wall

CONSTRUCTION METHODOLOGY REPORT

Cell no.	Working Areas	Location	Estimated overall length of flood defences in metres	Anticipated Form of Construction
	3-5	Mouth of the Grange Burn	683	Sheet Pile Wall
4	4-1	Upstream of M9	1078	Stone Clad Wall, Formed Concrete Wall
	4-2	Rannoch Park	559	Formed Concrete Wall
	4-3	Inchyra Road	505	Formed Concrete Wall & Embankment
	4-4	Whole-flats Road	2359	Formed Concrete Wall, Stone clad Wall, Sheet Pile Wall, Raising footway, Embankment, Regrading Existing Embankment, New Bridges
	4-5	Zetland Park	767	Stone Clad Wall & Embankment, Replacement Bridge (Dalratho)
	4-6	Dalratho to Bo'Ness Road	804	Stone Clad Wall
	4-7	Grangeburn Road	1250	Sheet Pile Wall, Stone Clad Wall, Formed Concrete Wall
	4-8	Petroineos	1051	Sheet Pile Wall, Stone Clad Wall
	4-9	Mouth of Grange Burn	1142	Sheet Pile Wall, Seepage Only
5	5-1	Smiddy Brae & Avondale Road	1786	Sheet Pile Wall, Formed Concrete Wall
	5-2	Flare Road & Road 33	1102	Sheet Pile Wall, Seepage Only

CONSTRUCTION METHODOLOGY REPORT

Cell no.	Working Areas	Location	Estimated overall length of flood defences in metres	Anticipated Form of Construction
	5-3	Grangemouth Road	1675	Sheet Pile Wall
	5-4	Mouth of the River Avon	438	Sheet Pile Wall, revetment
6	6-1 & 6-2	West of River Avon (Beach Road & Mouth of River Avon)	2166	Sheet Pile Wall, Bored Pile Wall with revetment
	6-3 & 6-4	East of River Avon (Chemical Works at River Avon & Chemical Works)	1422	Sheet Pile Wall & Embankment

Table 1 Summary of work areas

Summary of work areas (note that the above lengths have been rounded up or down and may vary slightly).

3. Advanced Works

The following section covers work which may be carried out in advance of the main works contract. This may be done also to reduce the risk of delay to the main works, provide greater certainty of cost, or reallocate activities which are more suited to specialist contractors.

It is considered unlikely that enabling works carried out in advance of the main works contract will require working within the watercourse. Where utility services cross bridges that are to be modified as part of the works, it is likely that the associated services will be diverted onto temporary support structures during the main works contract.

3.1 Tree Felling

The banks of the River Carron, River Avon, the Grange Burn, the Flood Relief Channel and parts of the Westquarter and Polmont Burns contain many trees. Most of these are self-seeded, and elsewhere, cultivated trees line sections of road and parkland. Both types of tree present an obstacle for construction of the flood defences, and several of them will have to be removed in their entirety (including stumps) to enable access and for the works to be constructed.

There are two possible approaches to tree felling which mitigate different risks to the project:

- The first approach would be to carry out tree felling in advance of the main works. This would enable trees to be felled outside the bird nesting season, therefore mitigating the risk of delay if trees identified for removal were found to contain nesting birds. However, this would likely have to be done prior to a main works contractor being appointed and might therefore result in more trees being felled than necessary, or trees being felled years in advance of works taking place, which may result in adverse public reaction.
- The second approach would be to make the main works contractor responsible for tree felling. This would reduce the number of trees felled to only those that the contractor needs to be removed. However, the contractor's construction programme may preclude all trees from being felled outside the bird nesting season, thereby increasing the risk of delay to the scheme's construction programme.

Further discussion is required to establish Falkirk Council's preferred approach to tree felling with a final decision unlikely to be made until they commence procurement of contractors which could be several years away. If trees are to be retained for as long as possible, and the number felled to be minimized, then tree felling should be included in the overall construction scope of works. It should be noted that due to the spatial extent and size of the project, it is likely that construction works will be spread over multiple breeding bird seasons.

A large number of trees in Cell 4 along the north side of Rannoch Park and along Grangeburn Road have been identified as suffering from Ash dieback disease and may need to be felled in advance of the Scheme proceeding, depending on the condition of the trees and the safety concerns this may pose to the public and property.

3.2 Service Diversions

Grangemouth contains numerous buried services (electricity, gas, telecommunications, water, waste, oil, etc.), as well as overhead services (telecommunications, electricity and lighting). Many of these present an obstacle for construction of the flood defences, as they either clash with, or are close to the works. Each statutory undertaker has been consulted to determine which services can be diverted and which will have to be protected.

Experience indicates that the diversion of services is a complex and lengthy process. The process is normally regulated under the New Roads and Streetworks Act 1991, but there is no provision for enforcing diversions to be completed within a specific time. If diversion works were included within the scope for the main works contract, the contractor could be delayed from carrying out their work caused by the service providers, and this is considered a likely scenario which would result in a risk of unacceptably high additional costs and delay.

Planning and carrying out the service diversions in advance would mitigate the risk of delays to the construction programme. Engaging a single contractor to carry out the preparatory pipe and duct laying for all the service providers would also minimise the number of occasions the road was excavated and therefore minimise the impact to the public. This approach generally worked well for the Selkirk and Hawick flood protection schemes although there still remains a risk of identifying uncharted services during the main construction works.

It is preferable to carry out service diversions as advance works with a single contractor, where possible, carrying out all preparatory pipe and duct laying with the final connections undertaken by each statutory undertaker. Such works will develop into a sizeable project in its own right and will require adequate staff to manage, co-ordinate and supervise, along with a contractor who is suitably experienced in coordinating the separate service providers. It is likely that street lighting diversion works will be undertaken as part of the main works contract.

There are a considerable number of above ground and buried pipelines within the Grangemouth area generally associated with the petrochemical works/ refinery and are privately owned by companies such as Ineos, Shell, BOC etc. Discussions with pipeline owners are ongoing, however, it is unlikely that many of these pipelines will be diverted due to the products transported by the pipeline, therefore it is likely that work to protect pipelines during the construction phase will be required. This work is likely to form part of the main scheme work contracts.

3.3 Traffic Management Preparatory Works

It is likely that temporary road closures and partial closures will be required for some of the construction works. For the diversion route to work effectively it may be necessary to provide temporary signalised priority at some locations and/ or implement one way operation and suspension of parking. It may also be necessary to provide additional pedestrian crossings and/or traffic management measures. This will be investigated further as part of a more comprehensive traffic management plan which would be prepared at the detailed design stage.

The sections below outline a cell-by-cell basis some of the required traffic management.

3.3.1 Cell 1

- Partial road closure of Stirling Road.
- Some footpath closures around the Carron Bridges, within the community woodland and by the Chapel Burn will be required.
- Temporary road closure of B902 for new bridge construction, traffic diverted via Stenhouse Road.

3.3.2 Cell 2

- Construction works are setback from the road on private land. A temporary closure of the Charlotte Dundas public footpath would be required.

3.3.3 Cell 3

- Partial road closure of South and North Shore Road would be required, any traffic management on Forth Ports land will need to be agreed with Forth Ports.

3.3.4 Cell 4

- Partial closure of Abbots Road, Grange Burn Road, Park Road and South Shore Road is required. This temporary closure will need to move with the construction works. Construction work will have to be sequenced to avoid Abbots Road, Grangeburn Road, South Shore Road and Park Road being closed at the same time. Pedestrian access will always be maintained in this cell.
- Partial closure of Wholeflats Road
- Work to Dalratho and Bo'ness bridges is required and would impact roads in the surrounding area.

- Work to multiple foot bridges on the Grange Burn and the flood relief channel.
- Traffic Management on the A9 and Grandsable Road at Beancross.
- Traffic Management on Smiddy Brae and Reddoch Road.

3.3.5 Cell 5

- Most of the construction work for this cell is on private land. Access to the construction works area will be required from Wholeflats Road and Bo'ness Road. To ensure safe access to the site from both these roads, temporary road works may be required to construct construction site access points.
- Partial closure of Wholeflats Road

3.3.6 Cell 6

- All construction works will take place on private / Falkirk Council owned land. Access for construction works will be taken from Wholeflats Road.

4. Site Compounds

Site compounds are necessary for the contractor to accommodate the facilities needed to construct the works. Ideally a main site compound would be located centrally and close to the construction works, and would comprise of offices, welfare facilities, parking, and space for storage of materials and equipment. Additional smaller satellite compounds would be advantageous, providing localised welfare facilities and storage for materials and equipment.

There are few unoccupied open areas in Grangemouth which lend themselves for use as site compounds. Possible sites include parks, car parks, brown field sites and disused buildings. Appendix C outlines locations the project team have identified as possible site compounds and main access routes. Subject to a contractor being appointed the exact location of site compounds is to be confirmed.

The locations outlined in Appendix C are not sequential, 4-C and 6-A have been omitted. The list of site compounds is as follows:

- Flood Cell 1: 1-A, 1-B
- Flood Cell 2: 2-B,
- Flood Cell 3: 3-A, 3-B
- Flood Cell 4: 4-A, 4-B, 4-D
- Flood Cell 5: 5-A, 5-B, 5-C
- Flood Cell 6: 6-B

5. Construction Access

5.1 General

As described in the introduction, many of the proposed work areas are difficult to access. This is due to the proximity of buildings, roads and other infrastructure to the riverbanks. Working from within the watercourse is a possible solution but it presents its own challenges.

Due to environmental and health and safety issues, construction plant cannot operate directly in the watercourse. Dry working areas are required to enable the works to be constructed safely, protect the equipment from water damage and to protect the watercourse from pollution. This can be achieved by forming temporary cofferdams to exclude water or raised platforms (typically formed from rock) which are above the 'normal' water level.

The use of such temporary working areas must be carefully planned and executed since they can affect the conveyance of the watercourse and increase flood risk. Narrowing the channel will result in river water levels which are higher and more sensitive to low return period rainfall events and the narrowing could lead to increased erosion and scour damage. Platforms which are set too low will be frequently inundated resulting in construction work stopping, and those set too high will have an unacceptable impact on river levels and flood risk. When the exact construction sequence is confirmed, further hydraulic modelling will be undertaken to determine the impact of the temporary works on water levels/ velocities and mitigation developed.

The position and extent of such working areas can also have an ecological impact. Disturbing the riverbed material during salmon spawning season is prohibited under legislation. Even when lawfully constructed outside this season, the position of working areas may affect the viability of habitats when spawning begins due to change in the normal river flow regime.

The design and implementation of temporary works, which includes construction access, will be the sole responsibility of the contractor. It will be for the contractor to propose temporary works as part of their method statements, which will then be submitted to the employer's representative for review and acceptance. These proposals would include measures to be taken (e.g. temporary flood defences) to mitigate any adverse impacts with the aim of ensuring there is no increase in flood risk. The purpose of the following sections is to discuss the advantages and disadvantages of different forms of temporary works and how these might affect the design of the flood defences and preparation of scheme documentation.

Appendix C outlines the possible site compounds.

5.2 Cofferdams

A cofferdam is a temporary structure, constructed around a working area to exclude water, and is normally formed with sheet piles. The effectiveness of this form of construction depends on the ability to make the cofferdam watertight. Water may enter the cofferdam either through the clutches between the piles, by seeping up through the underlying soils, or by overtopping the sheet piles.

The clutches of the sheet piles can be made mostly watertight by sealing them with wadding or welding them together. This is less common for temporary structures however, and it may be practical to pump out water which does seep through. This can be achieved with a trench which drains to a sump containing a submersible pump.

Where the underlying soil is permeable, the differential water pressure across the cofferdam may cause ground water to seep up through the bottom of the working area. This can be managed to some extent with over-pumping, described above. If the soil is very permeable however, the pumps may be unable to cope with the flow of water entering the working area. In addition, the pumped water will not be permitted to be discharged straight into the river, it will need to be filtered or settled out prior to discharge to reduce the pollution risk.

Ground investigation work is currently ongoing in Grangemouth, once this has been complete the project team will have a better understanding of underlying soil.



Figure 1: Example of a cofferdam, White Cart Water FPS, Glasgow, 2009

5.3 Raised Platforms

As an alternative to a cofferdam, a working area could also be formed in the watercourse by constructing a raised platform. This would occupy the same space as a cofferdam but would be raised above the water level and formed with crushed granular aggregate. The effectiveness of this form of construction depends on limiting the frequency of inundation and resisting erosion damage from the watercourse.

The level of the platform must be selected such that work can progress without regular interruption from rising river levels. However, narrowing the watercourse will make river level more sensitive to changes in flow, and therefore rise more quickly. Raising the platform further to compensate may have the effect of increasing flood risk because of reducing channel capacity. The platform must therefore be high enough to provide the contractor with a reasonable ability to work during typical conditions and wide enough to provide safe passage of construction vehicles and their operators.

Operating criteria are needed to establish optimal extents for such platforms. It must be wide enough to accommodate the largest plant (with space for manoeuvring), and high enough to limit inundation to an acceptable frequency. A piling rig could require 5-9 metres width in which to manoeuvre, and a platform level of c.1-1.5 metres above riverbed level (this will be confirmed during the detailed design stage and may change) could limit inundation to a tolerable frequency of once or twice per month during wet periods.

It is considered reasonable to assume that platforms would be constructed of clean crushed rock approximately 75-150mm in size placed on a separation geotextile and surrounded with sand-filled bulk bags. This was demonstrated to be effective at resisting erosion on previous projects such as White Cart Water FPS, pictured below.

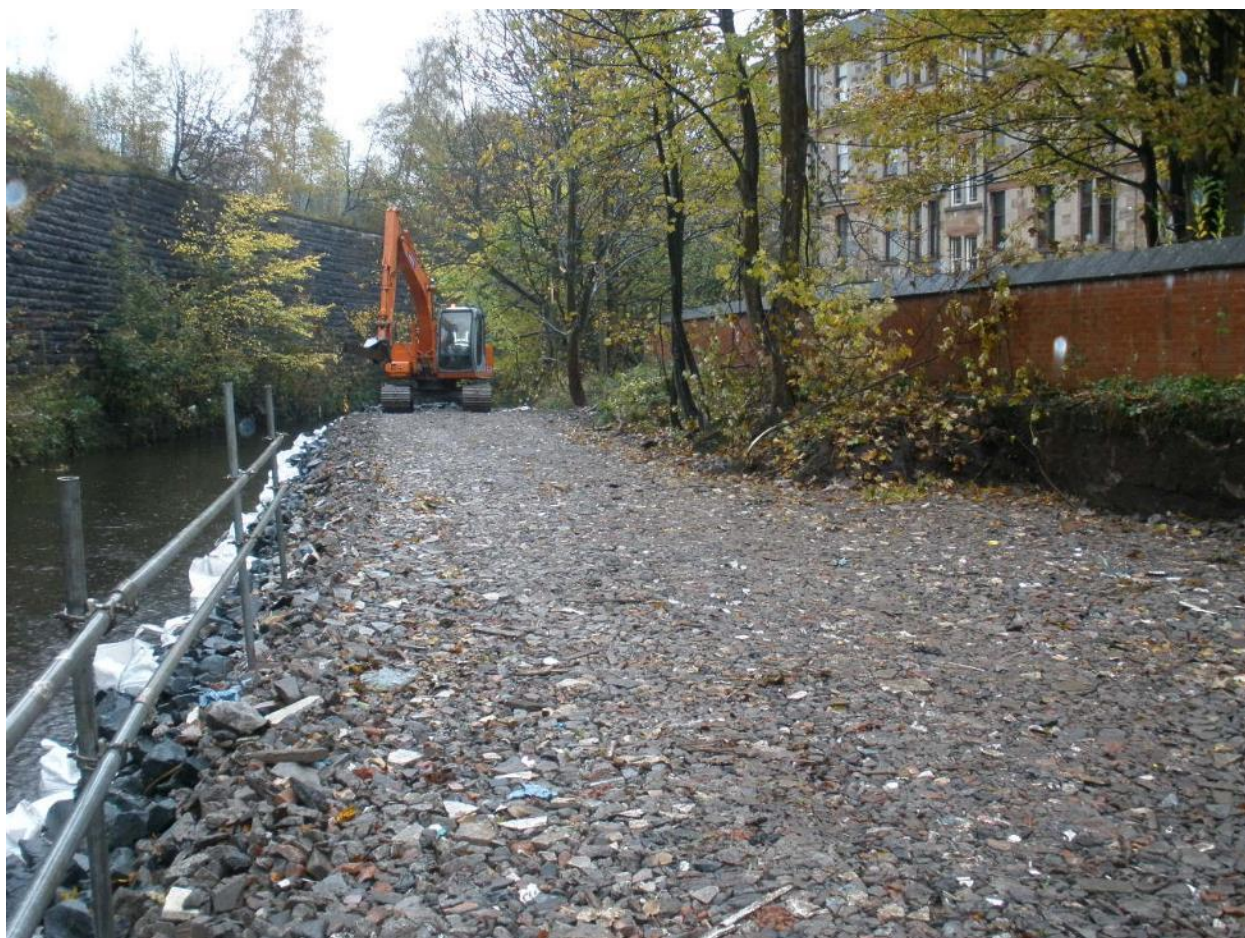


Figure 2: Example of a raised platform

Fish rescue may be required during installation of the temporary raised platforms in the watercourse, and after inundation events. The contractor will be required to develop an appropriate procedure for this as part of their method statements.

5.4 Crossing Points

Working areas in the watercourse would likely be parallel to the alignment of the flood defences. Access would be from the adjacent riverbank, except where this was not possible due to the presence of buildings or other barriers. In this event, crossing points would be required to access the working area from the opposite riverbank, and would most likely be formed from either:

- A pipe / flume bridge;
- A Bailey bridge; or
- Tracking directly across

Temporary works carried out in the River Teviot (Hawick) during September 2016 provided evidence of how a pipe crossing might perform under moderate flow conditions. A pipe bridge was constructed during low flow conditions, and comprised multiple concrete pipes of varying sizes, surrounded in 25-40 millimetre diameter aggregate. The river level rose in response to a rainfall event, exceeding the capacity of the pipes and engulfing the working area. Prolonged high river levels washed out the aggregate and washed the pipes downstream.

This suggests that the effectiveness of pipes bridges is largely dependent on the materials used and construction. They may be unsuitable during prolonged wet periods and depending on the nature of their construction, could result in increased flood risk.

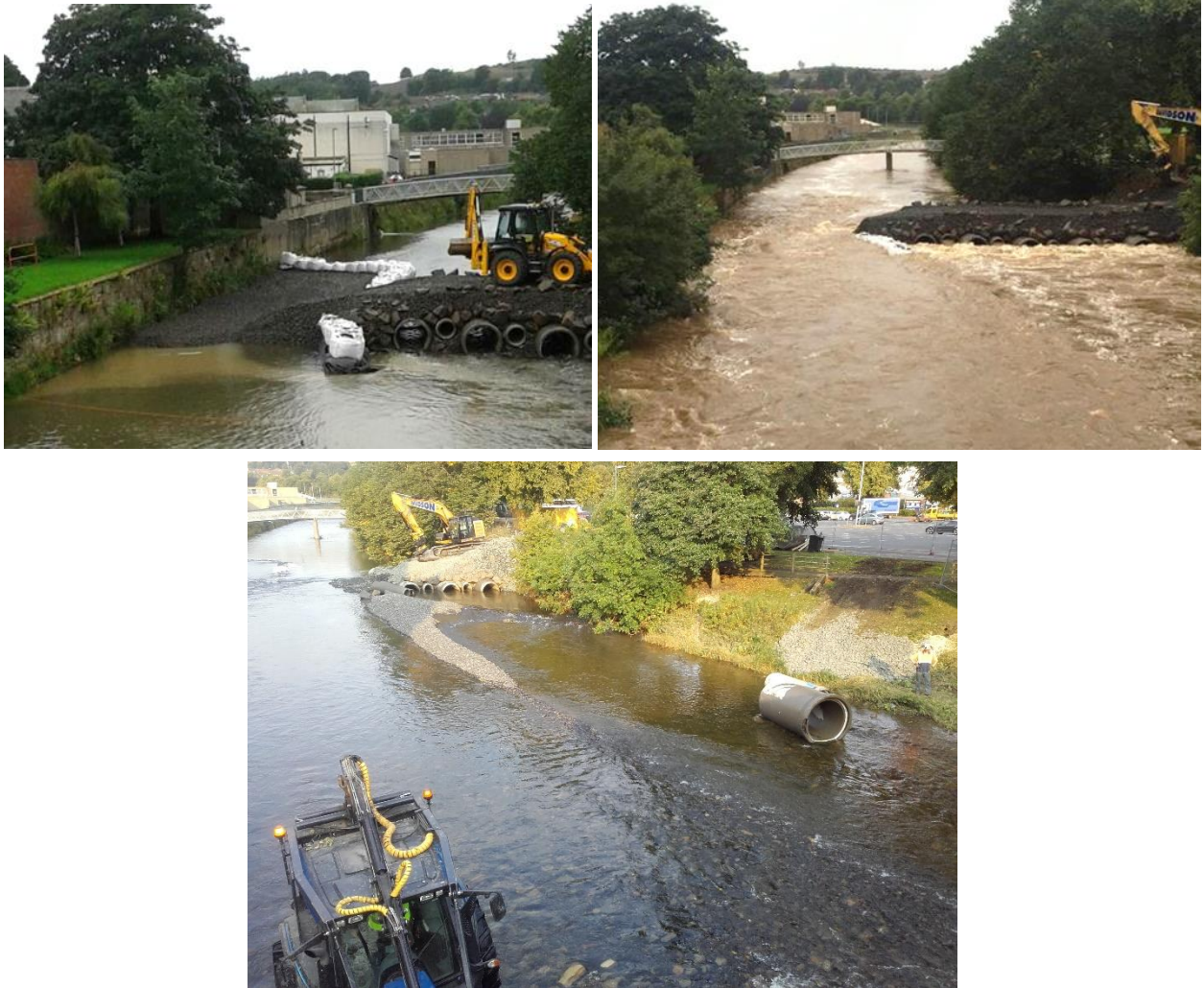


Figure 3: Pipe bridge under construction

A Bailey bridge can take several forms, but generally comprises a portable, modular deck supported on temporary abutments. This may be a more expensive solution than a pipe bridge, but it has advantages. The Bailey bridge presents less restriction to the flow of the watercourse and the deck can be more easily removed in the event of a flood alert.



Figure 4: Example of a Bailey bridge in use

The final option of tracking directly over the river bed presents the least impact to the flow of the watercourse. It is however most susceptible to rising water levels and would quickly become impassible. It would also impact ecological habitats on the riverbed, with work restricted during certain times of the year. For these reasons, this option was deemed unsuitable and not considered further.

5.5 Dewatering of Excavations

Where working within the watercourse is required, it is considered unlikely that dewatering techniques would be used, and that they would be largely ineffective if attempted.

Notwithstanding this, the contractor will be entitled to design their temporary works as they consider appropriate subject to any constraints imposed through the construction contract and or by licencing authorities. If the contractor chooses to use dewatering as part of their temporary works, they will be responsible for complying with SEPA's relevant General Binding Rules (GBRs), and for securing a license where necessary.

5.6 Temporary Culverting a Channel

As some of the watercourses and tributaries within in the scheme works are relatively narrow, it may be feasible to temporary culvert short lengths of the channel. This would allow a temporary working area to be create directly over the channel and facilitate access to construct flood defences, which would otherwise require significant working areas within the gardens of residential properties or require significant temporary works on the existing banks to divert the channel or over pump water. Once each section of flood defence is complete, the culverted section of the channel would be reverted to an open channel (current condition). If temporary culverting the waters courses is undertaken, the culvert capacity should be sufficient to pass at least a nominal flow determined by the project team and agreed with SEPA, and appropriate method statements should outline the procedure which is to be followed in the event of high flows, which may require the culvert to be removed or over pumping to take place.

6. Outline Construction Methods

The following section outlines possible construction methods for the main forms of construction that are likely to form part of the Grangemouth FPS. These methods are based on experience of similar construction activities which formed part of White Cart Water FPS, Broxburn FPS, Jedburgh (Skiprunning Burn) FPS, Selkirk and Hawick FPS from 2008 to present.

The form of construction for each work section was based on several factors, including cost, speed of construction, appearance, ground conditions, site access, and adjacent buildings. As the outline design is yet to be complete and a preferred scheme report prepared, several assumptions have had to be made.

It should be noted that while outline construction methods are provided, the actual construction method may vary. This is because the contractor will be responsible for selecting the most appropriate construction method in accordance with their contractual and regulatory obligations. As part of these obligations, they will also be required to submit detailed method statements for each construction activity to SEPA, Marine Scotland, Falkirk Council and Jacobs for acceptance prior to the activity being carried out.

The contractor will be required to prepare several management plans and method statements for carrying out the works. For example, the contractor will be required to prepare a Site Waste Management Plan, which will contain details of how different waste will be handled in accordance with the waste hierarchy and regulatory requirements. Also, as part of their method statements, the contractor will be required to propose appropriate methods for managing sedimentation risk during their construction works.

It is worth noting that in the maps provided for the EIA report, the term "Flood Gates: Ground Raising" is used in the map key. Ground raising refers to raising the existing ground level by <0.5m. The raised ground may be surfaced with a material to allow a footpath or vehicular access. Where required some surrounding ground may need to be re-landscaped to suit the new ground level.

6.1 General

6.1.1 Site Preparation

- Clear site of vegetation and fell trees, as necessary, which were not already removed during advance tree felling works.
- Locate/protect/divert, as necessary, any services which were not already dealt with during advance service diversion works. This includes individual connections to business and residential properties, and outfalls to the watercourse.
- Remove street furniture, fencing and walls as necessary. Steel items may be removed by burning or cutting through foundations. Concrete and timber items may be removed manually or with mechanical excavator. Precautions will be taken to prevent debris entering the watercourse and waste arising will be disposed of off-site.
- Excavate bound surfaces, as necessary, to carry out the works.
- Apply measures as necessary to minimise suspended solids, sediment, and contamination being released into the watercourse. This forms part of the contractor's temporary works and may include attenuation lagoons and settlement tanks to manage runoff.
- Strip topsoil using a mechanical excavator and store on site for later re-use on site where possible. Where topsoil is unacceptable for re-use on site, it will be disposed of off-site.
- Excavate to formation level using mechanical excavator and store arisings on site for later re-use on site where possible. Where arisings are unacceptable for re-use on site, they will be disposed of off-site.
- Formation to be inspected and soft spots excavated and replaced with structural upfill. Arisings will be disposed of off-site if they cannot be re-used.

6.1.2 Equipment and Materials

The following list provides an indication of the likely equipment which may be used to construct the flood protection scheme:

- 360 degree tracked excavators
- Wheeled excavators
- Dumpers
- Mobile cranes
- Tracked / Non-Tracked piling equipment
- Vibrating roller compactors
- Vibrating plate compactors
- Concrete cutting equipment
- Concrete pumps and skips and vibrating pokers
- Burning and steel cutting and welding equipment
- Drilling and coring equipment
- Mobile pumps
- Mobile settlement tanks
- Mobile generators
- Mobile compressors
- Mobile heaters
- Tarmac planers and pavers

The following list provides an indication of the likely materials which may be used to construct the flood protection scheme:

- Cohesive, low permeability fill
- Granular fill (Sands, gravels, and rock~)
- Rock armour stone
- Topsoil
- Steel sheet piles
- Precast concrete piles
- Mass and reinforced concrete
- Geotextiles
- Timber fencing
- Metal fencing
- Bitumen macadam
- Plastic pipework and ductwork

- Metal pipework
- Concrete pipework
- Mechanical/ electrical pumps
- Stonework, brickwork, and reconstituted stone products
- Precast concrete products
- Glass products
- Metal and plastic fixings and fixtures
- Hydrocarbon-based cellular products
- Organic-based coatings and sealants
- Paints, coatings, and sealants
- Lighting, wiring and fixtures
- Fuel oils
- Seeds, trees and plants
- Steel gates (flood gates and lock gates)
- Soil mixing additive (for example this could be cement, lime or pulverised fly ash)

6.2 Embankments

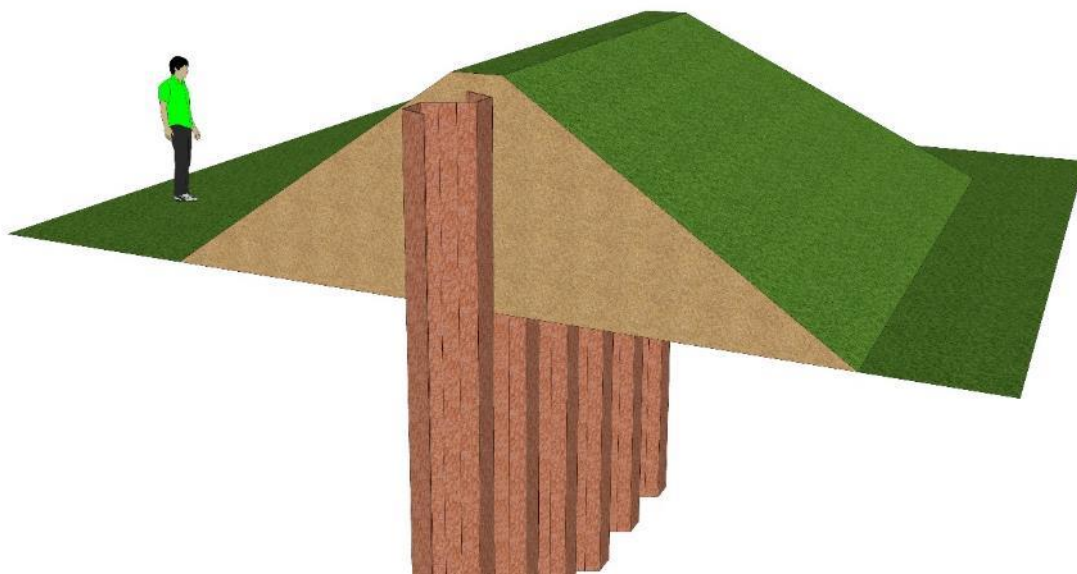


Figure 5: Schematic of Embankment with steel sheet pile core

- Where a sheet pile core is specified, excavate a leader trench to a depth of approximately 1 metre below existing ground level along the centre line of the proposed structure (if required). Pre-auger where necessary, and drive sheet piling to the required toe depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.
- Lay flood defence drainage where required, which may comprise filter pipes in a granular trench, gully pots, gratings, precast concrete or plastic manholes, carrier pipes, headwall structures and flap

valves. Cut openings in sheet piling as required to accommodate pipework or stop piles either side of existing pipes/ cables that cross the defence. Cap pipework until such time as it is fully connected.

- Place material separation geotextile across the extent of the excavation profile and fix to the underlying soil.
- Where required, place anti-burrowing geotextile across the extent of the excavation profile and provide sufficient material to wrap the entire surface of the embankment once placed.
- Place, compact and trim embankment fill material in layers and to the profiles shown on the drawings.
- Where a crest path is proposed, lay precast concrete edging on the crest to the widths shown on the drawings and secure with concrete haunching. Place and compact granular sub-base. Place bitumen-based binder course. Place asphalt surface course, add stone chips and roll to achieve an appropriate surface finish.
- Place and trim topsoil to the faces of the embankment, and seed with an appropriate grass and/ or wildflower mix.
- Place erosion protection geotextile on the faces of the embankment, overlapping the sheets, fix to the underlying embankment, and secure ends within anchor trenches at the toe and crest.
- Reinstate surrounding disturbed areas with topsoil and seed with an appropriate grass and wildflower mix.

6.3 Sheet Pile Walls (top of riverbank)



Figure 6: Schematic of Sheet Pile Wall with reinforced concrete stem (at top of riverbank)

- Excavate a leader trench to a depth of approximately 1 metre below existing ground level along the centreline of the proposed structure (if required). Pre-auger where necessary, and drive sheet piling to the required toe depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.

- Cut openings in sheet piling as required to accommodate existing and proposed outfall pipework. Form box-outs prior to concreting works.
- Pour blinding concrete within trench.
- Fix steel reinforcement and formwork for in situ concrete pile cap. Pour concrete pile cap and cure. Strike formwork, setting aside materials for re-use, and dispose of waste arisings off-site.
- Fix steel reinforcement and formwork for in situ concrete wall stem. Pour concrete wall stem and cure. Strike formwork, setting aside materials for re-use, and dispose of waste arisings off-site.
- Excavate further as required and lay flood defence drainage, which may comprise filter pipes in a granular trench, gully pots, gratings, precast concrete or plastic manholes, carrier pipes, headwall structures and flap valves. Cap pipework until such time as it is fully connected.
- Backfill flood defence wall and drainage with structural backfill.
- Where glazing is specified, post-drill holes for mechanical fixing. Insert glazing panels in the openings in the wall and secure to the concrete with mechanical fixings. Apply sealant around the edges of the glazing panel to provide a watertight seal with the surrounding wall.
- Where stone cladding is specified, fix individual masonry or prefabricated panels to face of wall with appropriate adhesive and point mortar beds. Lay mortar bed along top of wall and affix stone copes.
- Where there is a riverbank in front of the flood fence wall, reinstate riverbank using appropriate remediated recycled excavated material were available, or appropriate imported material where not available. Place and trim topsoil to the face of the riverbank, and seed with an appropriate grass and wildflower mix.
- Place erosion protection geotextile on the face of the riverbank, overlapping the sheets, fix to the underlying soil, and secure ends within anchor trenches at the toe and crest.
- Where rip rap is specified, place rock at the toe of the flood defence, ensuring sufficient interlocking occurs.
- Where a footpath is specified, lay precast concrete edging to the widths shown on the drawings and secure with concrete haunching. Place and compact granular sub base. Place bitumen-based binder course. Place asphalt surface course, add stone chips and roll to achieve an appropriate surface finish.
- Where a road is specified, lay precast concrete kerbs to the widths shown on the drawings and secure with concrete haunching. Place and compact granular sub base. Place bitumen-based binder course. Place asphalt surface course, add stone chips and roll to achieve an appropriate surface finish.

6.4 Reinforced Concrete Cantilevers Walls

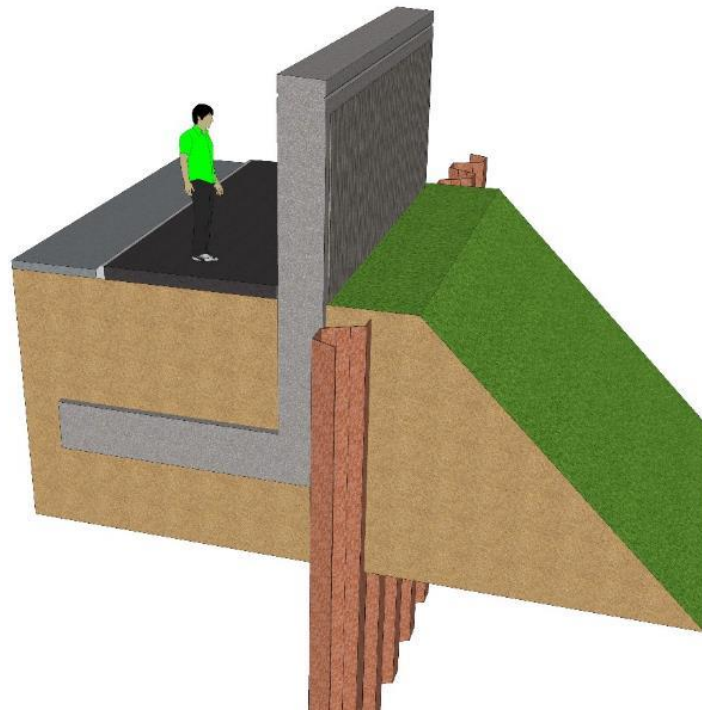


Figure 7: Schematic of Reinforced Concrete Cantilever Wall with steel sheet pile seepage cut-off

- Where a seepage cut-off is specified excavate a leader trench to a depth of approximately 1 metre below existing ground level along the centerline of the proposed seepage protection (if required). Pre-auger where necessary, and drive sheet piling to the required toe depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.
- Cut top of piles to the level shown on the drawings, ensuring that when the leader trench is backfilled, the top of the sheet piling will be buried.
- Cut openings in sheet piling as required to accommodate existing and proposed outfall pipework. Form box-outs prior to concreting works.
- Excavate down the dry side of the sheet piling, to formation level of the in situ concrete works, ensuring a safe excavate profile based on the ground conditions encountered.
- Pour blinding concrete within excavation.
- Fix steel reinforcement and formwork for in situ concrete **wall base**. Sheet pile seepage cutoff will form the rear formwork for the concrete. Pour concrete wall base and cure. Strike formwork, setting aside materials for re-use, and dispose of waste arisings off-site.
- Fix steel reinforcement and formwork for in situ concrete **wall stem**. Pour concrete wall stem and cure. Strike formwork, setting aside materials for re-use, and dispose of waste arisings off-site.
- Lay flood defence drainage, which may comprise filter pipes in a granular trench, gully pots, gratings, precast concrete or plastic manholes, carrier pipes, headwall structures and flap valves. Cap pipework until such time as it is fully connected.
- Backfill flood defence wall and drainage with structural backfill. Backfill seepage cutoff leader trench.
- Where glazing is specified, post-drill holes for mechanical fixing. Insert glazing panels in the openings in the wall and secure to the concrete with mechanical fixings. Apply sealant around the edges of the glazing panel to provide a watertight seal with the surrounding wall.

- Where stone cladding is specified, fix individual masonry or prefabricated panels to face of wall with appropriate adhesive and point mortar beds. Lay mortar bed along top of wall and affix stone copes.
- Where there is a riverbank in front of the flood fence wall, reinstate riverbank using appropriate remediated recycled excavated material where available, or appropriate imported material where not available. Place and trim topsoil to the face of the riverbank, and seed with an appropriate grass and wildflower mix.
- Place erosion protection geotextile on the face of the riverbank, overlapping the sheets, fix to the underlying soil, and secure ends within anchor trenches at the toe and crest.
- Where rip rap is specified, place rock at the toe of the flood defence, ensuring sufficient interlocking occurs.
- Where a footpath is specified, lay precast concrete edging to the widths shown on the drawings and secure with concrete haunching. Place and compact granular sub base. Place bitumen-based binder course. Place asphalt surface course, add stone chips and roll to achieve an appropriate surface finish.
- Where a road is specified, lay precast concrete kerbs to the widths shown on the drawings and secure with concrete haunching. Place and compact granular sub base. Place bitumen-based binder course. Place asphalt surface course, add stone chips and roll to achieve an appropriate surface finish.

6.5 Bare Sheet Pile

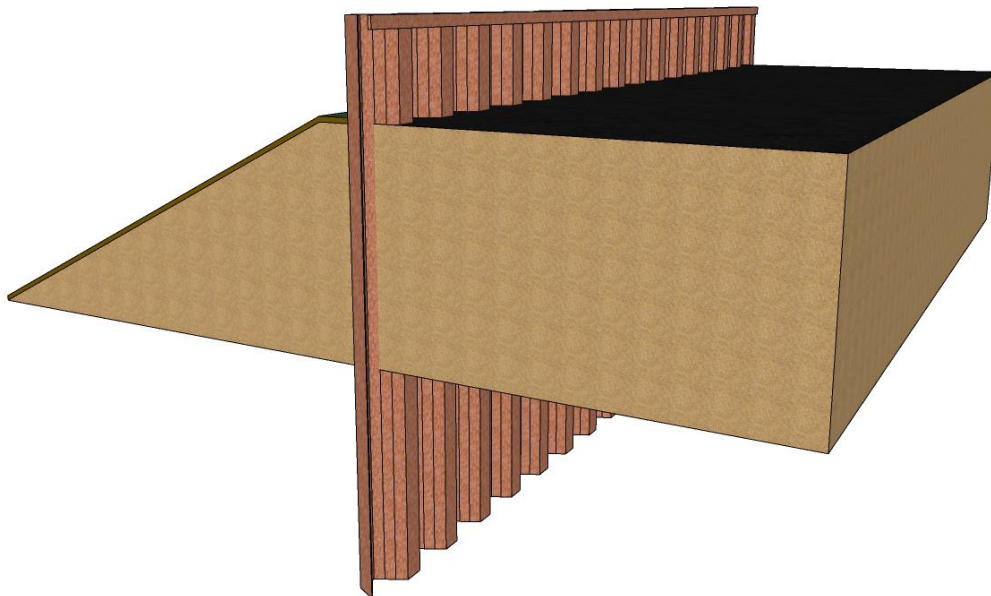


Figure 8A: Bare sheet pile wall

- Pre-auger where necessary, and drive sheet piles to the required depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.
- Weld pile clutches above ground/ clutch sealant installed prior to driving
- Weld a flat steel plate to the top of the piles

6.6 Bare Sheet Pile with granular shoulders

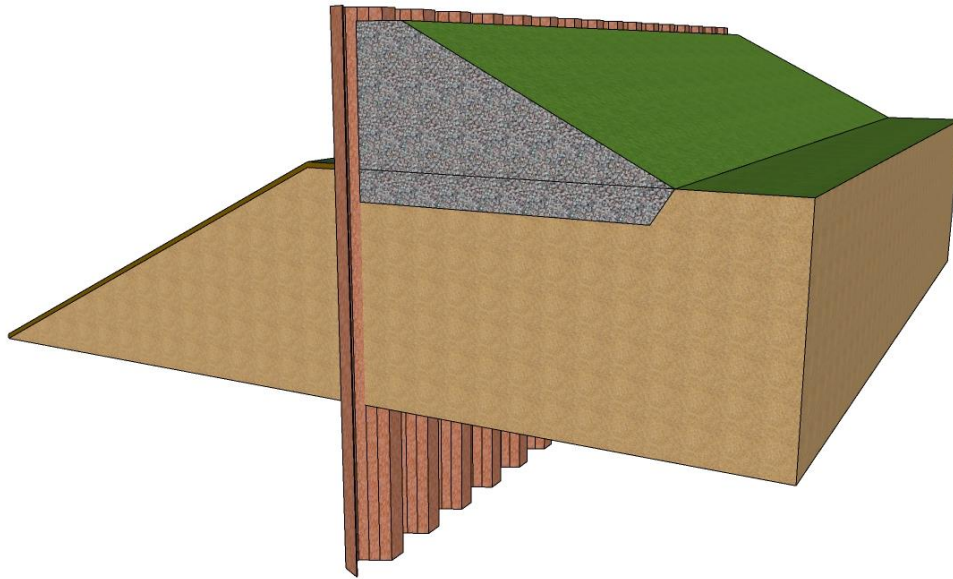


Figure 8B: Bare sheet pile wall with granular shoulder fill

- Pre-auger where necessary, and drive sheet piling to the required toe depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.
- Weld pile clutches
- Place material separation geotextile across the extent of the excavation profile and fix to the underlying soil.
- Place, compact and trim embankment fill material in layers and to the required profile.

6.7 Augured (continuous flight augured) piles

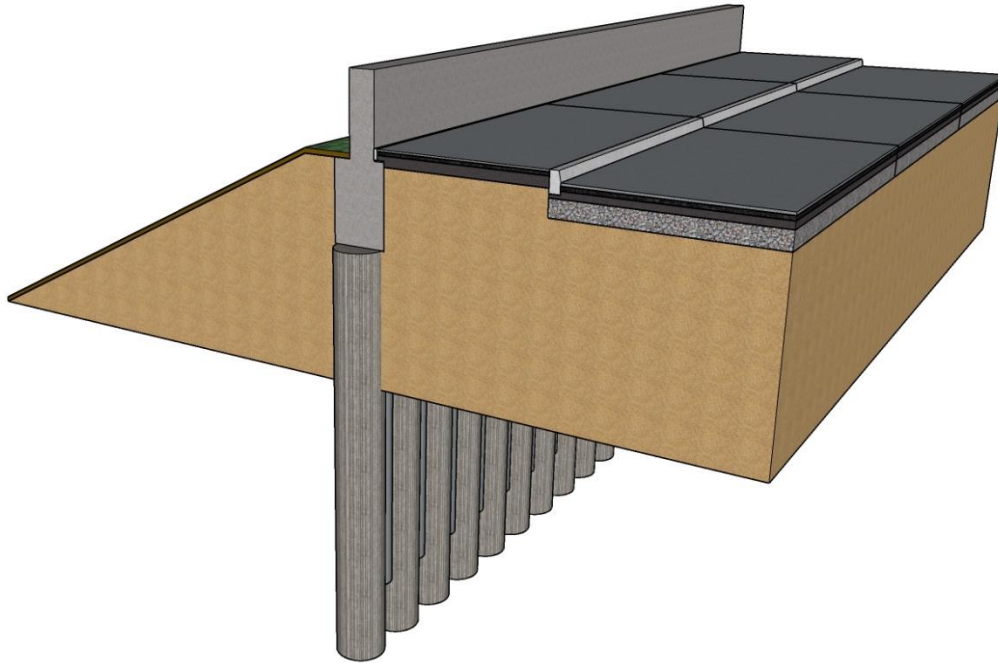


Figure 9: Schematic of Bored pile with reinforced concrete stem

- Install any formwork, or pre-made mould/pile guide, this may require formwork to be erected and concrete poured.
- Auger (drill) into the ground to the required depth.
- Pump concrete into the hole through auger and withdraw auger as hole is being filled.
- Install reinforcement, with started bars exposed to connect to wall stem
- Place steel reinforcement for wall stem
- Erect wall stem formwork and pour concrete
- Remove wall stem formwork

6.8 Coastal Structures

Three types of coastal defence structures have been designed, to protect against coastal erosion/scour and wave action. Figure 10, outlines the location of the three defence structures.

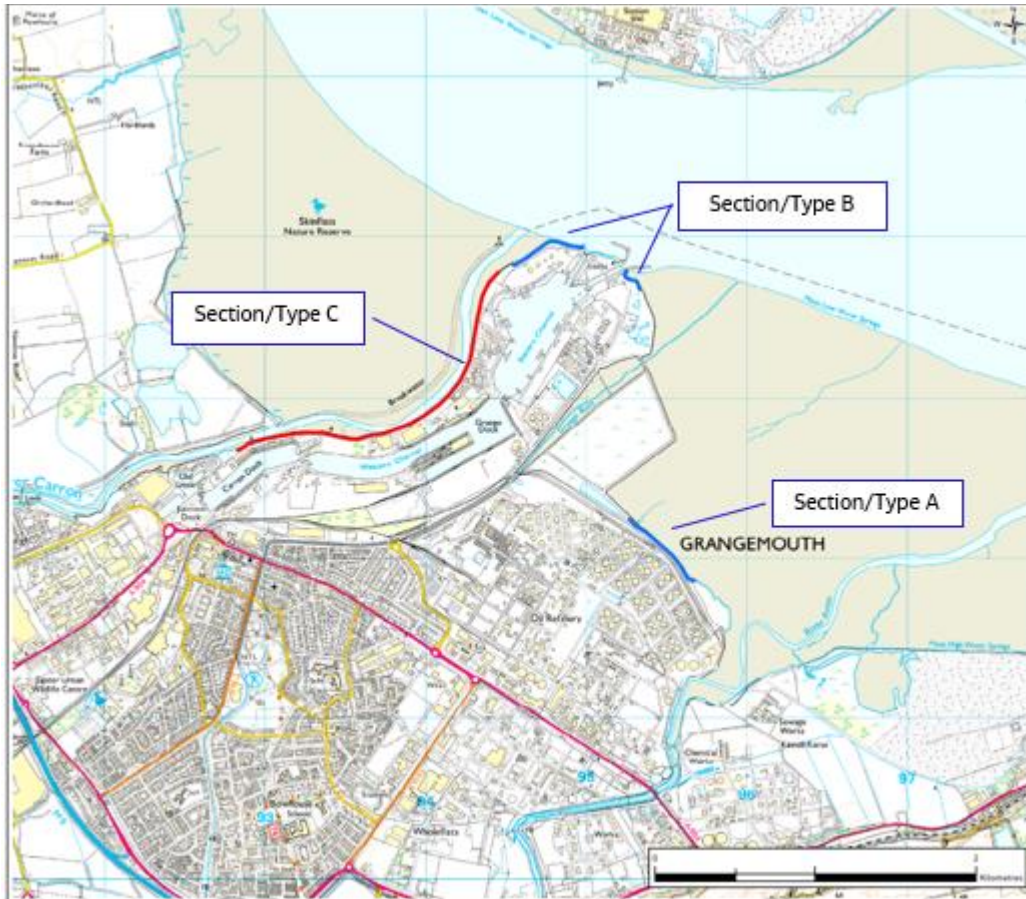


Figure 10: Location of coastal structures

6.8.1 Rock Revetment with a flood wall along the estuary frontage (Section /Type A)

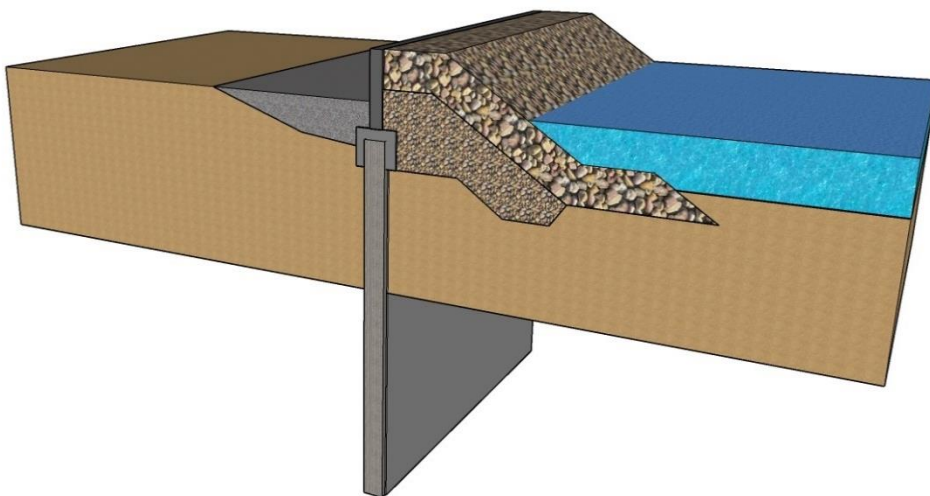


Figure 11: Schematic of rock revetment along the estuary frontage

The text below only relates to the construction of the rock revetment. Section 7.6 will describe the ground improvements and wall construction.

- Install temporary access road/platform through ground improvement work see section 7.6.
- Break out and remove any improved ground, where necessary.
- Install a geotextile on top of the improved ground, and ensure the ends sufficiently bedded in.
- Install riprap underlay stone.
- Install rock armour stone on top of the riprap, in two layers with stones interlocked.
- All work would be constructed from the dry side of the wall, with the bored pile installed prior to installation of the revetment.

6.8.2 Rock Revetment with flood wall adjacent to the harbour entrance (Section/Type B)

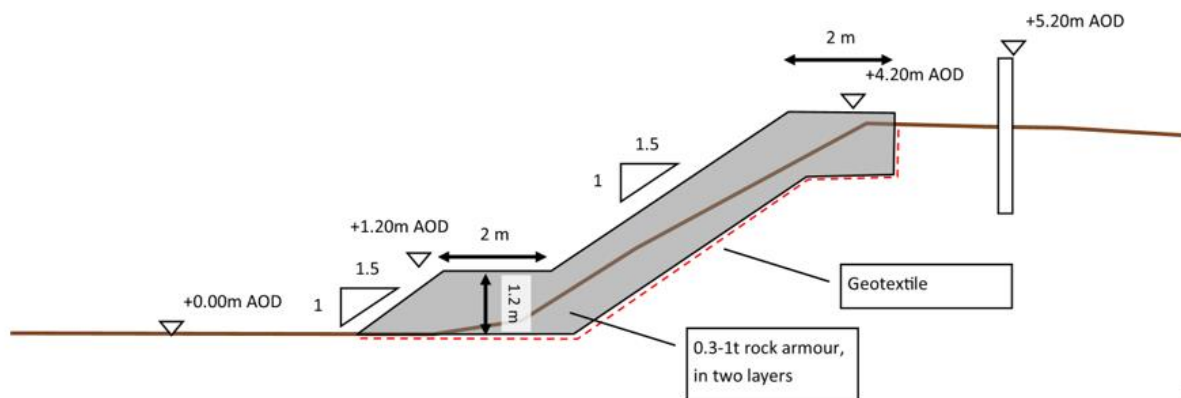


Figure 12: Typical cross-section steel sheet piled wall with capping beam/plate and rock armour revetment. The revetment may be directly adjacent to the wall or separated with a gap depending on the local constraints

- Excavate a leader trench to a depth of approximately 1 metre below existing ground level along the centreline of the proposed structure (if required). Pre-auger where necessary, and drive sheet piling to the required toe depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.
- Cut openings in sheet piling as required to accommodate existing and proposed outfall pipework. Form box-outs prior to concreting works.
- Pour blinding concrete within trench.
- If concrete capping beam is required, fix steel reinforcement and formwork for in situ concrete **pile cap**. Pour concrete pile cap and cure. Strike formwork, setting aside materials for re-use, and dispose of waste arisings off-site.
- Excavate further as required and lay flood defence drainage, which may comprise filter pipes in a granular trench, gully pots, gratings, precast concrete or plastic manholes, carrier pipes, headwall structures and flap valves. Cap pipework until such time as it is fully connected.
- Backfill flood defence wall and drainage with structural backfill.
- The ground on the wet-side of the wall will be excavated to formation, a geotextile will be laid with sheets overlapping two layers of armour stone will be placed on top the revetment toe will need to be anchored into the existing ground with geotextile wrapped around the anchor stone and buried at least 1m below existing ground level.

- Armour stone will be placed from toe to top when above water, armour stones are placed starting at the base of the slope towards the top; when below water, the boulders are placed using clamshells onto the mud.
- Where armour stone is specified, the stone will be placed to ensure enough interlocking / points of contact occur as outlined in the specification. A minimum two layers of stone will be required.

6.8.3 Scour Protection Revetment (Section/Type C)

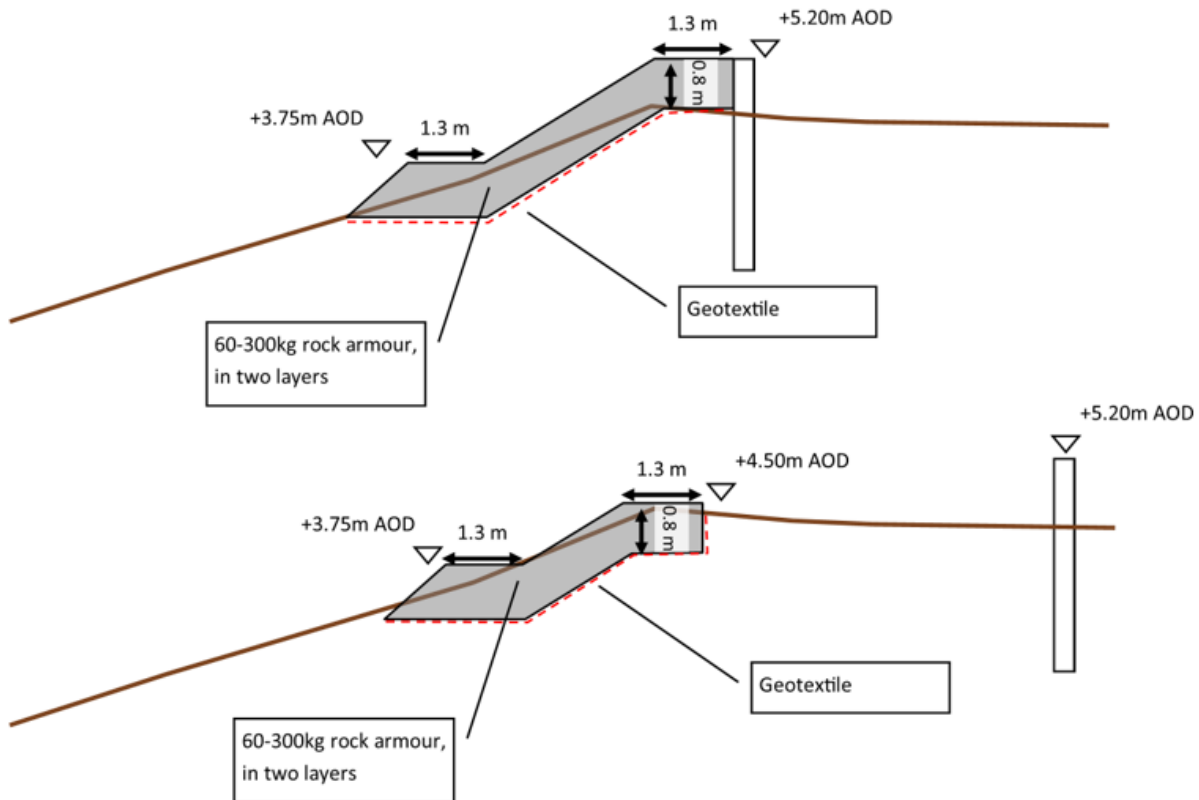


Figure 13: Typical cross-section bare steel sheet piled wall with scour protection – depending on local constraints the scour protection revetment may be directly adjacent to the piled wall or set back.

- Excavate a leader trench to a depth of approximately 1 metre below existing ground level along the centreline of the proposed structure (if required). Pre-auger where necessary, and drive sheet piling to the required toe depth. Driving may be achieved by either vibro-driving, impact-driving or hydraulic pressing.
- Cut openings in sheet piling as required to accommodate existing and proposed outfall pipework. Form box-outs prior to concreting works.
- Excavate further as required and lay flood defence drainage, which may comprise filter pipes in a granular trench, gully pots, gratings, precast concrete or plastic manholes, carrier pipes, headwall structures and flap valves. Cap pipework until such time as it is fully connected.
- Backfill flood defence wall and drainage with structural backfill.
- The ground on the wet side of the wall will be excavated to formation, a geotextile will be laid with sheets overlapping. Two layers of armour stone will be placed on top. The revetment toe will need to be anchored into the existing ground with geotextile wrapped around the anchor stone and buried at least 1m below existing ground level.
- Armour stone will be placed from toe to top (when above water, rock armour boulders are placed starting at the base of the slope towards the top; when below water, the boulders are placed using clamshells onto the mud).

- Where armour stone is specified, the stone will be placed to ensure enough interlocking / points of contact occur as outlined in the specification. A minimum two layers of stone will be required.

6.9 Ground Improvements

Due to the extremely soft ground along the estuary frontage, improvement works to the existing ground are required to increase the strength (bearing capacity) of the ground. The flood wall will consist of a bored pile into the improved ground. The bored pile is likely to be concrete and extend no more than 4m below the existing ground level. The bored pile will have a concrete capping beam and a reinforce concrete wall stem or pre-cast concrete wall stem.

The following outlines the activities associated with carrying out the ground improvements:

- An additive (lime, cement, pulverised fly ash – PFA) will be added to the ground.
- The additive will be mixed into the ground to a depth of up to 4m below existing ground level.
- The additive will be pumped to a rotavator head and mixed into the existing ground using an excavator.
- The additive is not a free draining liquid and needs to be mixed into the ground.
- All work will take place at low tide and be submerged by the high tide.
- The improved ground will all be below the existing ground level.
- Ground improvement works will be undertaken before the piles are installed and the rock revetment is installed. The improved ground will form part of the temporary haul road along the estuary frontage.

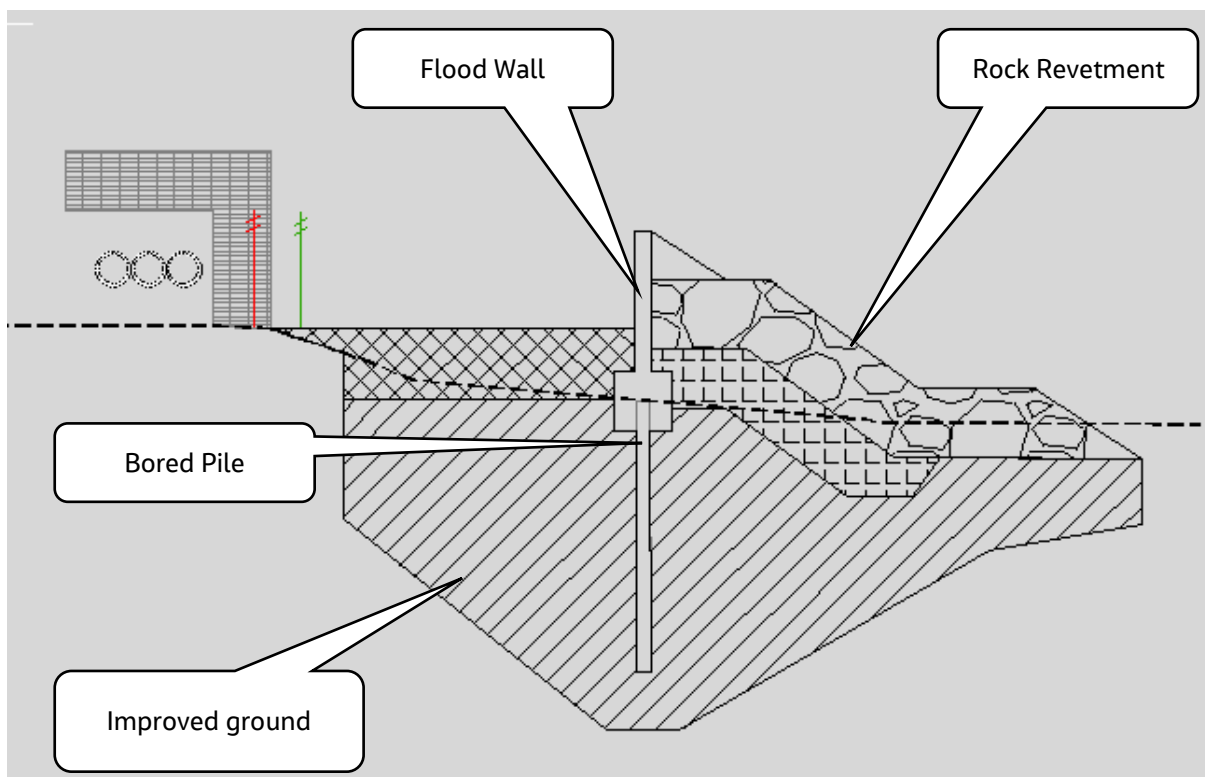


Figure 14: Typical x-section of the ground improvement work with flood wall and rock revetment

Appendix D has more detail on the method of construction for works along the estuary frontage.

6.10 New Culverts

- Set up mobile pump(s) and form temporary sump at upstream end of the proposed culverting works. Over-pump the working area, returning the flow of water to beyond the downstream extent of the works.
- Excavate existing channel to the required formation level, setting aside river cobbles for re-use if appropriate. Demolish or partly demolish existing riverbank structures as necessary to concrete the proposed culvert.
- Lay new culvert sections within the excavation, ensuring securing a good seal between lengths.
- Backfill around culvert with mass concrete or structural backfill, as specified.
- Pour blinding concrete for connections at upstream and downstream ends of culvert.
- Fix steel reinforcement and formwork for in situ concrete **connection chambers**. Pour concrete connection chambers and cure. Strike formwork, setting aside materials for re-use, and dispose of waste arisings off-site.
- Stop over-pumping and return flow of water to new connection chamber and culvert.
- Backfill crown of culvert with structural backfill, dress with topsoil and seed with an appropriate grass and wildflower mix.
- Where specified, fit manhole covers to connection chambers.
- Reinstate surrounding disturbed areas with topsoil and seed with an appropriate grass and wildflower mix.

6.11 Riverbank (fluvial) Erosion Protection

The maximum velocities for a 1 in 200-year event are estimated to be 4.2m³/s for the fluvial dominated areas and 1.5m/s for the tidal dominated areas. Due to difficult access to areas where proposed flood defences are required to be constructed, some construction work equipment is likely to be required to be positioned within the river channel on temporary work platforms / areas. To access the construction zone for the flood defences, the existing bank vegetation and some trees will need to be removed to facilitate access for the construction works. Once the flood defences are constructed, riverbank erosion protection, or bank protection, will need to be installed on the riverbank. Various methods and materials could be used to provide bank protection and at this stage it is not known the exact method of bank protection. The proposed bank protection can be split into soft-engineered techniques; bio-engineered products such as a pre-seeded hessian mat that are anchored to the bank with wooden or metallic anchors, overtime the hessian mat breaks down and bio-degrades into the bank leaving a vegetated bank. The other option will be for a hard-engineered technique; rock gabions or reno mattresses could be installed with some planting in the gaps between rocks.

For the EIA Report a soft engineered technique should be assumed to be used for all the areas identified as requiring bank protection, unless stated otherwise on the plans.

- Prepare slope for geotextile separation layer and excavate anchor trench at top of slope.
- Starting at the downstream extent of the area requiring protection, unroll geotextile from top to bottom of slope, securing sufficient length inside the anchor trench with wooden / metallic stakes. Secure down the slope with further stakes in a pattern in accordance with the manufacturer's recommendations.
- Repeat the process, continuing in an upstream direction until the full stretch of riverbank is protected. Place adjacent lengths of geotextile, ensuring a minimum 500mm overlap, with each upstream length on top of the previous length.
- Anchor matting as required.

6.12 Bridge Modification

- Breakout / take down existing parapet walls and prepare surface for additional reinforcement to be attached. If required drill holes for metal dowels to be installed.
- Fix reinforcement / dowel bars with resin and prepare for concrete pour, erect formwork.
- Pour concrete and strike formwork.
- Where required clad wall with stone; reinstate surrounding ground as required.

6.13 Bridge Replacement

- Divert existing services contained within or suspended from the bridge deck
- Provide containment/protection below deck to prevent debris falling into watercourse
- Remove existing bridge deck – breakout concrete deck and crane out girders
- Breakout and remove existing concrete abutments
- Construct new bridge abutments
- Construct new bridge deck and incorporate services if required
- Reinstate riverbank

6.14 Flow Control Structures

A flow control structure is proposed on the upper section of the Grange Burn, to limit / control the downstream flow. The flow control structure will be an orifice with an overflow weir, discussions with SEPA are ongoing to assess what types of structure what be acceptable. Whatever structure is proposed, some construction work would be carried out within the channel, existing flows will be temporarily diverted / over pumped or the channel narrowed to allow a working area to be constructed. Once the water in the channel has been controlled, a dry working area will be created, the bed of the channel will be excavated, and blinding concrete will be poured. Steel reinforcement and formwork for the insitu bed and weir / control structure will be installed. Strike formwork and set aside material for re-use if the structure is cast in multiple stages. The bank and channel bed upstream and downstream will need to be reinstated possibly reprofiled.

6.15 Flood Relief Channel Relining

The Flood Relief Channel is a concrete / bitumen lined channel that was constructed in the 1960's to divert flow from the Grange Burn during storm events. Minimal maintenance and remedial work have taken place since its construction. The Flood Protection Scheme proposes to utilise the channel and requires the channel to be relined. This could involve demolishing and rebuilding the channel or relining the channel with engineered pre-cast concrete sections or shotcrete.

For the EIA Report shotcrete should be assumed to be used, with some degree of work required to fill-in voids

- Break out existing channel when required.
- Fill voids and broken out areas with concrete
- Install shotcrete as per manufacturer's instructions.

6.16 Demolished Structures

Where required some existing structures/building will need to be demolished. All services to be disconnected and made safe. A mechanical excavator will be used to remove the roof and walls. Where required dust suppression measures will be used.

6.17 Other Works to be Undertaken

6.17.1 Forth Ports - Lock/Flood Gates

The middle set of gates within the port entrance channel will be replaced with new bespoke flood gates. This will require the existing lock gates to be removed, civil works will need to be undertaken on the quayside and within the lock (possibly requiring a limpet dam, and underwater working). The level of detail at this stage of the project is limited, as a specialist contractor will undertake these works. For the purposes of this report, it is assumed all construction work will take place on Forth Ports land and not encroach into the SPA.

6.17.2 A9 (Beancross) Underpass

Closing off the A9 underpass during a flood event would the underpass to be infilled with concrete. A new at-grade, traffic signal controlled crossing is to be provided on the A9 west of the underpass. The council plan to install the basic infrastructure for the crossing (ducts, sockets for signals etc) as part of a planned upgrade of the A9/ Grandsable Road junction which will be carried out in advance of the FPS.

6.17.3 Flood Wall across the Western Lock

At present, no specific design or construction method has been identified for constructing a flood wall across the lock. Further analysis and exploratory works are required. For the EIA Report and HRA, an assumed method of installing a coffer dam should be used, whereby a dry working area is created by installing piles at the end (estuary edge) of the lock. A piled wall would be installed within the dry working area with the top section of the wall protruding above the existing quayside.

6.18 Access for Construction/Working in the Channel

The project team have identified locations where temporary construction work is likely to take place within the channel on a cell-by-cell basis:

6.18.1 Cell 1 – Upper Carron

Cell 1 has been sub divided into the following Working Areas:

- Stirling Road,
- Carron Bridges/Beaumont Drive,
- Chapel Burn
- Dock Street

Stirling Road

Some working in the water course will be required, however this will be limited to a short section where a new head wall and flood wall is required. Construction access for the majority of flood defences will be from Stirling Road, which will require traffic management.

Carron Bridges/Beaumont Drive

Working in the river channel will be required to access river bank between Stenhouse Road and New Carron Road bridges, extending downstream to access sections adjacent to Beaumont Drive. In most cases a temporary access track/working platform will be required from the existing banks down to the channel. For the section between the Carron bridges it may be possible to create a temporary working platform on the north bank and not within the channel, this would be determined onsite. Where possible construction work should take place from the bank.

A temporary road closure of the Stenhouse Road Bridge will be required along with some footpaths in the area. Access to the flood defences in the Carron Works site will be from Stenhouse Road, with the potential

for some additional enabling works required at the rear of Carron Phoenix / off Stenhouse Road – this is to be confirmed. Access to the flood defences on the south bank, upstream of Stenhouse Bridge, would be taken from the existing footpath off Stenhouse Road. Access to the flood embankment at the rear of the properties on Park Road, will be taken from the roundabout on Cotland way, with a haul road created in the landscaped area to the rear of the properties.

A temporary working platform will be constructed within the river channel downstream of the New Carron Road bridge, retained using bulk sandbags and/ or sheet piles. This will provide construction access along the riverbank, directly to the rear of the properties along Beaumont Drive. The working platform would be accessed from the opposite riverbank via Bailey bridges (or similar).

Chapel Burn

Construction of a temporary working platform along the south bank of the Chapel burn would be the preferred option here to allow construction of a flood wall along the rear of the properties backing onto the Chapel Burn. Bulk sandbags would be installed to retain the working platform along the bank edge. Access from the opposite bank (car park area) would be provided by installing Bailey bridges or culvert crossing points along the length of the burn. Alternatively, temporarily culverting the burn from Carronshore Road, in 50-100m sections could be carried out to create a temporary working platform on top of the culvert. Near the mouth of the Chapel Burn the installation of a river working platform would be required to allow access for a temporary working platform to be created in the River Carron, directly upstream of the Chapel Burn. This would allow access to construct a flood wall along the alignment of the existing fence line and provide bank protection works. Flood defences on the north bank of the Chapel Burn and River Carron would be constructed from the footpath between Carronshore Road and Rae Court, the footpath would need to be closed for the duration of the works.

Dock Street

Access from Dock Street to the working area, temporary ramped access to the channel at the end of Dock Street would be constructed.

6.18.2 Cell 2 – Lower Carron

Dry side working is mainly proposed for the construction of the new flood defences between the Helix Sea Lock on the Forth and Clyde canal to the Leisure Harbour/boat yard. Access can be gained to the upstream end of defences via Clyde Street, through the Scottish Water pumping station site. Downstream access can be gained via Jarvie Plant's premises, the scaffold storage yard, Roscco Properties premises and the Leisure Harbour/Forth Clyde boat repair yard off Grange Lane. A short section of in-water working is proposed at the rear of Roscco Properties and would require bulk bags to be used to create a platform for construction plant to sit on.

6.18.3 Cell 3 – Port of Grangemouth

Access to the channel would be taken from North Shore Road. Temporary access ramps would be constructed at appropriate locations to allow access to the channel if required. Most construction works would take place from the carriageway of North and South Shore Roads, with the toe of the revetment requiring some construction work in the channel. Some In-channel working will be required around the rear of the RLPG facility with construction of a temporary working platform into the Forth Estuary. Some construction work will be required in and around the Port Lock-Gates, with some temporary working areas created at the edge of the Forth Estuary. It is highly likely that construction plant will be able to be positioned on the bank and reach the toe of the revetment without needing to be positioned in the water or creating a temporary working platform with the water environment. The exception for this, is the work on the western lock, which is likely to require a floating barge to install piles at the edge of the lock to create a dry working area within the lock.

6.18.4 Cell 4 – Grange Burn

Cell 4 has been sub divided into the following Work Areas:

- Upstream of M9
- Flood Relief Channel (FRC) – Rannoch Park

- FRC – Inchyra / Whole-flats Road
- Millhall Burn
- Grange Burn (GB) – Zetland Park
- GB – Dalratho Road to Bo'ness Road
- GB – Grangeburn Road
- GB – Petroineos
- GB – Mouth of Grange Burn

Upstream of M9

Some temporary work within the channel will be required, temporary ramped access to the channel will need to be created. Where possible access for construction works will be taken from Grandsable Road / A9, fields and public footpaths. Some traffic management will be required on Grandsable Road / A9. It should be noted that Falkirk Council plan upgrade works at Grandsable Road / A9 junction – details of the upgrade are still to be confirmed.

FRC – Rannoch Park

Ramped access to the Grange Burn (GB) and the Flood Relief Channel (FRC) will be required. Some construction work will be required in the channel for the construction of the flow control structure in the Grange Burn and lining the FRC. Managing flows within the Grange Burn and FRC will need to be considered during the construction works, this may involve over pumping or temporary diversion of flows.

FRC – Inchyra / Whole-flats Road

Ramped access to the FRC will be required to and from the surrounding banks. Most access for construction works will be from fields and roadside verges. Managing flows within the FRC, will be required when the channel is relined. Some access from Reddoch Road and Grange Road will be required.

Millhall Burn

Most construction work will require access from Smiddy Brae, Reddoch Road, Millhall Gardens and land parallel to the channel. Any in channel work will need to manage flows within the Millhall Burn.

GB – Zetland Park

Access to the right bank (looking downstream) will be from Zetland Park, this will require the temporary closure of some footpaths within Zetland Park. If access to the channel is required, ramped access from the bank will be taken. Access to the left bank will be from the B9132 (Abbots Road), this will require a partial road closure. The length of the partial road close of Abbots Road will be restricted to 250m and pedestrian access will always be maintained.

GB – Dalratho Road to Bo'ness Road

Access to the right bank (looking downstream), will be from Park Road, this will require a full closure of Park Road, to limit the disruption to the communities in Grangemouth, the maximum length of the road closure (Abbots Road and Park Road) will be 250m. If access to the channel is required, temporary ramped access from Park Road will be created. Access to the left bank, will be from the B9132 (Abbots Road), a partial road closure of the B9132 will be required. Temporary bridges / access points from the right bank will be required across the channel. If this is not possible, a full closure of the B9132 will be required, this may require enabling works on the surrounding roads to maintain access to the town center of Grangemouth. If access to the channel is required, temporary ramped access from the B9132 will be required.

GB – Grangeburn Road

Access to the right bank (looking downstream) will be from Grangeburn Road, which will require a full road closure. To minimize the impact on communities in Grangemouth, the road closure will be limited in length to a maximum of 250m of Grangeburn Road. If access to the channel is required, temporary ramped access

from Grangeburn Road will be required. Access to the left bank will be from South Shore Road, which will require a full road closure from Bo'ness Road to the roundabout. To minimize the impact on communities in Grangemouth, the road closure will be limited in length to a maximum of 250m. If access to the channel is required, temporary ramped access from South Shore Road will be required.

GB – Petroineos / Mouth of GB

Access to the right bank (looking downstream) will be taken from within Petroineos's site, due to the limited space and steep bank, access from the bank to the channel may be difficult, if work is required in the channel, a temporary working platform will be created with machinery / materials craned down to the platform. Access to the mouth of the Grange Burn, will require construction plant and materials to take access through Petroineos's site, via the site entrance off Powdrake Road, the exact route through Petroineos's site is to be confirmed with Petroineos over the coming months. If access to the channel is required, downstream of the railway line, a temporary ramp and working platform in the channel will be constructed.

6.18.5 Cell 5 – River Avon

Access for construction works will be taken from either the A905 or A904. Where flood defences are constructed in this cell, a permanent access track is proposed, which will be contained within the temporary construction zone.

Access from the A905, will provide access to construct flood defences on both banks from the A905 Road Bridge. Access from within INEOS's site will be needed, exact access routes will be confirmed in the coming months / years. Where bank protection works required, construction work will take place from the existing bank, some temporary construction platforms may be required along sections of the River Avon, ramped access from the bank will be taken. Flood defences upstream of the A905 Road Bridge will be access from the A905 and Avondale Road, no working in the channel is required here.

For flood defences on the banks near the A904 Road Bridge, access will be taken from the A904 and within INEOS's, INEOS FPS's and Versalis sites, temporary construction access points will be required off the A904. Access from the A904, will also be used as an access route for construction of flood defences in parts of Cell 6, significant amounts of construction materials would need to be brought into Cell 6 via this access point.

6.18.6 Cell 6 – Estuary Frontage

Access for construction work would be taken from the east and west extents of the cell. Where flood defences are constructed in this cell, a permanent access track is proposed, which will form part of the temporary construction zone. The western and eastern extents refer to extents from the mouth of the River Avon.

West Extents

Temporary construction access from within Petroineos's site to cross the railway line and construct an access track outside Petroineos's fence line, along the estuary frontage.

A permanent access track will be constructed at the rear of the proposed flood defences on the west bank of the River Avon from the A904. The temporary construction zone will include the footprint of the permanent access track and flood defence. Land reclamation will be required for some of the permanent access track along the estuary frontage. Where land reclamation takes place, temporary working platforms / areas may be required, the height of these temporary working platforms will need to be determined at the detailed design stage to ensure the height of platform is above the mean high tide level to allow construction work to take place during the daily tidal cycles. See Appendix D which details the construction methodology along the estuary frontage.

East Extents

Access from the A904, along the track to Scottish Waters Kinneil Waste Water Treatment Plant will be taken. Temporary access across twin above ground pipelines is required, this may require a temporary bridge to be constructed, ramped access over the pipelines. A temporary ramp into the channel for constructing flood defences on the east bank of the River Avon, downstream from the A904 Road Bridge will be required.

7. Impact of Construction Sequence and Timing

The project is complex in its nature, incorporating aspects of construction, logistics, river management, traffic management, and public interface. The work is spread over a large spatial area, across Grangemouth and surrounding area. The contractor will be responsible for determining the programme and construction sequence of the works in accordance with their contractual and regulatory obligations. There are innumerable possible combinations for this, therefore it is not possible to determine with any certainty the construction sequence prior to a contractor being appointed.

7.1 Sequence/Phasing

Due to the scope / extent of the proposed flood defences (~28km in total), it is very unlikely that a single construction contract will be let for all the scheme works. It is more realistic to assume the construction works will be divided into at least 5 phases, with each phase potentially involving more than one construction contract. At this stage, we are not able to confirm the exact construction phasing plan but it is likely that construction work will take place in a range of flood cells within each construction phase as noted in the table below.

Phase no.	Flood Cell no.
1 (Residential areas)	1 & 4 (part)
2 (Port - Lock Gates)	3
3 (Port -Flood Defences)	3
4 (Industrial areas – not estuary frontage)	2, 4 (part) & 5
5 (Industrial areas - estuary frontage (Ineos Companies)	6

The sequencing and timing of construction works is not definitively known, however, it is envisaged that the construction phase of the scheme works will last for approx. 5 – 10 years, depending on how the construction contracts overlap. The sequencing of construction works is likely to mean that only two phases can be undertaken at the same time. The chart below indicates the current anticipated construction phasing plan. The compensatory habitats referred to in Figure 16 are those identified in the Habitats Regulations Appraisal report.

Flood Cell No.	Area	Working Area	Location	Year 1			Year 2			Year 3			Year 4			Year 5			Year 6			Year 7			Year 8			Year 9			Year 10			Year 11		
				Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	Jan	Apr	July	Oct	
1 and 4	Residential	1-1, 1-2, 1-3, 1-4, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6 and 4-7 (part)	Enabling Works for flood defences in the residential areas on the River Carron and Grange Burn catchments																																	
1 and 4	Residential	1-1, 1-2, 1-3, 1-4, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6 and 4-7 (part)	Includes flood defences covering the residential areas on the River Carron and Grange Burn catchments																																	
2, 4 (part) and 5	Industrial areas and Ineos Companies	2-1, 2-2, 4-7 (part), 4-8, 4-9, 5-1, 5-2, 5-3 and 5-4	Includes flood defences covering the industrial areas on the lower sections of the River Carron, Grange Burn and on the banks of the River Avon																																	
6	Ineos Companies	6-1, 6-2, 6-3 and 6-4	Includes flood defences along the estuary frontage																																	
3	Port (excluding Lock Gates)	3-1, 3-2, 3-3 (part), 3-4 (part) and 3-5	Includes flood defences on the banks of the River Carron and Grange Burn around the Port of Grangemouth																																	
3	Port (Lock Gates)	Part 3-3 and 3-4	Includes flood defences at the locks																																	
NA	Compensation sites	NA	Bothkennar and Kinneil																																	

Figure 15: Estimated phasing of construction work

7.2 Timing

Table 2 Construction duration estimates for work areas

gives an indication of the overall construction durations in each working area. Assets such as flood gates and demountable barriers are included in the estimated overall length but not in the anticipated finish column:

Cell no.	Working Areas	Location	Estimated overall length of flood defences in m	Anticipated Form of Construction	Duration of Construction	Anticipated Finish – in m
1	1-1	Stirling Road	1524	Formed Concrete Wall, Brick Clad Wall, Seepage Only, Embankment	24 months	Formed Concrete – 303 Brick Clad – 1177 Embankment - 44
	1-2	Carron Bridges	990	Brick Clad Wall, Stone Clad Wall, Stone Clad Wall with Glass Panels, Formed Concrete Wall, Embankment, Replacement Bridge (B902)	18 months	Stone Clad – 211 Stone Clad with glass panels - 110 Earth Embankment - 400 Brick Clad- 217 Formed Concrete Wall – 16 New bridge - parapet 36
	1-3	Chapel Burn	685	Brick Clad Wall, Stone Clad Wall	12 months	Brick Clad – 662 Stone Clad - 24
	1-4	Dock Street	538	Formed Concrete Wall	9 months	Formed Concrete – 529 Local ground raising – 9
2	2-1	Forth and Clyde Canal Lock	653	Embankment & Sheet Pile Wall	9 months	Bare Sheet Pile – 348

CONSTRUCTION METHODOLOGY REPORT

Cell no.	Working Areas	Location	Estimated overall length of flood defences in m	Anticipated Form of Construction	Duration of Construction	Anticipated Finish – in m
						Earth Embankment - 305
	2-2	Jarvie Plant/Rossco Properties	792	Sheet Pile Wall	9 months	Bare Sheet Pile – 792
3	3-1	Mouth of the River Carron	945	Sheet Pile Wall & revetment	9 months	Bare Sheet Pile - 945
	3-2	West Coast of the Port	965	Sheet Pile Wall & revetment	9 months	Bare Sheet Pile - 965
	3-3	West Gate to the Port	1167	Sheet Pile Wall & revetment	9 months	Bare Sheet Pile - 1167
	3-4	East Gate to the Port	888	Sheet Pile Wall, Plain Concrete Wall, Formed Concrete Wall	9 months	Bare Sheet Pile – 751 Plain Concrete – 135 Formed Concrete – 2
	3-5	Mouth of the Grange Burn	678	Sheet Pile Wall	6 months	Bare Sheet Pile – 678
4	4-1	Upstream of M9	1055	Stone Clad Wall, Formed Concrete Wall	15 months	Formed Concrete – 972 Stone Clad - 83
	4-2	FRC – Rannoch Park	557	Formed Concrete Wall	9 months	Formed Concrete - 557
	4-3	FRC – Inchyra Road	505	Formed Concrete Wall & Embankment	12 months	Formed Concrete – 387 Earth Embankment 118

CONSTRUCTION METHODOLOGY REPORT

Cell no.	Working Areas	Location	Estimated overall length of flood defences in m	Anticipated Form of Construction	Duration of Construction	Anticipated Finish – in m
	4-4	FRC – Whole-flats Road	2351	Formed Concrete Wall, Stone clad Wall, Sheet Pile Wall, Raising footway, Embankment, Regrading Existing Embankment, New Bridges	27 months	Local ground Raising – 105 Stone Clad – 689 Bare Sheet Pile – 899 Formed Concrete – 622 Earth Embankment – 25 New bridge Parapet – 11
	4-5	GB – Zetland Park	764	Stone Clad Wall & Embankment	12 months	Stone Clad – 667 Embankment – 177
	4-6	GB – Dalgrain to Bo'Ness Road	800	Sheet Pile Wall	12 months	Stone Clad – 763 New bridge parapet – 37
	4-7	GB – Grangeburn Road	1250	Sheet Pile Wall, Stone Clad Wall, Formed Concrete Wall	18 months	Bare Sheet Pile – 595 Stone Clad – 644 Formed Concrete Wall – 11
	4-8	GB – Petroineos	973	Sheet Pile Wall, Stone Clad Wall	12 months	Bare Sheet Pile – 842

Cell no.	Working Areas	Location	Estimated overall length of flood defences in m	Anticipated Form of Construction	Duration of Construction	Anticipated Finish – in m
						Stone Clad - 131
	4-9	GB – Mouth of Grange Burn	1049	Sheet Pile Wall, Seepage Only	9 months	Bare Sheet Pile – 1049
5	5-1	Smiddy Brae & Avondale Road	1764	Sheet Pile Wall, Formed Concrete Wall	18 months	Bare Sheet Pile – 923 Formed Concrete - 841
	5-2	Flare Road & Road 33	995	Sheet Pile Wall, Seepage Only	9 months	Bare Sheet Pile – 995
	5-3	Grangemouth Road	1632	Sheet Pile Wall	12 months	Bare Sheet Pile – 1632
	5-4	Mouth of the River Avon	429	Sheet Pile Wall & Embankment	9 months	Bare Sheet Pile – 429
6	6-1 & 6-2	West of River Avon (Beach Road & Mouth of River Avon)	2157	Sheet Pile Wall, Bored Pile Wall with revetment	21 months	Bare Sheet Pile - 1215 Bored Pile– 941
	6-3 & 6-4	East of River Avon (Chemical Works at River Avon & Chemical Works)	1423	Sheet Pile Wall & Sheet Pile Wall with Embankment	18 months	Bare Sheet Pile Combined with Earth embankment – 692 Bare Sheet Pile - 730

Table 2 Construction duration estimates for work areas

The durations for the work areas outline above in Table 3 are estimates of duration and may change subject to further design development.

It is important to note the engineering team do not envisage construction works taking more than 12 months in duration at a single location within a Cell or Working Area. For the purpose of the EIAR and HRA the assessment should be based on:

Flood Defences	Weeks taken to construct approx. 100m
Wall – sheet piled foundation with reinforced concrete stem and clad	8

Flood Defences	Weeks taken to construct approx. 100m
Wall – sheet piled foundation with reinforced concrete stem and formed finish	7
Embankment – Granular fill and seepage barrier	8
Bare sheet pile wall	5
Soil Mixed ground with bored pile, concrete wall and rock armour revetment	16

Table 3 Estimates the duration of construction works

It is likely that flood walls will be constructed in sections of 10-15m lengths, it is highly unusual to finish a 10-15m section of wall before moving onto the next section. Work is usually carried out over a number of wall sections simultaneously, particularly for the clad walls.

7.3 Transport Planning

7.3.1 HGV Movements

The number of HGV movements has been assessed considering the main construction activities at each working area (e.g. mobilisation/ demobilisation, piling, concrete, reinforcement, formwork, earthworks, temporary surfaces, rock armour, cladding and drainage). The average number of vehicles per day was calculated by taking the total number of vehicles and dividing by the duration. In order to reflect that for different forms of flood defence construction there may be multiple activities being carried out in parallel (e.g. a clad flood defence may have piling, concrete and cladding all progressing at the same time) a multiplier was applied depending on the principal type of defence construction in each working area. There were 1.5 for bare sheet piles, 2 for formed concrete and 3 for clad flood defences.

The estimated HGV numbers are noted in the table below. These represent one-way movements i.e. HGV's travelling to site. The total two-way movements of vehicles travelling to site and then leaving will be double these numbers.

Cell No	Working Area	Duration (weeks)	Average Vehicles per day	Peak vehicles per day
Cell 1	1-1	108	4	8
Cell 1	1-2	81	5	15
Cell 1	1-3	54	4	12
Cell 1	1-4	41	4	8
Cell 2	2-1	41	5	10
Cell 2	2-2	41	5	8
Cell 3	3-1	41	5	8
Cell 3	3-2	41	5	8
Cell 3	Lock Gates	68	5	10
Cell 3	3-3	41	6	9
Cell 3	3-4	41	5	8
Cell 3	3-5	27	6	9
Cell 4	4-1	68	4	8

Cell No	Working Area	Duration (weeks)	Average Vehicles per day	Peak vehicles per day
Cell 4	4-2	41	4	8
Cell 4	4-3	54	5	10
Cell 4	4-4	122	5	15
Cell 4	4-5	54	4	12
Cell 4	4-6	54	4	12
Cell 4	4-7	81	4	12
Cell 4	4-8	54	5	8
Cell 4	4-9	41	6	9
Cell 5	5-1	81	5	15
Cell 5	5-2	41	6	9
Cell 5	5-3	54	7	11
Cell 5	5-4	41	6	9
Cell 6	6-1 & 6-2	95	9	14
Cell 6	6-3 & 6-4	81	8	12

Table 4 Estimates HGV construction vehicle movements

7.3.2 Car Movements

The number of private car movements has been assessed on the basis of an estimate of the workforce and assuming 1.5 persons per car to reflect there will be some car sharing and/ or crew buses used to transport people to and from the site.

Cell No	Working Area	Duration (weeks)	Average Cars per day (summer)	Average Cars per day (winter)
Cell 1	1.1	108	22	13
Cell 1	1-2	81	17	9
Cell 1	1-3	54	13	7
Cell 1	1-4	41	8	4
Cell 2	2-1	41	5	3
Cell 2	2-2	41	6	4
Cell 3	3-1	41	7	5
Cell 3	3-2	41	7	5
Cell 3	Lock Gates	68	10	8
Cell 3	3-3	41	8	6
Cell 3	3-4	41	7	5
Cell 3	3-5	27	5	4
Cell 4	4-1	68	16	7
Cell 4	4-2	41	8	4
Cell 4	4-3	54	12	6
Cell 4	4-4	122	35	20
Cell 4	4-5	54	14	7

Cell No	Working Area	Duration (weeks)	Average Cars per day (summer)	Average Cars per day (winter)
Cell 4	4-6	54	15	8
Cell 4	4-7	81	17	9
Cell 4	4-8	54	14	7
Cell 4	4-9	41	8	6
Cell 5	5-1	81	19	11
Cell 5	5-2	41	8	5
Cell 5	5-3	54	12	8
Cell 5	5-4	41	3	2
Cell 6	6-1 & 6-2	95	15	10
Cell 6	6-3 & 6-4	81	10	7

Table 5 Estimates car movements

7.4 Contract Constraints

Notwithstanding this, contract conditions can be imposed on the contractor to constrain how they are permitted to sequence the work. These constraints should be used with caution however, as overuse of contractual constraints can increase the duration, cost, and complexity of the works and even cause certain operations to become impossible to construct. Taking this into consideration, the following combinations and sequences of work may be discounted due to contractual constraints which are likely be placed on the contractor:

- Where work areas on directly opposite riverbanks are both to be constructed from working areas in the watercourse, these may be prohibited from occurring at the same time due to the excessive constriction which would be imposed on the watercourse.
- Where a work area will require traffic management (such as diversions, and one-way traffic under traffic light control), and where another work section affects a likely alternative route, these two work sections may be prohibited from occurring at the same time.
- Where a work area will require traffic management to a long length of road, the contractor may be restricted to the length of working area which can be closed to the public at any one time, thereby limiting the extent of the traffic management.
- Haul roads in the watercourse can have an impact on the flow of water, a limit may be imposed on the total length of such haul roads that is permitted to be in place at any one time.
- Specific construction activities which produce considerable noise, and which are in proximity to schools, are likely to be restricted during major examination periods.
- Work which disturbs the riverbed, such as construction or removal of cofferdams or raised platforms, is likely to be restricted during salmon spawning season.
- Prior to felling trees during bird nesting season, supplementary surveys for breeding birds may be required to comply with relevant legislation.
- Where bridges are closed because of the works, adjacent bridges must remain open to pedestrians at all times.
- Depending on the outcome of discussions with SEPA, Marine Scotland and NatureScot, some constraints may be placed on certain activities, and this will be discussed further in the Environmental Statement.

- Some construction work will take place on private land, and have restrictions imposed on them by the site operator.
- Depending on the outcome of the HRA, a restriction of working out-with the over wintering bird season may be applicable for Cells 3 and 6.

7.5 Temporary Flood Protection

The sequence of construction may have the effect of temporarily lowering the standard of protection at locations where flood defences have yet to be constructed. Where a flood defence is constructed on one riverbank, it may direct more flow to the opposite riverbank where defences have yet to be constructed, lowering the standard of protection there until both sides are complete. Likewise, defences completed on both sides may channel flow further downstream, lowering the standard of protection there until their defences are completed.

Temporary changes to the standard of protection are an inevitable consequence of constructing large flood protection schemes, since all defences cannot all be constructed simultaneously. The risk may be mitigated by providing temporary flood defences at locations where the permanent works have not yet been completed or leaving out small sections of otherwise complete sections of flood defences. The level of such protection could be selected such that the same standard of protection is maintained as existed before the project began. Establishing this level would require hydraulic modelling to be carried out by the Employer, based on a construction sequence provided by the contractor.

Provision of temporary defences could be incorporated in the main works contract. This could require the contractor to deploy temporary defences over specified stretches based on his construction sequence, or simply to maintain ready supplies of materials which could be easily and effectively deployed in the event of a flood alert.

8. Reinstatement

8.1 Residential Gardens

The required standard of reinstatement for residential gardens is a subjective matter to each landowner, and not suited to being carried out by a large engineering contractor. Experience indicates that a basic level of reinstatement can be consistently achieved by the contractor, comprising topsoil and hard landscaping such as gravel or paving. Beyond that, it is proposed that the landowner may be better placed to arrange soft landscaping to suit their needs and expectations, with the costs of this provided for within the scheme. The landowner will also most likely be in a better position to water and maintain the soft landscaping to meet their expectations.

Where the landowner is unable to arrange reinstatement of soft landscaping themselves, it may be possible to engage a specialist contractor for this work, with the costs provided for within the scheme.

8.2 Amenity Areas

Public amenity areas such as parks, playgrounds and grass verges will be reinstated by the contractor. A similar form of landscaping could be provided, or alternatives developed in consultation with the relevant planning authorities within Falkirk Council. This will form part of the detailed design phase of the project.

8.3 Roads and Footpaths

Where roads are open to both the public and the contractor, experience indicates that it is difficult to attribute deterioration to construction traffic and thereby require the contractor to carry out repairs at their expense. This is particularly the case where roads are used by buses and HGVs.

One option is to prescribe within the contract which roads are expected to require reinstatement and to what standard. Where reinstatement is not necessary, this activity could later be removed from the contract, although experience indicates that the true cost may not be fully recovered by doing this.

A second option is to remove road reinstatement from the main works contract and make provision for it to be carried out separately by Falkirk Council. This would ensure that cost is only incurred where reinstatement is necessary and is likely to be a more cost-effective option as the extra fees associated with NEC compensation events would not be incurred.

Where roads are within the site boundary and excavation by the contractor is required, it is more straightforward to include reinstatement of these surfaces under the contract. Likewise, where damage or deterioration is clearly due to the contractor (such as track marks or concrete spills) reinstatement of these areas can more easily be included in the contract. A comprehensive dilapidation survey in advance of the contractor taking possession of the relevant Working Area is essential.

8.4 Existing Structures

As described in Section 7, many of the work sections are near existing structures, and the risk of damage should be considered carefully. The NEC Engineering and Construction Contract Clause 80.1 states that the following is an Employer's risk:

"Claims, proceedings, compensation and costs payable which are due to use or occupation of the Site by the *works* or for the purpose of the *works* which is the unavoidable result of the *works*."

Damage caused by the Contractor providing the works is therefore only a Contractor's risk if it is deemed to be avoidable. Experience indicates that, particularly in the case of old structures, this can be difficult to resolve after the fact.

It is therefore recommended that provision be made within the contract such that the Contractor is required to declare that their method of working has been selected such that no damage or deterioration shall occur to any building, structure, property, or the natural environment as an unavoidable result of the works. Failure to make this declaration would give the Employer cause to reject the Contractor's method statement.

Notwithstanding the above provision, it is also recommended that allowance be made within the monetised risk register for claims, proceedings, compensation, and costs payable due to damage of this nature.

9. Recommendations

This report should be reviewed by members of the project team at key stages of the detailed design, to ensure any changes to the design are reflected in this report.

Appendix D: Estuarine Geomorphology

1. Purpose of Appendix

It was identified that there is potential for long-term changes in the estuarine processes and geomorphology of the Firth of Forth. This appendix summarises the assessment of the potential impacts on estuarine processes and the water environment as a result of the Scheme, conducted as part of Chapter 10 (Water Environment) and Appendix C10.2 (Estuarine Geomorphology) for the Environmental Impact Assessment Report (EIA Report) (Jacobs, 2024). The full assessment is detailed within these documents. This appendix therefore uses EIA assessment terminology and does not include any assessment information specific to the HRA.

2. Methodology

2.1 Baseline

The study area for the assessment of estuarine receptors includes the Middle Forth Estuary, which extends between Kincardine Bridge upstream and the town of Bo'ness, downstream on the southern bank of the Forth and includes the tidal reaches of the River Carron, Grange Burn and River Avon as listed below:

- the estuarine sections of River Carron, River Avon and Grange Burn, which extend between the Middle Forth Estuary to the Normal Tidal Limit (NTL);
- the estuarine frontage of the Site Boundary within the Middle Forth Estuary; and
- the Middle Forth Estuary, which extends between Kincardine Bridge and the town of Bo'ness in the Firth of Forth.

The effects on estuarine processes have been assessed for the following Flood Cells:

- Flood Cells 1 and 2: Transitional section of the River Carron up to the NTL (here in referred to as the Lower Carron Estuary);
- Flood Cell 3: Lower Carron Estuary and Middle Forth Estuary;
- Flood Cell 4: Transitional section of the Grange Burn from the NTL to the Middle Forth Estuary (herein referred to as Grange Burn Estuary);
- Flood Cell 5: Transitional section of the River Avon (herein referred to as the Lower Avon Estuary); and
- Flood Cell 6: Middle Forth Estuary.

The baseline appraisal draws upon prior studies and modelling exercises for the estuary to inform baseline understanding of estuary dynamics. No new modelling has been undertaken for the Scheme.

Baseline surveys of the estuarine frontage were conducted between 10 and 13 May 2016 (CH2M, 2017) and supplemented by additional photographs were taken on 10 and 11 April 2019. The site survey walkovers were supported with desk study analysis and have been used to establish the baseline for the study area and identify water environment receptors. An importance value was then assigned to each receptor, based on the criteria presented in Table D1.

Although waves and tides may be altered by the presence of a new structure, they largely represent 'pathways' as opposed to receptors. Wind, waves, and tides are the mechanisms that control local and regional patterns of sediment transport, erosion, and deposition, and these in turn directly influence

morphological change of the subtidal and intertidal areas. Therefore, it is typically the morphological features, such as intertidal mudflats, that form the key receptors. Designated estuary features are also included in the list of physical processes receptors. Importantly, the assessment of potential effects to nearby designated sites considers the potential for significant modification of the naturally occurring physical processes and/or features that could indirectly impact the habitats they sustain.

Table D1: Receptor Importance Criteria and Typical Examples

Importance	Typical Examples
Very High	Water feature has a very high quality and/or rarity on a national and/or international scale.
	A coastal/estuarine water body supporting a range of species and habitats sensitive to changes in erosion, sediment transport and deposition. Water body appears in complete equilibrium with natural erosion and deposition occurring at equal rates. Includes sites with international and UK statutory nature conservation designations (including SSSI and Ramsar sites) due to water-dependent ecosystems. Includes a diverse range of shoreline/estuarine morphology, including a variety of natural features such as sandbanks, creeks, intertidal mudflats and saltmarshes. Presents a lack of anthropogenic interruption and modification. Higher likelihood of morphological adjustment, such as excessive erosion and sediment deposition as a direct result of modification.
High	Water feature has a high quality and/or rarity on a national scale.
	A coastal/estuarine water body supporting a range of species and habitats sensitive to changes in erosion, sediment transport and deposition. Water body appears in complete equilibrium with natural erosion and deposition occurring at equal rates. Includes non-statutory sites of regional or local importance designated for water-dependent ecosystems. Includes a range of shoreline/estuarine morphology, including some natural features such as sandbanks, creeks, intertidal mudflats and saltmarshes. Presents a minor anthropogenic interruption and modification. Higher likelihood of morphological adjustment, such as excessive erosion and sediment deposition, as a direct result of modification.
Medium	Water feature has a medium quality and/or rarity on regional/local scale.
	A coastal/estuarine water body supporting some species and habitats sensitive to changes in erosion, sediment transport and deposition. Includes non-statutory sites of regional or local importance designated for water-dependent ecosystems. Moderate morphological diversity (geodiversity). Evidence of localised modification such as shoreline protection, but natural features such as sandbanks and intertidal flats are present.
Low	Water feature has a low quality and/or rarity on local scale.
	A coastal/estuarine water body which does not support any significant species sensitive to changes in erosion, sediment transport and deposition. No designated sites within water body. Water bodies exhibiting no morphological diversity (geodiversity); shoreline type is uniform and stable. Evidence of modification such as a sea defences, realignment and/or deepening. Very limited potential for morphological adjustment, such as erosion and sediment deposition, as a direct result of modification. Groundwater feeding GWDTEs with a low groundwater dependence within areas of local environmental importance.

2.2 Impact Assessment

2.2.1 General Assessment Methodology

Potential impacts as a result of the Scheme are identified along with the magnitude of the impact. The criteria for identifying the magnitude are presented in Table D2. The nature and characteristics of

impacts have been described to enable their magnitude to be determined. The nature of the impacts has first been expressed as:

- Adverse – detrimental or negative impacts on an environmental resource or receptor;
- Beneficial – advantageous or positive impact on an environmental resource or receptor.

By considering the importance of the receptor and the magnitude of the impact, the significance of the effect on the receptors and receptor's attributes during construction and operation can be established using Table D3.

The baseline material provides sufficient detail and understanding of estuary dynamics to inform the impact assessment. This is considered appropriate for the estuarine aspects of the assessment for the following reasons:

- Expert professional judgement identified that due to the small increase in the footprint of the flood defences, changes in water levels/current speeds were likely to be negligible for the wider Firth of Forth and very small for the local area. This was confirmed when differences in tidal prisms (the volume of water that flows into and out of the estuary between low and high tide) with and without the Scheme locally and regionally were calculated; and
- previous hydrodynamic modelling undertaken for other developments within the Firth of Forth were reviewed in support of this assessment. Those were undertaken for the Forth Replacement Crossing (Jacobs Arup, 2009) and Rosyth International Container Terminal (HR Wallingford, 2015; 2016).

The assessment methodology follows the source-pathway-receptor model. The receptor can only be exposed to a change if a pathway exists through which an impact can be transmitted between the source activity and the receptor. Those effects described as 'Moderate Adverse' significance or above are significant for this assessment.

Table D2: Magnitude Criteria for Impact Assessment

Magnitude	Typical Examples
Major Adverse	Major adverse changes to the geomorphological elements of the coastal/estuarine water body including: Estuarine sediment regime - Major changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to impacts to habitats and/or sensitive species resulting from changes in erosion, transport and deposition of suspended sediment and/or bedload. Shoreline, intertidal and subtidal morphology - Major changes to any part of the shoreline, intertidal area and subtidal bed of the estuary leading to a reduction in morphological diversity with consequences for geodiversity or ecological quality. Estuarine processes - Major changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition.
Moderate Adverse	Moderate adverse changes to the hydromorphological elements of the water body including: Estuarine sediment regime - Moderate changes to any part of the shoreline, intertidal area and subtidal bed of the estuary caused by erosion (scour) and/or deposition leading to impacts to habitats and/or sensitive species as a result of changes in erosion, transport and deposition of suspended sediment and/or bedload. Shoreline, intertidal and subtidal morphology - Moderate changes to estuarine morphological diversity. Estuarine processes - Moderate changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition.
Minor Adverse	No substantial changes to the hydromorphological elements of the coastal/estuarine water body: Estuarine sediment regime - No substantial changes to sediment transport resulting in negligible impacts on species or habitats as a result of changes to suspended sediment concentration or turbidity. No discernible impact to sediment patterns and behaviour over the development area due to either erosion or deposition.

Magnitude	Typical Examples
	Shoreline, intertidal and subtidal morphology - No substantial impact to estuarine morphological diversity. Estuarine processes - No substantial changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition. Any changes are likely to be localised.
Negligible	No discernible changes to the hydromorphological elements of the coastal/estuarine water body: Estuarine sediment regime - No discernible changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition. Any changes are likely to be highly localised. Shoreline, intertidal and subtidal morphology - No substantial impact to estuarine morphological diversity. Estuarine processes - No discernible changes/interruption to estuarine processes such as shoreline evolution or erosion and deposition. Any changes are likely to be highly localised.

Table D3: Criteria for Significance of Adverse Effects

Magnitude of Impact	Importance of Receptor			
	Very High	High	Medium	Low
Major Adverse	Very Large	Large or Very Large	Moderate or Large	Slight or Moderate
Moderate Adverse	Large or Very Large	Moderate or Large	Moderate	Slight
Minor Adverse	Moderate or Large	Slight or Moderate	Slight	Neutral or Slight
Negligible	Slight or Moderate	Slight	Neutral or Slight	Neutral

2.2.2 Intertidal area loss

The impact assessment for intertidal area loss, also referred to as encroachment, is undertaken based on the comparison between the current estuarine baseline of the study area and potential changes due to the Scheme. The Intertidal area covers all areas between the Mean High Water mark (MHW) and the Mean Low Water mark (MLW), which includes extensive reaches of some watercourses (e.g. on the River Carron, this is more than 5km upstream of the confluence with the Firth of Forth). In the context of this assessment, the intertidal area also includes any habitat that falls between MHW and MLW (e.g., gravels, saltmarsh, mudflats, rock armour revetment, etc.). Temporary and permanent intertidal area loss as a result of the Scheme was identified using GIS shapefiles prepared by the design team:

- Temporary intertidal area loss during construction was calculated by subtracting the Permanent Works footprint from the Site Boundary footprint, which identifies the working areas required during construction. Temporary intertidal area loss is expected to be less than is calculated for in-channel working areas as contractors will likely work from watercourse banks wherever possible. Temporary intertidal area loss will be restored where possible.
- Permanent intertidal area loss as a result of the flood defences is calculated from the Permanent Works footprint.

3. Baseline

In general, the Firth of Forth has mixed muddy bottom sediments, and a diverse morphological nature including saltmarshes, dune systems, maritime grasslands, heath and fen, cliff slopes, shingle, and brackish lagoons (Jacobs Arup, 2009). Within the Middle Forth Estuary, mudflats are dominant, supporting a rich invertebrate fauna, and eelgrass. These features provide important food sources for the large numbers of migrating and wintering waterbirds that utilise the estuary.

The Middle Forth Estuary represents a sediment sink, receiving material from the open coasts to both the north and south (Pontee et al., 2004). In the Middle and Upper Forth, intertidal areas are mainly supplied with fine material on each tide from the relatively high suspended sediment concentrations (SSC) within the estuary, through the areas of channel restriction such as the Kincardine Bridge and Grangemouth (ABPmer, 2018). At these locations, the constriction leads to turbulent flows and sediment resuspension (ABPmer, 2014).

Recent changes in geomorphology in the Forth have been heavily dictated by anthropogenic pressures, such as land claim, construction of sea defences, bridges, piers, harbours, breakwaters and dredging within navigation channels. The morphology of the shoreline and channel of the Firth of Forth (offshore from the Scheme frontage) have been historically modified by engineering structures including the flood defence walls and associated infrastructure of the Port of Grangemouth.

Most of the banks within the study area along the estuary front have existing defences of some form, which function as erosion control structures. These defences are privately owned and are therefore considered to be informal defences. For the purpose of the assessment, it has been assumed that, in the absence of the Scheme, the current defences would be maintained. The effects of the Scheme were therefore assessed through the comparison of the defences built as designed for the Scheme compared to a baseline with the existing, informal defences in place.

4. Potential Impacts

Potential impacts during the construction and operation of the Scheme were identified and are described below, with further detail in Table D4.

4.1 Construction

Potential impacts as a result of construction of the Scheme may include:

- changes in erosion/accretion in the intertidal and subtidal arising from changes in tidal flows (speed and direction). This has the potential for increased erosion around working platforms where the channel is constrained and accretion where channel is unconstrained;
- morphological changes due to the direct disturbance of intertidal areas by heavy machinery operating on the intertidal areas, potentially causing erosion or compaction. This could become a permanent effect depending on the degree of disturbance and the reinstatement works;
- changes in subtidal morphology due to erosion of the intertidal area and release of sediments into the navigation channel, which could have two potential effects:
 - temporary local increase in suspended sediment concentrations; and
 - permanent shallowing of parts of the subtidal slope due to deposition of material eroded from the intertidal, which could have implications for navigation.

4.2 Operation

Potential impacts as a result of operation of the Scheme may include:

- loss of intertidal area directly under the Scheme footprint;
- changes in water levels;
- changes in flow speeds and directions;
- changes in estuarine morphology due to changes in tidal currents and accretion/erosion; and
- changes in estuarine geomorphology response under a scenario of climate change.

Table D4: Impact Assessment for Coastal Geomorphology

Impact	Receptor	Importance	Description of Impact	Magnitude	Significance
Construction					
Changes in flow speeds and directions	Middle Forth Estuary	Very High	Changes in the speed and direction of tidal flows could arise from temporary structures reducing channel cross-sectional area in the tidal sections of the rivers and at the estuarine frontage. This would have the potential to temporarily change erosion and accretion patterns in the intertidal and subtidal areas within the vicinity of the working area. These changes, although noticeable would be temporary during construction only, returning to pre-construction conditions once works are removed.	Negligible	Slight
	Lower Carron Estuary	High			
	Lower Grange Burn Estuary	High			
	Lower Avon Estuary	High			
	Navigation channel of Forth Estuary	Low		Negligible	Neutral
Morphological changes due to direct disturbance of intertidal areas.	Lower Carron Estuary	High	Morphological changes due to disturbance of intertidal areas could occur due to working platforms and any plant movements across the intertidal area. This could potentially change the intertidal surface composition, allowing more sediment to be eroded or, where sediment is regularly driven over by heavy machinery compaction could reduce the erodibility of the material. A total of 6.82 ha of intertidal area would be temporarily affected due to construction, of which 0.34 ha from Flood Cell 1, Flood Cell 0.10 ha from Flood Cell 2, 0.65 ha from Flood Cell 3, 1.02 ha from Flood Cell 4, 3.47 ha from Flood Cell 5 and 1.24 ha from Flood Cell 6. This would be a temporary impact over the construction period which would be localised to the footprint of the works. Once the works are removed, the area will be reinstated after the construction and the waterbodies are anticipated to recover.	Minor	Slight
	Lower Grange Burn Estuary	High			
	Lower Avon Estuary	High			
	Middle Forth Estuary	Very High		Negligible	
Changes in subtidal morphology	Middle Forth Estuary	Very High	Potential changes in subtidal areas could occur due to the localised erosion of the foreshore during the transport of materials to the construction site. Erosion could release material to the subtidal channel, with the following potential effects: - temporary local increase in suspended sediment concentrations which would lead to a reduction in water clarity, increased turbidity and a change to the type and size of material in suspension; and - permanent shallowing of the subtidal slope due to deposition of material eroded from the intertidal, which could have implications for navigation. Any increases in suspended sediment concentration would be temporary and localised to the working areas. Additionally, this is a macro tidal environment, with high suspended sediment concentrations under baseline conditions.	Negligible	Slight
	Lower Carron Estuary	High			
	Lower Grange Burn Estuary	High			
	Lower Avon Estuary	High			

Impact	Receptor	Importance	Description of Impact	Magnitude	Significance
			Permanent shallowing would be extremely localised given the likely volumes of sediment that would be produced in comparison to background conditions.		
	Navigation channel of Forth Estuary	Low	Permanent shallowing within the Navigation Channel as a result of localised erosion is unlikely, given the artificial nature of the channel and its associated upstream components. Any impacts would be temporary and localised. The channel does not display any morphological characteristics that would be impacted through shallowing.	Negligible	Neutral
Operation					
Loss of intertidal area	Middle Forth Estuary (Flood Cells 3 and 6)	Very High	In the Middle Forth Estuary, there are areas of encroachment, resulting in loss of intertidal area, equal to 504 m ² in Flood Cell 3 and 8,439 m ² in Flood Cell 6. These areas fall within the Firth of Forth SPA/Ramsar/SSSI.	Negligible	Slight
	Lower Carron Estuary (Flood Cells 1, 2 and 3)	High	There are two small potential areas of encroachment, and resulting loss of intertidal area, into the Lower Carron Estuary. One area of 19 m ² in Flood Cell 1 and 361 m ² of intertidal area in Flood Cell 2 (which do not fall within the Firth of Forth designated sites).		
	Lower Grange Burn Estuary (Flood Cell 4)	High	There is one very small potential area of encroachment, resulting in the loss of 26 m ² of intertidal area (which does not fall within a designated site) in the Lower Grange Burn Estuary.		
	Lower Avon Estuary (Flood Cell 5)	High	There are two small potential areas of encroachment, and resulting loss of non-designated intertidal area, into the Lower Avon Estuary of 129 m ² cumulatively. These areas do not fall within the Firth of Forth designated sites.		
Changes in water levels	Middle Forth Estuary (Flood Cells 3 and 6)	Very High	The encroachment due to increases in defence footprint in both Flood Cells 3 and 6 is unlikely to cause discernible changes to water levels to the Middle Forth Estuary given the scale of the changes in relation to the waterbody scale. In addition, the mouth of the Avon has been in a fixed position for at least 50 years due to land reclamation, with very little change in the extent of the mudflats at this location.	Negligible	Slight
	Lower Carron Estuary (Flood Cells 1, 2 and 3)	High	Such small areas of encroachment are unlikely to result in discernible changes in water levels at the water body scale, with any changes being small and extremely localised to the encroachment areas in Flood Cells 1 and 3.		
	Lower Grange Burn Estuary (Flood Cell 4)	High	Such a small area of encroachment is unlikely to result in discernible changes in water levels at the water body scale, with any changes being small and extremely localised to the encroachment area.		

Impact	Receptor	Importance	Description of Impact	Magnitude	Significance
	Lower Avon Estuary (Flood Cell 5)	High	Such small areas of encroachment are unlikely to result in discernible changes in water levels at the water body scale, with any changes being small and extremely localised to the encroachment areas.		
Changes in flow speeds and directions	Middle Forth Estuary (Flood Cells 3 and 6)	Very High	The proposed increase in defence footprint will follow the current shoreline alignment, with the toe of the proposed defences placed below the MHW. As the intertidal mudflats at the Grangemouth frontage are wide, with a shallow slope, flow speeds at the top of the intertidal are likely to be much reduced than the subtidal values. It is therefore unlikely that the increase in defence footprint would cause a discernible change in flow speeds and direction in the Middle Forth Estuary.	Negligible	Slight
	Lower Carron Estuary (Flood Cells 1, 2 and 3)	High	The proposed defences within Flood Cell 1, when adjacent to the river margins will be constructed following the current channel alignment. At their set back position, the proposed defences will be above MHW. In Flood Cell 3, tidal flows are relatively slow at this section of the Lower Carron Estuary and the area of encroachment would be localised relative to the water body scale.		
	Lower Grange Burn Estuary (Flood Cell 4)	High	The proposed defences within Flood Cell 4, when adjacent to the river margins will be constructed following the current channel alignment. At their set back position, the proposed defences will be above MHW.		
	Lower Avon Estuary (Flood Cell 5)	High	The proposed defences within Flood Cell 5, when adjacent to the river margins will be constructed following the current channel alignment. At their set back position, the proposed defences will be above MHW.		
Changes in estuarine morphology	Middle Forth Estuary (Flood Cells 3 and 6)	Very High	The total area of designated intertidal area encroached upon is small in relation to overall intertidal habitat within the Middle Forth Estuary. It is unlikely that such a small area of encroachment will promote a discernible change to the current sediment supply. The loss of mudflats would unlikely cause a reduction in sediment supply, given that the fine sediments within the mudflats are related to the high concentrations of sediment in suspension within the Middle Forth Estuary Changes in flow speeds and direction are likely to be small and localised and therefore the potential increase in bed scour and indirect intertidal erosion are likely to be indiscernible	Negligible	Slight
	Lower Carron Estuary (Flood Cells 1, 2 and 3)	High	In Flood Cell 1, permanent loss of natural bank would possibly occur over a length of 26 m, on the left bank on the River Carron. An increased defence footprint in this area would be very small and above MLW.		

Impact	Receptor	Importance	Description of Impact	Magnitude	Significance
			In Flood Cell 3, the area of potential encroachment has the potential to marginally reduce sediment supply locally to the adjacent intertidal area. The total area of intertidal encroached upon is small in relation to overall intertidal habitat within Lower Carron Estuaries and it is unlikely to promote a discernible change to the current sediment supply. Tidal flows are only likely to marginally increase locally, bed scour or intertidal erosion due to higher flow velocities is not likely to increase above background conditions. The proposed defences along Flood Cell 1 will constrain around 27 % of the north bank and 5 % of the south bank of the Lower Carron Estuary, approximately 64 % of the south bank of the Lower Carron Estuary in Cell 2. However, these areas are already constrained by residential and industrial properties and associated road infrastructure. The proposed defences are not likely to change patterns of erosion of the riverbanks.		
	Lower Grange Burn Estuary (Flood Cell 4)	High	The proposed defences are not likely to modify the sediment regime or natural bank profile due to the landward position in which they will be built. Likewise, effects in terms of potential scour increase at the defence toe are not likely to occur. Tidal flows are only likely to marginally increase locally, bed scour or intertidal erosion due to higher flow velocities is not likely to increase above background conditions. The proposed defences along Flood Cell 4 will constrain 100 % of both the north and south banks of the Lower Grange Burn Estuary. This will reduce the cross-sectional area of the channel during higher flows. However, the areas along the north and south banks where new defences are proposed are already constrained by properties and roads. The proposed defences are not likely to significantly change patterns of erosion.		
	Lower Avon Estuary (Flood Cell 5)	High	Permanent loss of natural bank would possibly occur over a length of 35 m, on the left bank on the River Avon. An increased defence footprint in this area would be very small and above MLW. Tidal flows are only likely to marginally increase locally, bed scour or intertidal erosion due to higher flow velocities is not likely to increase above background conditions. The proposed defences along Cell 5 will constrain around 62 % of the north bank and 75 % of the south bank of the Lower Avon Estuary. All the areas to receive new defences, however, are already constrained by industrial infrastructure associated with the oil refinery. The proposed defences are not likely to change patterns of erosion of the riverbanks.		
Changes in estuarine	Middle Forth Estuary (Flood Cells 3 and 6)	Very High	The entire frontage within Flood Cells 3 and 6 is composed of made ground following historic land reclamation.	Negligible	Slight

Impact	Receptor	Importance	Description of Impact	Magnitude	Significance
geomorphology response under a scenario of climate change			The estuarine area within Flood Cell 3 under current sea level conditions is too high to develop saltmarsh. However, this could change as a result of future sea level rise (SLR) which would reduce the Mean High Water Springs (MHWS) elevation, allowing the development of saltmarsh by 2030 (with a 0.10 m SLR at predicted rates) on the northeast section of Grangemouth Port. Given that the Scheme is proposing a set-back defence at the same location as the existing embankment the proposed structures will not change the development of saltmarsh in this area in the future. The frontages along the Middle Forth Estuary in Flood Cell 3 are already constrained by defences and / or high made ground and, even in a future baseline scenario (i.e., without the proposed defences) would not develop intertidal habitats in the future. The proposed defences along both frontages are not likely to cause changes in estuarine geomorphology response under a climate change scenario. In Flood Cell 6, elevations are higher than the Highest Astronomical Tide (HAT). There are two areas which could potentially develop intertidal habitat if defences were to fail, however the proposed defences will be built behind these areas. The intertidal habitats in the Middle Forth Estuary have shown to accrete over the past 100 years. The rate of SLR of which could erode saltmarshes and mudflats is not likely to be reached until 2070. Therefore, no coastal squeeze is currently occurring, nor is likely to occur for the next 50 years. By then, and if the current existing defences in Flood Cell 6 fail, intertidal habitats could develop in the area between the existing and the proposed defences. If these defences fail and intertidal habitat is developed along the right bank of the Avon, then water levels and flow speeds could potentially change along the mouth of the Avon and within the Middle Forth Estuary, increasing speeds during peak flows and increasing levels during high tides. Those changes would, however, be characterised as natural, given that there are no proposals to actively breach defences in this location. Therefore, the proposed defences are not likely to cause coastal squeeze or changes in water levels / flow speeds along the Flood Cell 6 frontage.		
	Lower Carron Estuary (Flood Cells 1, 2 and 3)	High	The proposed defences along Flood Cell 1, 2 and 3 will be located within reaches already constrained by properties, industry, infrastructure, and existing defences. In the absence of the Scheme, these areas would not develop intertidal areas in the future, albeit there would be a potential increase in tidal inundation under a scenario of sea-level rise. With sea-level rise, the Scheme would restrict the locations where high water levels during storms could travel. An increase in inundation could potentially occur to areas not constrained by defences, such as at the vegetated areas on the south bank of the Lower Carron Estuary in Cell1. This, however, would be difficult to quantify in scenarios both with or without the		

Impact	Receptor	Importance	Description of Impact	Magnitude	Significance
			Scheme. In Flood Cell 2, this could result in faster tidal flows, which could increase the erosion of intertidal features within the Lower Carron Estuary. However, this section of the Carron is already constrained. In Flood Cell 3, the proposed defences are not likely to cause changes in estuarine geomorphology response under a climate change scenario.		
	Lower Grange Burn Estuary (Flood Cell 4 and 3)	High	The proposed defences along Flood Cell 4 will be located at areas already constrained by properties and infrastructure. In the absence of the Scheme, these areas would not develop intertidal areas in the future. In Flood Cell 3, the natural development of intertidal habitats along the left bank of the Lower Grange Burn Estuary under rising sea levels could potentially change water levels or flow speeds within Grange Burn, with a marginal increase in water levels during high tides and increase in peak flow speeds during mid to high tides. Those changes would, however, be characterised as natural, given that there are no proposals to actively change defences in this location.		
	Lower Avon Estuary (Flood Cell 5)	High	The proposed defences along Flood Cell 5 will be located at areas already constrained by earth embankments, industry, and infrastructure. Under a scenario of sea level rise, either with or without the Scheme in place, these areas would not be likely to develop as intertidal areas in the future, albeit there would be a potential increase in tidal inundation under a scenario of sea-level rise.		

5. Mitigation

The estuarine geomorphology assessment conducted for the Water Environment chapter of the EIA Report determined that the Scheme is unlikely to cause any significant effects to coastal and estuarine geomorphological receptors. However, the Water Environment chapter includes mitigation items to further reduce the potential impacts of the Scheme on the Lower Grange Burn Estuary. These mitigation items are presented in Table D5.

Table D5: Summary of secondary mitigation for operational phase

Item No.	Mitigation Description
W30	Soften banks on the Grange Burn (Grange Burn/Westquarter Burn) during reinstatement from Bo'ness Rd to the estuary, between NGR NS 92993 81990 and NS 94587 82541. Soft bank protection includes pre-planted coir matting or rolls which supports riparian vegetation to quickly re-establish.
W31	Reprofile the banks on the Grange Burn/Westquarter Burn along Grange Burn Road between NGR NS 93036 82090 and NGR NS 94587 82541 to restore morphological diversity to the channel. Slope reprofiling extent should limit the impact on tree and shrub cover on the north bank.

6. Residual Impacts

Given that there are no significant impacts, and no mitigation will be required for coastal and estuarine geomorphology, no residual effects of significance are predicted for the Scheme's construction or operation within the Water Environment chapter of the EIA Report.

7. References

ABPmer (2014). Grangemouth Siltation Study: Process Understanding and Options Review. ABPmer, Report No. R.2284.

ABPmer (2018). Skinflats Reserve Managed Realignment Project - Environmental Appraisal report. ABPmer Report No. R.2884. A report produced by ABPmer for RSPB Scotland. February 2018, 143p.

CH2M (2017). Grangemouth Flood Protection Scheme – Geomorphology Baseline Assessment. A CH2M report prepared for Falkirk Council. February 2017, 69p.

HR Wallingford (2015). Rosyth International Container Terminal. Wave and tidal modelling. Report no. DER5459-RT001-R02-00, for Babcock Marine (Rosyth) Ltd. September 2015.

HR Wallingford (2016). Rosyth International Container Terminal. Plume dispersion studies. Report no. DER5459-RT002-R01-00 for Babcock Marine (Rosyth) Ltd. February 2016.

Jacobs Arup (2009). Forth Replacement Crossing, DMRB Stage 3 Environmental Statement. Chapter 9: Water Environment. [Online] Available at: <https://www.transport.gov.scot/publication/forth-replacement-crossing-environmental-statement/j11223-014/> (Accessed January 2024)

Jacobs (2024). Grangemouth Flood Protection Scheme Environmental Impact Assessment Report. Chapter 10: Water Environment

Pontee, N. I., Drummond, J.R. and Morrissey, D.J. (2004). Coastline change and implications for habitat loss. Proceedings of the Institution of Civil Engineers. Maritime Engineering, 157, Issue MA3, pp.133-142.

Appendix E: In-Combination Assessment

1. Introduction

This appendix describes the in-combination assessment that has been undertaken to identify whether there are any other plans and projects which could affect the integrity of the Firth of Forth SPA/Ramsar site in-combination with the Scheme.

Article 48 of the Habitats Regulations requires that the determination of whether a plan or project is likely to have a significant effect on a European site includes consideration of other plans or projects which could affect site integrity in combination with the proposal under assessment.

There is potential for adverse effects on the integrity of the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar to accrue as a result of the construction of the Scheme in-combination with other proposed developments on, adjacent to, or within the area. Relevant developments might impact on the estuarine system and the qualifying species by causing disturbance and/or loss of habitat and/or introducing barriers to migration or normal ranging behaviour of the qualifying species within the estuarine catchment.

In terms of the potential for in-combination effects with the Scheme, the key issue, based on the assessment identified within this HRA, is considered to be the potential for other developments to result in an increase in habitat loss and disturbance (and therefore also displacement) within the Firth of Forth estuary, which may impact on the qualifying species of the Firth of Forth SPA/Ramsar site and one qualifying species of Loch Leven SPA/Ramsar site (cormorant, which is known to travel to the Firth of Forth).

The in-combination assessment may identify developments which are themselves considered likely to have a significant effect on the Firth of Forth SPA/Ramsar site and Loch Leven SPA/Ramsar site, and which will also be required to undergo an Appropriate Assessment under Regulation 48 of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended). Equally, there may also be plans or projects which, when considered individually, or collectively with each other, may not adversely affect a European site, but which may have an adverse effect when combined with the Scheme.

2. Projects and Plans Considered in the Assessment

A search on the planning portals for City of Edinburgh Council, Clackmannanshire Council, East Lothian Council, Falkirk Council, Fife Council and West Lothian Council was first undertaken in December 2019 to identify any projects or plans that may act in combination with the Scheme to result in a Likely Significant Effect (LSE) on European sites included in the Stage 1 Screening. Updates were undertaken as necessary during the development of Scheme design, with final searches carried out in February 2025.

All projects or plans within 2km of the Firth of Forth estuary that were in progress at the time of the initial search were identified. Subsequent searches tracked the projects over time and those where no conceivable effects on European sites were identified and which were completed (or were no longer live) were removed from further assessment.

At Loch Leven, projects and plans within 2km were not considered due to the extremely small number of cormorant recorded during the surveys for the Scheme and distance between the Scheme and Loch Leven SPA. Cormorant has a low sensitivity to human disturbance - foraging and/or roosting/loafing cormorants, if disturbed at either or both schemes, have abundant nearby alternative available suitable habitat. No in-combination effects on cormorant are identified.

A search for Marine Licence Applications was also undertaken covering all applications within the Forth Estuary that may act in combination with the Scheme to result in an LSE on European sites, with the most recent search conducted in February 2025.

Available Habitats Regulations Appraisals (HRA), Environmental Impact Assessment Reports (EIA Reports), correspondence with NatureScot or other documentation relevant to the protection of European/international sites were reviewed to determine if the project should be scoped in for consideration of potential in-combination effects with the proposed Scheme.

A number of planning applications exist for minor alterations, extensions to buildings and change in property use, within the Grangemouth and Falkirk areas. Due to the small-scale nature of these proposals, they have been omitted as there is no potential for in combination effects, either solely or cumulatively, with the Scheme.

All information can be found below in Table E1 (plans and projects) and Table E2 (marine licences).

Table E1: Notable plans and projects identified for consideration for in-combination effects with the Scheme

Proposal Name	Location and Distance from Scheme	Local Authority and Planning Application Reference Number	Status/ Decision	Commentary and Potential for In Combination Effects	Conclusion
Redevelopment of former Power Station site with a mix of Class 4 (Business), 5 (General Industrial) and 6 (Storage and distribution) Uses, service facilities, SUDS, landscape works and associated development at Longannet Power Station, Fife.	Longannet, Fife 1.3km	Fife Council 19/02331/EIA Associated proposal and reference: 19/00627/PAN 21/02995/EPN	Permission Expired (Application Permitted with Conditions on January 2020 and valid for three years)	Planning Permission was granted in January 2020 for the redevelopment of the former power station, with a total development area of 122.8ha. Supporting documentation for the proposal included an EIA report and an HRA, the latter of which concluded no adverse effect on site integrity for the Firth of Forth SPA. The site is located on the Longannet Power Station site, and is adjacent to the Firth of Forth, albeit set back from the shore front. The HRA concluded that due to the nature of the development and the responses of birds to disturbances, there would be no adverse effect on site integrity of the Firth of Forth SPA. As there would be no land-take from the Firth of Forth SPA proposed as part of the redevelopment, the availability of habitat for waders and waterfowl would not change. It is therefore considered that there is no potential for in-combination effects with the Scheme in relation to habitat loss. Planning permission for the development has now lapsed and no updated planning permission has been sought in recent years. The future of the site is uncertain, with no confirmed plans communicated by the site owner (Scottish Power). Any future planning applications which require an HRA will be required to consider the Scheme as part of their in-combination assessment.	No in-combination effects. The proposal has no adverse or residual effects on the Firth of Forth SPA or any other European site and the planning permission has now expired.

Proposal Name	Location and Distance from Scheme	Local Authority and Planning Application Reference Number	Status/ Decision	Commentary and Potential for In Combination Effects	Conclusion
Demolition Of Existing Farmhouse And Farm Buildings, Erection of 5 Bonded Warehouses (Class 6) containing 35 Cells, Ancillary Buildings (Workshop, Office, Fork Lift Charger Building), 2 No. Sprinkler Water Tanks And Pump House, Electricity Substation, Hardstanding for Cask/Pallet Storage, Vehicle And Pedestrian Accesses, Parking, Landscaping, Drainage Including SUDS Pond, And Security Fencing - Amended to Reduce Number of Cells from 41 to 35	Cambus, Clackmannanshire 14.5km	Clackmannanshire Council 21/00198/PAN 22/00072/FULL	Approved	The planning statement (21/00198/PAN) identified that the Firth of Forth SPA and River Teith SAC 'are over a kilometer from the site boundary, separated by built environment' and that the proposals 'ensure the safeguarding of the River Teith SAC and Firth of Forth SPA/SSSI qualifying interests.' The HRA considered potential impacts for loss of non-designated habitat used as either roosting and/or feeding areas, and disturbance of qualifying species during the construction and operational phases. Winter and summer bird surveys were conducted to inform the assessment. Oystercatcher was the only Firth of Forth SPA species recorded within the development site during these surveys and recordings were rare. It was also noted that 'Low numbers of birds in general (in terms of assemblage) used the adjacent section of the Firth of Forth SPA, including qualifying species of waders and wildfowl'. The HRA stated 'There will be temporary noise disturbance during the period of construction, but this will take place outwith the SPA and behind an existing 6m earth embankment separating the SPA and proposed development fields. Background operational noise levels are likely to be of a similar nature to the lighting around the existing bonded warehouses immediate to the north'. The HRA concluded that there would be no likely significant effects on any of the SPA qualifying features or site integrity. 'It is proposed the development is constructed over a period of approximately five years working from the west of the site Eastwards. Phase 1 would compromise two warehouses to the west, welfare buildings, access road, SUDS pond and all landscape planting'. No in-combination effects are anticipated.	No in-combination effects. Bird surveys identified that SPA qualifying species did not regularly utilise the development site. The site is located more than 1km from the Firth of Forth SPA (and 14.5km from the proposed Scheme) and existing infrastructure would further reduce the potential for noise and visual disturbance during construction works.

Proposal Name	Location and Distance from Scheme	Local Authority and Planning Application Reference Number	Status/ Decision	Commentary and Potential for In Combination Effects	Conclusion
Granton Harbour Redevelopment Proposal to Develop 152 new flatted units in 4 residential blocks with associated landscaped central courtyard, parking, ancillary structures, and amenity space.	Granton, Edinburgh 26.7km	City of Edinburgh Council 18/01428/PPP 23/00756/FUL 23/00220/REF 23/02575/AMC	Permission Expired. An application to alter conditions has been refused. An appeal was raised, which has also been refused.	The HRA concluded that the potential long-term displacement impact would not result in AESI due to sufficient alternative foraging habitat. An application was made in 2023 to amend conditions of approval PPA-230-2253 (18/01428/PPP), to extend the duration of the permission for three years to 20th June 2026. The application was refused. NatureScot commented that a new HRA was required for the application. An appeal was raised in November 2023 (23/00220/REF) and was dismissed on 13th June 2024. Any future planning applications which require an HRA will be required to consider the Scheme as part of their in-combination assessment.	No in-combination effects. An appeal to extend planning permission was dismissed and there are currently no other active planning permissions in place for this development. Therefore, there are no adverse or residual effects on any European site.
Craighall Residential Development, Musselburgh, mixed use development	Old Craighall Village, Musselburgh 36.9km	East Lothian Council 17/00007/PAN 18/00485/PPM 19/01321/AMM 22/00681/AMM 23/00297/AMC	Granted Planning Permission in Principle	This proposal is for: a mixed use development comprising residential development, education, business, industry and storage and distribution, innovation hub (including classes 2,3,4,5 and 6), employment uses, commercial hub including hotel, local retail, cafe/restaurant and community facilities, residential neighbourhood centre (including use classes 1,2,3 and 10), playing fields and changing facilities, public park(s), construction of the grade-separated junction on the A1, roads and foot/cycle paths, and all ancillary and related development, including improvement to Musselburgh Rail Halt. NatureScot identified the potential for disturbance to foraging birds associated with amenity use of estuarine and coastal fringe habitats. However, they did not consider that the proposed development would have any demonstrable impact on the European sites, certainly not as would equate to more than negligible. The development design should include the provision of high value greenspace for on-site recreation, which would reduce the magnitude and significance of any potential/perceived off-site negative recreational effects. There is no potential for the development to act in-combination with the Scheme and the development based on the available information. Works at the site continue and permission was most recently granted in September 2023 for the erection of an innovation hub building and associated works. No in-combination effects are anticipated.	No in-combination effects. NatureScot advised that they considered that there would be no demonstrable impacts to European sites and none that would equate to more than negligible.

Proposal Name	Location and Distance from Scheme	Local Authority and Planning Application Reference Number	Status/ Decision	Commentary and Potential for In Combination Effects	Conclusion
Musselburgh Flood Protection Scheme	Musselburgh, East Lothian 39km	The scheme will not be consented through the local planning process	Flood order notice, scheme documents, and EIAR were published on 21st March 2024	The proposed scheme will consist of a combination of direct defences (walls and embankments), pumping stations and bridge removal/replacement in Musselburgh town centre along with flood alleviation measures in the upper catchment. Defences for the proposed Musselburgh FPS are to be constructed along the River Esk, which flows through the town, and along the coastal boundary of the Firth of Forth SPA. An options appraisal process has been undertaken and the preferred scheme was approved by the East Lothian Council's cabinet on 21 January 2020. The Outline Design for the scheme was presented to East Lothian on 23rd January 2024 and the scheme documents (including EIA Report) were published on 21st March 2024 (East Lothian Council and Jacobs, 2024). The HRA for the scheme is in development and there is currently no information available on this specific assessment. However, there is sufficient information provided within the EIA Report Biodiversity chapter to determine that no in-combination effects are predicted. Further information on this assessment is provided in Section 3.4 of this HRA.	No in-combination effects. Further information on this assessment is provided in Section 3.4 of this HRA.

Proposal Name	Location and Distance from Scheme	Local Authority and Planning Application Reference Number	Status/ Decision	Commentary and Potential for In Combination Effects	Conclusion
Planning permission in principle for proposed onshore transmission works associated with the Inch Cape Offshore Wind Farm comprising the construction, operation and decommissioning of an onshore substation, electricity cables and associated infrastructure required to export electricity from the Inch Cape Offshore Wind Farm to the National Electricity Transmission	Prestonpans, East Lothian 42.7km	East Lothian Council 16/00021/PAN 17/00008/PAN 18/00189/PPM 21/01474/PPM	Planning Permission granted	The HRA conducted for the scheme concluded that it would not have an adverse effect on the site integrity of any SPA, nor would it contribute to any cumulative impacts of habitat loss in combination with other plans or projects. Planning permission for the development was granted in March 2019. A condition of the approval was that landscape and visual mitigation design must be finalised through consultation with NatureScot to avoid likely environmental impacts identified in the EIAR. This process will include a CEMP and consultation on mitigation measures (such as for noise impacts) for agreement with East Lothian Council. There is no potential for the development to act in-combination with the Scheme based on the available information. Planning permission was renewed in 2021. The Scheme of Landscaping (condition 13) was approved by East Lothian Council in February 2023. <i>'Enabling works for the project were completed in autumn 2023 and construction of the substation began in January 2024. It is expected to take approximately two years to complete'</i> (East Lothian Council, 2024). Therefore, works will be completed prior to the commencement of works for the Scheme. Additionally, Firth of Forth SPA qualifying species recorded at Grangemouth are unlikely to travel to Prestonpans, 42.7km from the Scheme, and any that did would be focussed on inshore foraging and roosting habitat. No in-combination effects are predicted.	No in-combination effects. The proposal has no adverse or residual effects on any European site. Works are also anticipated to be completed prior to construction of the Scheme.

Proposal Name	Location and Distance from Scheme	Local Authority and Planning Application Reference Number	Status/ Decision	Commentary and Potential for In Combination Effects	Conclusion
Levenmouth Demonstration Turbine, Fife Energy Park	Levenmouth, Fife 44.6km	Fife Council 18/03383/FULL 18/03385/FULL	Application Permitted with Conditions	The Appropriate Assessment concluded that the area adjacent to the development was not of high-value to qualifying interests of the Firth of Forth SPA, the habitat was relatively poor and a small area would be impacted by the proposal. <i>'SNH concluded the turbine will have no adverse effect on the integrity of the Firth of Forth SPA...'</i>. Additionally, the AA did not identify any cumulative or in-combination effects. A variation to the application was submitted (18/03385/FULL) and was approved with conditions. This condition stated that <i>'The development authorised by this permission shall be removed and the land restored to its former condition no later than 5th September 2029 (or any time before this expiry period).'</i> As of February 2025, the demonstration turbine is still in operation. It is anticipated that this will be removed prior to the commencement of construction works adjacent to the SPA for the Scheme. Additionally, Firth of Forth SPA qualifying species recorded at Grangemouth are unlikely to travel to Levenmouth, 44.6km from the Scheme, and any that did would be focussed on inshore foraging and roosting habitat. No in-combination effects are predicted.	No in-combination effects. The proposal has no adverse or residual effects on any European site and the land is expected to be restored to its former condition prior to the Scheme works commencing adjacent to the Firth of Forth SPA.

Table E2: Notable marine licences identified for consideration of in-combination effects with the Scheme

Licence	Location	Approximate Distance from Scheme	Application Date and Status	Commentary and Potential for In Combination Effects	Conclusion
Maintenance and Capital Dredging and Sea Disposal – Port Babcock Rosyth, Dunfermline, Fife Marine Scotland 00010502	Rosyth, Fife	13km	Granted	The application is for the continuation of a licence for maintenance dredging of port approaches and disposal of the arisings at a recognised disposal site. The works are focussed within the port. Within this area, there is regular disturbance from the movement and operation of vessels and terrestrial plant as part of typical port activities. The works are a continuation of an existing licence, and the application documentation did not indicate that the proposals would result in any impacts or LSEs to European sites. The licence will expire on 19 th February 2027, prior to the commencement of construction works adjacent to the SPA for the Scheme. Therefore, no in-combination effects are anticipated.	No in combination effects. No impacts to European sites were highlighted within the application documents and the licence expires prior to the commencement of Scheme works adjacent to the Firth of Forth SPA
Granton Harbour Redevelopment, revetment reconstruction and extension Marine Scotland 00009904 00009905	Firth of Forth at Granton Harbour, Edinburgh	27km	Granted	These works form part of the Granton Harbour Regeneration Development. In the west harbour, revetment will be reconstructed and extended. The HRA conducted states ' <i>MS-LOT conclude that providing the conditions listed in section 12 are adhered to, there will be no adverse effect on the site integrity of the Firth of Forth SPA</i> ' (and six other European sites) ' <i>either in isolation or in-combination with other projects.</i> ' The licence will expire on 31 st July 2025, prior to the commencement of construction works for the Scheme. Therefore, no in-combination effects are anticipated.	No in-combination effects. The proposal has no adverse or residual effects on any European site and the licence expires prior to the commencement of Scheme works.
Construction and Dredge and Deposit – Port of Leith Outer Berth Marine Scotland 00009818 00009819	Firth of Forth at Port of Leith, Edinburgh	30km	Granted	Works include the construction of a new berthing facility, redevelopment of an existing berth, and dredging. The HRA concluded that the proposal would not result in any adverse effects on the site integrity on the Firth of Forth SPA (or eight other European sites) either in isolation or in combination with other plans or projects, providing that the conditions set out in Section 4 are complied with. The only potential source of cumulative impacts identified was underwater noise. Licences were granted for Construction, alteration or improvement of any works (22 nd December 2022) and Deposit of any substance or object (23 rd December 2022). Both licences expire on 31 st December 2025, prior to the commencement of construction works for the Scheme. No in-combination effects are anticipated.	No in-combination effects. No adverse or residual effects on any European site have been identified.

Licence	Location	Approximate Distance from Scheme	Application Date and Status	Commentary and Potential for In Combination Effects	Conclusion
Inch Cape Offshore Windfarm (Revised Design) - Additional Landfall Works at Cockenzie Marine Scotland 00010546 00010672 00010690 00011083	Firth of Forth at Cockenzie, Prestonpans	43km	Granted (Awaiting decision for 00011083)	The marine licence is required for the proposed seawall and revetment works and East Lothian Council Outfall Diversion (the 'Additional Landfall Works') to facilitate the Offshore Export Cables installation for the Inch Cape Offshore Wind Farm. The works include sections of the existing sea defence wall at Cockenzie being temporarily removed and then reinstated on completion of the cable installation. NatureScot commented that '<i>we do not support the proposed approach to HRA (section 4.5) which concludes that 'no LSE' arises from the additional works. We advise that there is connectivity from the additional works to several European sites, and that they generate likely significant effects upon those sites.</i>' However, NatureScot further stated that '<i>as the scale and magnitude of these effects fall within existing consented parameters, we advise that the previous HRA and appropriate assessment can be used in support of these additional works. In our view the previous conclusions of no adverse effects on site integrity on any European site apply to the current proposal.</i>' Disturbance to birds was considered to be not significant as the area of the works is small in relation to the wider availability of habitat and is temporary in nature, and that there are large areas of sufficient alternative habitat available for all ornithological receptors. A request (00011083) was submitted on 10th February 2025 for a variation to licence 00010672. The proposed variation captures the following changes: - removal and re-construction of the East Lothian Council outfall is no longer required; - minor changes to the layout and methods for the seawall removal and reinstatement; and - minor updates to temporary and permanent deposit of materials. The changes mean that an offshore cofferdam, granted under marine licence 00010690, is no longer required. Instead, an onshore secant pile cofferdam will be installed, which is permitted through a separate planning permission. The licence application states that '<i>any impact arising from the revised proposed works have been considered to fall within the impacts originally assessed</i>'. It is proposed that the Additional Landfall Works will be undertaken between April 2025 and December 2028, including any backfilling activities after the cable protection systems are installed. The Inch Cape project website confirmed on 27/01/2025: '<i>Construction of the onshore substation and early landfall works are now underway in Cockenzie, East Lothian</i>' (Inch Cape Wind, 2025). No in-combination effects are anticipated.	No in-combination effects. No adverse or residual effects on any European site have been identified.
Forthwind Demonstration Project	Firth of Forth at Methil, Leven	44km	Granted	The site is situated approximately 1.5km off the coast of Methil, Leven. The project will consist of a single test and demonstration turbine with an installed	No in combination effects. The proposal has no adverse

Licence	Location	Approximate Distance from Scheme	Application Date and Status	Commentary and Potential for In Combination Effects	Conclusion
Marine Scotland 00009834				capacity of 20MW, and an operational life of 25 years. A temporary meteorological mast will also be installed, with a design life of 5 years. The HRA Appropriate Assessment states ' <i>MS-LOT concludes that there will be no adverse effect on the site integrity of the... Firth of Forth SPA</i> ' (and seven other European sites) ' <i>from the Forthwind proposal either in isolation or in combination with other projects.</i> ' Firth of Forth SPA qualifying species recorded at Grangemouth are unlikely to travel to Methil, 44km from the Scheme, and any that did would be focussed on inshore foraging and roosting habitat. Therefore, no in-combination effects are anticipated.	or residual effects on any European site.

3. In-Combination Conclusion

No other plans or projects were identified which could affect the integrity of the Firth of Forth SPA/Ramsar site in combination with the Scheme. The potential for projects identified in Tables E1 and E2 to have an adverse effect when combined with each other and the Scheme has been considered. No in combination effects were identified when taking into account factors such as timing of works, proposed mitigation, habitat use, and distance from the Scheme. Therefore, whilst it has been concluded that there is the potential for an AESI on the Firth of Forth SPA from the Scheme, there will be no cumulative effects to exacerbate this impact.

4. References and Information Sources

East Lothian Council (2024). Planning and Building Standards. Former Cockenzie Power Station. Available at: https://www.eastlothian.gov.uk/info/210547/planning_and_building_standards/12312/former_cockenzie_power_station [Accessed January 2025]

East Lothian Council and Jacobs (2024). Musselburgh Flood Protection Scheme. Available at: <https://www.musselburghfloodprotection.com/proposed-scheme/> [Accessed October 2024].

Inch Cape Wind (2025). Scottish flagship offshore wind project Inch Cape reaches financial close. Available at: <https://www.inchcapewind.com/scottish-flagship-offshore-wind-project-inch-cape-reaches-financial-close/> [Accessed February 2025]

Planning and Licence Portals

City of Edinburgh Council:
<https://citydev-portal.edinburgh.gov.uk/idoxpa-web/search.do?action=simple&searchType=Application>

Clackmannanshire Council:
<https://publicaccess.clacks.gov.uk/publicaccess/search.do?action=simple&searchType=Application>

East Lothian Council:
<https://pa.eastlothian.gov.uk/online-applications/search.do?action=simple&searchType=Application>

Falkirk Council:
<https://planning.fife.gov.uk/online/search.do?action=simple&searchType=Application>

Fife Council:
<https://planning.fife.gov.uk/online/search.do?action=simple&searchType=Application>

Marine Scotland:
<https://marine.gov.scot/marine-licence-applications>

Grangemouth Flood Protection Scheme Outline Construction Environmental Management Plan

Document no: B2487700-JEC-S5-XXX-XXX-RE-I-0002
Revision: 0.1

Falkirk Council
B2487700

Grangemouth Flood Protection Scheme
23 May 2025

Grangemouth Flood Protection Scheme
Outline Construction Environmental Management Plan

Client name: Falkirk Council
Project name: Grangemouth Flood Protection Scheme
Client reference: B2487700 **Project no:** B2487700
Document no: B2487700-JEC-S5-XXX-XXX-RE-I-0002 **Project manager:** Alan McGowan
Revision: 0.1 **Prepared by:** Rosanna Mooney
Date: 23 May 2025 **File name:** GFPS Outline CEMP
Document status: For issue

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
0.1	27/04/2025	Document draft	RM	PS	RMe	AM
0.1	23/05/2025	Clean version for issue	RM	PS	RMe	AM

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments

Jacobs U.K. Limited

95 Bothwell Street
Glasgow, Scotland G2 7HX
United Kingdom

T +44 (0)141 243 8000
F +44 (0)141 226 3109
www.jacobs.com

© Copyright 2025 Jacobs U.K. Limited. All rights reserved. The content and information contained in this document are the property of the Jacobs group of companies ("Jacobs Group"). Publication, distribution, or reproduction of this document in whole or in part without the written permission of Jacobs Group constitutes an infringement of copyright. Jacobs, the Jacobs logo, and all other Jacobs Group trademarks are the property of Jacobs Group.

NOTICE: This document has been prepared exclusively for the use and benefit of Jacobs Group client. Jacobs Group accepts no liability or responsibility for any use or reliance upon this document by any third party.

Contents

1.	Introduction.....	2
1.1	Purpose of the Outline Construction Environmental Management Plan.....	2
1.2	The Project.....	2
1.3	Environmental Context and Constraints	3
1.4	Construction Phase Activities	3
2.	Project team Roles and Responsibilities	4
2.1	Roles and Organisations Involved in the Delivery of the CEMP	4
3.	Environmental Actions and Commitments.....	6
3.1	Record of Environmental Actions and Commitments	6
4.	Consents and Permissions	8
5.	Environmental Asset Data and As-Built Drawings.....	10
5.1	Collection and Submission of Environmental Data	10
5.2	Collection and Submission of Engineering Data.....	10
6.	Details of Maintenance and Outline CEMP Monitoring Activities	11
6.1	Environmental Monitoring Requirements	11
6.2	Monitoring of Proposed Mitigation	11
6.3	Environmental Management Plans.....	11
7.	Induction, Training and Briefing Procedures for Staff	12
7.1	Overview.....	12
	Appendix 1: Record of Environmental Actions and Commitments	14
	Appendix 2: Additional information	54
	Annex A: Key Environmental Constraints Figure	55
	Annex B: Relevant Management Plans.....	56
	Annex C: Environmental Method Statements.....	57
	Annex D: Emergency Procedures and Record of Any Environmental Incidents	58
	Annex E: Copy of Evaluation of Change Register	59
	Annex F: Final Environmental Investigation and Monitoring Reports	60
	Annex G: Risk Register	61

1. Introduction

1.1 Purpose of the Outline Construction Environmental Management Plan

Jacobs undertook an environmental assessment, including an Environmental Impact Assessment Report (EIA Report) (Jacobs, 2024) and a Habitats Regulations Appraisal (HRA), on behalf of Falkirk Council for the Grangemouth Flood Protection Scheme (hereafter referred to as 'the Scheme').

As part of the EIA Report assessment process, a number of commitments were made to action good practice measures during design and construction. In addition, mitigation measures were proposed and committed to, to offset any significant effects identified as part of the assessment.

The unpublished Habitats Regulations Appraisal (HRA) for the Scheme, also details mitigation and compensation measures to avoid, reduce and offset potential impacts to qualifying species of the Firth of Forth Special Protection Area (a European site).

During consultation with NatureScot on the HRA for the Scheme, NatureScot requested that an Outline Construction Environmental Management Plan (CEMP) be presented to the Competent Authority prior to consent of the Scheme to provide the Competent Authority with confidence that appropriate mitigation is implemented at the relevant time and location. Falkirk Council will act as the Competent Authority for the Scheme.

This Outline CEMP provides an indication of how the final CEMP should be structured and provides clarity on what it should contain. It is expected that this Outline CEMP will be further developed into a more detailed CEMP by the Contractor prior to, during and post-construction as appropriate. Post-construction, the CEMP will be provided to the Falkirk Council for future management and operation.

The requirement for a CEMP, or documents that sit within the CEMP, is stated within the EIA Report and in the HRA.

1.2 The Project

The Scheme is mostly located within the town of Grangemouth, which is situated along the southern shore of the Firth of Forth, approximately 5 km northeast of the town of Falkirk and 30 km west of the city of Edinburgh. Some sections of the Scheme extend into the boundaries of smaller settlements, including Wholeflats, Glensburgh, Langlees, Carron and Carronshore.

The Scheme comprises approximately 28 km of flood defences, consisting of flood walls, embankments, coastal revetment, the relining of the flood relief channel, modification to the port entrance, modifications to several existing bridges and a new flow control structure on the Grange Burn. To accommodate access, the Scheme also includes pedestrian and vehicular flood gates, ramps and access tracks or footpaths. Following construction, river channels/banks temporarily affected during construction will be restored. Appropriate landscaping measures will be incorporated to reduce the effects the Scheme has on views and the local landscape; these will be finalised once the Scheme has been confirmed by Falkirk Council. A detailed description of the Scheme is provided in Chapter 4: The Scheme, of the EIA Report, and an overview of the Scheme location can be found in Figure A1.1 in Appendix A of the EIA Report.

The Scheme will provide flood risk protection up to the 1 in 200-year level. In addition to protecting against coastal flood risk from the Firth of Forth, the Scheme will address fluvial flood risk, primarily from the Rivers Carron and Avon, the Grange Burn and associated flood relief channel, as well as short sections of their tributaries (the Westquarter, Polmont, Chapel and Millhall Burns). Overall, the Scheme is anticipated to protect 2,760 residential properties, 6,025 people, 23 km of roads and 1,200 non-residential properties including a petrochemical complex, a major port and associated nationally important infrastructure (e.g. pipelines

importing crude oil and gas from the North Sea and exporting refined products to industrial installations in northeast England) (Falkirk Council and Jacobs, 2023).

1.3 Environmental Context and Constraints

The Contractor will identify the key environmental constraints in the vicinity of the Scheme. It is likely that a figure will be prepared for each specific phase of the construction works and these can be provided in Annex A: Key Environmental Constraints Figure of this document. Identification of key environmental constraints should include consideration of, but may not be limited to, the following:

- Designated sites: Firth of Forth Special Protection Area; Firth of Forth Ramsar site; and Firth of Forth Site of Special Scientific Interest;
- Non-designated sites: local wildlife sites and a Site of Nature Conservation (SINC);
- Woodland listed on the Ancient Woodland Inventory (AWI);
- Water Framework Directive waterbodies and other notable features within the water environment;
- Scheduled monuments and listed buildings;
- Air Quality Management Areas; and
- Rights of way, local paths and cycle routes.

1.4 Construction Phase Activities

The Contractor will be responsible for developing the programme and sequencing of construction works, subject to any constraints imposed by the project team and/or planning/licence conditions. The construction period for the Scheme is estimated to be up to 10 years, with discrete sections being completed in phases within that timeframe. The sequencing of construction works is likely to mean that only two phases can be undertaken at the same time. Table 1 identifies the current expected phasing plan. Construction works are anticipated to be carried out from Monday to Friday, over a period of 50 working weeks each year. Working hours are expected to be within 08:00 to 18:00 Monday to Friday. If any weekend or bank holiday working is required, this must be approved by the client.

More information on the anticipated construction phasing and methods is provided in Appendix C4.2: Construction Methodology Report of the EIA Report.

Table 1: Approximate Phasing of Construction Works

Phase Number	Flood Cell Number
1 (Residential areas)	1 & 4 (part)
2 (Port – lock gates)	3
3 (Port – flood defences)	3
4 (Industrial areas – not estuary frontage)	2, 4 (part) & 5
5 (Industrial areas – estuary frontage)	6

The key dates for the anticipated construction programme are outlined below, assuming the hearing for the Scheme is concluded by 2026 and the Scheme is confirmed. These dates are subject to change and will be periodically reviewed.

- Enabling works: 2028.
- Main construction phase: late 2028 – 2038 (Scheme operational by 2038).
- Defects correction period: minimum two years post-construction works (landscape maintenance period is to be confirmed in due course).

2. Project team Roles and Responsibilities

2.1 Roles and Organisations Involved in the Delivery of the CEMP

Falkirk Council will be responsible for overseeing delivery of the Scheme within agreed timeframes and budgets. Falkirk Council will confirm prior to construction if responsibility for overseeing environmental management on site will be delegated to the Contractor. The Contractor will be responsible for the construction phase of the Scheme, including any subcontractors. They will be appointed in writing by Falkirk Council to plan, manage, monitor and coordinate health and safety during this phase. The Contractor will also be responsible for updating this Outline CEMP, once design and construction plans have been finalised, and handing the updated CEMP over to Falkirk Council for monitoring during operation, as appropriate. Some of the site supervision roles involved in the delivery of the CEMP mitigation will be delegated where required by the Contractor. These suitably experienced onsite personnel will be responsible for implementation, reporting and monitoring of environment mitigation during the contract period. This includes, but is not limited to, the Ecological Clerk of Works (ECoW) who may supervise, monitor or check the Contractor's Environmental Method Statements, Management Plans and working methods.

A summary of key personnel and their anticipated responsibilities are provided in Table 1. In addition, the delegation of responsibilities will be clearly identified within relevant project documents and site files. The Contractor is required to keep a record of competent expert statements including contact details and lines of escalation for personnel involved in the implementation, reporting and monitoring of the environmental mitigation required through this Outline CEMP, including the organisations described in Table 2.

Table 2: Key Scheme Roles and Associated Responsibilities

Role	Responsibilities
Falkirk Council	Oversee and monitor the implementation of whole Scheme, including the personnel fulfilling the roles detailed below.
Contractor	- Legally and contractually responsible for the implementation of the CEMP and ensuring that the environmental requirements outlined in the CEMP are understood and implemented on Site. - Responsible for consultation with statutory consultees (including NatureScot, Marine Scotland, Scottish Environment Protection Agency (SEPA)) as required.
Engineering Manager	They will oversee all engineering related aspects of construction to ensure adherence to appropriate engineering standards and regulations.
Environmental Manager (as appointed by the Contractor)	The Environmental Manager would be responsible for the maintenance of all environmental plans and registers including ensuring that the environmental measures and mitigations are implemented on site and recorded within the CEMP. The Environmental Manager would be the main point of contact with the Engineering Manager and the Community Liaison Officer. They would also develop good working relationships with key stakeholders and the local authorities.
Senior Health, Safety, Security and Environment (HSSE) Lead (as appointed by the Contractor)	Responsible for all Health and Safety processes and procedures for the project.
Site Personnel	- Attend site induction(s) and environmental and/or training (including toolbox talks and stand downs) as instructed. - Carry out all works in accordance with agreed methods, trainings and briefings. - Stop works if a new environmental constraint is identified or any methods/conditions deviate from agreed processes and report information to Principal Contractor. - Follow incident reporting procedures.
Environmental Clerk of Works / Environmental Specialists (as appointed by the Contractor or Falkirk Council)	- Deliver specific environmental mitigation and monitoring the implementation of specific as detailed in Appendix 1: Record of Environmental Actions and Commitments. - Monitor the overall implementation of the CEMP. - Provide site inductions on environmental practices, conducting toolbox talks, specialist surveys and overseeing monitoring activities as required. - Undertake day to day monitoring and compliance checks. - Monitor environmental compliance and good practice on site.

	• Monitor implementation of the relevant mitigation measures identified in Appendix 1. • Maintain and update site specific method statements. • Oversee the environmental components of the project. • Co-ordinate with specialists and liaise with the Local Authority and relevant stakeholders to agree working hours, discuss working methods and secure formal consents where required. • Audit the Contractor's Site Environmental Management Plans and Programmes and ensuring compliance. • Monitor compliance with the environmental requirements of the Contract, Works Information and the CEMP. • Review and maintaining awareness of the requirements of key legislation, policies, and strategies prior to and during construction. • Manage and oversee other environmental specialists.
Ecological Clerk of Works (ECOW) (as appointed by the Principal Contractor)	• Provide ecological advice over the entire construction programme. • Undertake or oversee pre-construction surveys for protected species in the areas affected by the Scheme. • Ensure mitigation measures are implemented to avoid and reduce impacts on ecological features. • Monitor the implementation of the mitigation measures during the construction phase to ensure compliance with protected species licence conditions, legislation and commitments within the EIA Report and associated HRA for the Scheme. • Consult with NatureScot as appropriate on potential changes to mitigation commitments or potential breaches of licensing conditions and legislation.
Employer's Ecologist (acting on behalf of Falkirk Council)	• Supervise the Contractor's ECOW to ensure compliance with specific mitigation (as detailed in Appendix 1). • Undertake bird monitoring surveys for the winter period prior to construction works along the Forth Estuary and throughout construction.
Community Liaison Officer	• Provide consultation and engagement with all relevant parties. This includes site personnel, Falkirk Council, relevant local authorities, other statutory bodies and regulatory authorities, relevant community groups, businesses and residents in local communities affected by the construction works. • Notify occupiers of nearby properties of the nature and anticipated duration of planned construction works that may affect them. • Establish dedicated contact details (such as a dedicated email address, postal address or social media account) for enquiries and complaints during the construction phase. The relevant contact details will as a minimum be displayed on signs around the construction site and will be published on the project website. Enquiries and complaints will be logged by the Community Liaison Officer in a register and appropriate action will be taken in response to any complaints.

3. Environmental Actions and Commitments

3.1 Record of Environmental Actions and Commitments

The Record of Environmental Actions and Commitments (REAC) (provided in Appendix 1) identifies the environmental commitments made during the design stage to address the potential environmental effects of the Scheme. The environmental commitments, including the assumptions and reasoning for which the actions are based and the relevant legislation which governs them, are provided in the technical chapters of the EIA Report. Table 2 provides the EIA Report chapter numbers which relate to the mitigation item codes used in the REAC.

Table 2: Mitigation Item Reference

Chapter Number	Chapter Title	Mitigation Item Reference
6	Population and Human Health	PHH (PHH1 - PHH10)
7	Biodiversity	E (E1 – E26)
8	Noise and Vibration	NV (NV1 – NV2)
9	Landscape and Visual	LV (LV01 – LV27)
10	Water Environment	W (W1 – W40)
11	Soils, Geology and Land Contamination	G1 (G1 – G16)
12	Air Quality and Climate Change	AQ (AQ01), CC (CC01 – CC06)
13	Cultural Heritage	CH (CH1 – CH6)
14	Traffic and Transport	TT (TT1 – TT3)

Chapter 16 (Schedule of Environmental Commitments) of the EIA Report collates the environmental mitigation from the technical chapters as well as standard mitigation and mitigation for environmental topic areas which were scoped out of the assessment.

The REAC also includes mitigation measures detailed in the HRA, which must be implemented to reduce or avoid potential adverse impacts on qualifying species of the Firth of Forth SPA.

The REAC will be updated as the project progresses and will be finalised at the end of construction upon completion of the Scheme. Post construction, the CEMP will be provided to Falkirk Council for the future maintenance and operation of the Scheme.

The REAC states at which stage of the project the environmental mitigation commitment is aligned to. For clarity, pre-construction works include advance works (including service diversions and some environmental mitigation) and site mobilisation (i.e. the establishment of construction site). The Contractor is responsible for monitoring and managing change, e.g. a change in programme and associated seasonal restrictions, and should update Annex E (Copy of Evaluation of Change Register) as appropriate.

The REAC requires the Contractor to produce and develop multiple Environmental Management Plans and Method Statements. These will be produced pre-construction and updated and refined through construction as appropriate. Annex B (Relevant Management Plans) and Annex C (Environmental Method Statements) have been provided as placeholders for the Contractor to populate and they list the management plans and method statements that are required as mitigation through the REAC.

The Contractor is required to monitor the achievement of environmental mitigation and should develop achievement criteria as well as utilising the Completion Record column of the REAC. Risks associated with non-compliance of the environmental commitments outlined in the REAC will be managed by the Contractor and recorded in the Risk Register (refer to Annex G).

4. Consents and Permissions

The Contractor will be required to comply with the conditions of all permits, consents and licences obtained during the construction phase. Table 3 lists the anticipated consents and licences, including the party responsible for obtaining the licences, and will be reviewed and updated by the Contractor, as required, throughout the Scheme.

[Note: Contractor to update as required]

Table 3: Anticipated Consents/Licences Required

Consent or Licence Required	Relevant Legislation	Description	Relevant Mitigation Item	Timing/Phase	Responsible Party
Marine Licence	Marine (Scotland) Act 2010 Marine Licensing (Pre-application Consultation) (Scotland) Regulations 2013	The Marine (Scotland) Act 2010 requires that licences are obtained for certain activities, including construction work, below the mean high water springs limit. The Licensing Operations Team at the Marine Directorate is responsible for granting licences.	W23	Pre-Construction	Client Contractor (responsible for temporary works)
CAR Licence	The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) (CAR)	CAR licences from SEPA will be required for some construction work in the vicinity of watercourses and for some water run-off from construction sites.	E17 W23	Pre-Construction Construction	Client Contractor
European Protected Species Licence	Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland)	Licences may be required where works could disturb European protected species, obstruct access to or destroy their shelters. This may include, but is not limited to, works that could affect bats, otter or great crested newt.	E10 E12	Construction	Contractor
Protected Species Licence	Wildlife and Countryside Act 1981 (as amended) Wildlife and Natural Environment (Scotland) Act 2011	Licences may be required where works could constitute an offence to species protected under UK legislation. This includes works that could affect badger and species listed under the relevant Schedules of the Wildlife and Countryside Act (as amended).	E12	Construction	Contractor
Special Site of Scientific Interest Operations Requiring Consent	Wildlife and Countryside Act 1981 (as amended)	Works will be required within the Firth of Forth SSSI. Permission must be sought from NatureScot for any works that are listed as Operations Requiring Consent within the SSSI.	N/A	Pre-Construction	Contractor
Scheduled Monument Consent	Ancient Monuments and Archaeological Areas Act 1979 Historic Environment Scotland Act 2014	The Antonine Wall is designated a Scheduled Monument and UNESCO World Heritage site and requires consent for construction works within	CH6	Pre-Construction Construction	Client Contractor

	The Scheduled Monument Consent Procedure (Scotland) Regulations 2015	the boundary of the Scheduled Monument and the UNSECO World Heritage site.			
Forth Ports Works Licence	1964 Harbours Act	As Port Authority, Forth Ports are required to issue a Works Licence for construction work within the Port of Grangemouth. This is part of the statutory consents for construction work within the Port, or land owned by Forth Ports.	N/A	Construction	Contractor
Forth Ports Works Permit	N/A	Forth Ports have indicated a Works Permit would be required for construction work on Forth Ports land. This is an internal method for Forth Ports to manage work within the Port or on land Forth Ports own.	N/A	Construction	Contractor
Petrochemical Plant Permit	Control of Major Accident Hazards (COMAH) Regulations	Consent from the site operator is required to undertake work within the site or close to their apparatus. The Petrochemical Plant have indicated that they will consent construction works for the Scheme via a Works Permit.	N/A	Construction	Contractor

5. Environmental Asset Data and As-Built Drawings

5.1 Collection and Submission of Environmental Data

The collection and submission of environmental data is an ongoing process. Data collected during the design stage of the Scheme has informed the assessment process and is presented in the EIA Report and HRA. Where additional environmental data is expected to be required during the pre-construction and construction phases, the Contractor is responsible for collating and submitting this data to Falkirk Council and any relevant stakeholders. During these stages, the Contractor should update this section of the CEMP to detail the submission arrangements of data.

[Note: Contractor to update as required]

5.2 Collection and Submission of Engineering Data

It is anticipated that the Scheme would be procured through multiple individual contracts. Some of these contracts are likely to be on a construct only basis, where the appointed Contractor constructs the Scheme in accordance with the detailed design carried out by designers appointed by Falkirk Council. Some elements of the Scheme are likely to be procured on a design and construct basis where the appointed Contractor is also responsible for carrying out the design in accordance with a performance specification provided by Falkirk Council. Under the terms of both these contract types, the Contractor would undertake the design of the temporary works. Engineering data, including outline design drawings, used in the EIA Report will be provided to the appointed Contractor as appropriate.

The Contractor will be required to submit design drawings and specifications to Falkirk Council for acceptance for all aspects they are responsible for designing.

[Note: Contractor to update as required]

6. Details of Maintenance and Outline CEMP Monitoring Activities

6.1 Environmental Monitoring Requirements

This section summarises the systems of monitoring which will be required to maintain an audit trail of the environmental obligations of the Scheme.

6.2 Monitoring of Proposed Mitigation

The Contractor will be responsible for implementing and, where appropriate monitoring, the mitigation measures outlined in Appendix 1 Record of Environmental Actions and Commitments.

As described in Table 1 and Appendix 1, the Contractor's compliance with specific mitigation measures will be monitored through a number of different means. Monitoring is required to ensure compliance and ensure construction activities are carried out in such a manner to reduce environmental impacts. As identified in the HRA section of the REAC in Appendix 1, bird monitoring is also required to confirm the effectiveness of the HRA compensation sites and observe qualifying species within the Firth of Forth SPA/Ramsar site to determine if mitigation measures require adjustments to reduce potential disturbance. Monitoring roles may be conducted by an Environmental Clerk of Works (EnvCoW), an Ecological Clerk or Works (ECoW) or an ecologist appointed by Falkirk Council. The specific measures these representatives may take in order to provide this monitoring of compliance will be detailed in the Employers Requirements in the Contract. In addition, SEPA may conduct site visits to monitor compliance of pollution prevention mitigation and any licence conditions.

The Contractor will keep a record of environmental mitigation monitoring and any potential areas of non-compliance as well as completing a final environmental investigation. The Contractor should record this monitoring by updating Annex F (Final Environmental Investigation and Monitoring Reports) of this Outline CEMP as appropriate.

6.3 Environmental Management Plans

The Contractor will be required to provide environmental management plans which inherently require monitoring of environmental data and the interaction with construction activities. Annex B (Relevant Management Plans) provides a list of some of the environmental management plans that are likely to be required as part of the Scheme construction. The Contractor will monitor compliance using these management plans and should update this annex with the plans as appropriate.

An Outline Landscape, Ecology and Habitat Management Plan (LEHMP) has been produced as part of the EIA Report (Appendix B9.10 of the EIA Report). The Contractor is required to follow the guidance therein and update the management plans where appropriate.

7. Induction, Training and Briefing Procedures for Staff

7.1 Overview

Table 4 identifies an indicative programme of training on environmental issues relevant to the Scheme that have been identified for delivery prior to and during the construction stage. On commencement of site mobilisation, the Contractor will be responsible for site inductions and training of all personnel on the site, whether visitors, full time staff or subcontractors.

All individuals working on or visiting the site will be required to attend the Contractor's site-specific induction. Those participating in or near to specific activities that have an environmental impact will be required to attend additional training led by the Contractor or appointed specialists, on considerations including ecology, pollution control, waste management and emergency procedures for minor and major incidents. The Contractor should update Annex D (Emergency Procedures and Record of Any Environmental Incidents) with emergency procedure guidance and with a record of incidents.

Toolbox talks will be posted within common use areas such as welfare unit areas. Key environmental issues linked to the programme will be targeted on the daily notice board as a reminder to all staff on site, e.g. seasonal environmental constraints such as bird nesting seasons.

The list in Table 4 is not exhaustive, and the Contractor or an appointed specialist on site must highlight requirements for additional training as the project progresses to improve and add value to the overall site environmental awareness and compliance. It is a requirement for the site to maintain the standard of environmental management and minimise risks that could negatively impact on the environment. The Contractor must keep a record of training for audit and monitoring purposes.

Any additional induction and training requirements should be inserted in Table 4 by the Contractor as they are identified throughout the lifetime of the Scheme.

Table 4: Indicative Training Requirements

Topic	Personnel	Delivery	Description
Site Safety Induction and Environmental Awareness	All	Site induction	Environmental training during the induction is likely to include the following: • company/project environmental policy; • site environment; • fuel containment; • earthworks and excavations (risk of exposing contamination); • pollution protocol and measures (e.g. use of spill kits); • defined materials storage area (excavated and imported); • defined waste areas (domestic and construction materials); • wheel wash and road sweeping; • dust and emissions control; • noise and vibration control; • site traffic protocols and routes in the form of a Traffic Management Plan (TMP) (including haul routes and staff travel to site plan); • warning signs; • site inspection and monitoring forms; • material procurement; • toolbox talks where relevant to specific works; • communication systems on site (e.g. dealing with the public, incident and near miss reporting, environmental observations and suggestions etc.); • site organisation, key personnel responsibilities and contact details;

			• emergency response plan(s) for addressing safety and environmental issues; • contamination risk assessment; and • update and maintain site specific toolbox talks or advisory sheets relevant to the Scheme.
Ecological toolbox talk	All	Site induction	An ecological toolbox talk will be delivered to site personnel prior to works commencing. This will cover all ecological receptors likely to be present on site and associated legal compliance.
Noise and vibration toolbox talk	All	Site induction	A noise and vibration toolbox talk will be delivered to all site workers prior to working on the construction site. This will cover best practice construction methods relating to noise and vibration control e.g. by employing techniques to keep site noise to a minimum.

[Note: Contractor to update as required]

Appendix 1: Record of Environmental Actions and Commitments

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
EIA Report Chapter 6: Population and Human Health							
PHH1	Pre-construction	- Major Incident Control Committee (MICC) to be consulted at detailed design to discuss whether the Scheme construction or operation may affect emergency procedures and whether changes may be required. - Ensuring contractor is briefed on emergency procedures and risks. - Ensuring there are access routes to every section of the flood defences to facilitate inspection and repair following any disaster such as a significant flood event or an earthquake	To manage risks of accidents and disasters				
PHH2	Construction	Ensuring the contractor provides temporary flood protection (e.g. temporary sheet piling / dumpy bags / sandbags / boards) to all areas potentially affected by increased flood risk during construction. Where there is not enough room to erect temporary flood defences or e.g. where surface water flooding occurs on the dry side of emerging defences before the secondary drainage is complete, bespoke temporary solutions are to be developed during the detailed design and/or preconstruction phases.	To address flood risks during construction.				
PHH3	Pre-Construction	- Review health, safety and environmental risk at detailed design (e.g. to address risk response to flash flood events during/post construction). - Ensure the contractor includes appropriate measures to maintain worker, driver and pedestrian safety during construction (e.g. providing suitable access diversions to avoid areas of risk). - Ensure procurement documentation conditions adhere to best-practice and HSE guidelines relating to construction site planning and management. - Ensure a construction and access management and phasing plan are prepared to reduce the extent of any disruption such that health and safety risks are avoided or reduced	To manage safety during construction.				
PHH4	Construction	- Phase works that require the temporary closure or diversion of footpaths, cycle routes and areas available for recreation to limit the spatial extent of the impact on the whole network. - Ensure a robust traffic management plan is prepared and key facilities are informed of works periods and consulted on specific access needs or vulnerabilities. - Ensure all potentially disruptive works or plant movements are ceased at key locations during the one-week fair leading up to Children's Day celebrations at	To mitigate impacts on recreation and disturbance				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		Zetland Park (and any other sensitive events within the vicinity of the Scheme Working Areas). - Plant (amenity) trees or shrubs in vacant areas and existing parks within proximity of the Scheme where possible to mitigate impacts on recreation, green spaces and vegetation loss (natural heritage). - Establish a community liaison officer for the Scheme and a construction liaison committee to ensure the smooth management of the project/public interface. It is proposed that representatives of Falkirk Council, the construction contractors, the local community, and, if appropriate, the Police form the committee. Develop a Communications Plan for targeted and regular updates to the public and key stakeholders. Display appropriate contact details. - Ensure contractor compliance with current regulations (Health and Safety Executive, n.d.) and measures described in Chapter 8: Noise and Vibration and Chapter 14: Traffic and Transportation. - Ensure contractors are required to submit a Construction Environmental Management Plan (CEMP) and Code of Practice or similar to be approved by environmental officers at Falkirk Council before construction can commence. Such documentation is expected to address not only noise, but other nuisance impacts such as the timing of works, dust, mud, visual impacts, contamination risk and traffic disruption amongst others. - Liaison with businesses to understand access needs and busy periods. - Implementing a traffic and access management plan. - Sign-post diversions and provide clear and accessible public information.					
PHH5	Procurement	Ensure contract provisions include reference to the Council's Sustainable Procurement Strategy (Falkirk Council, n.d.) (e.g. the contractor could have a target for sourcing services locally and, where feasible, providing training to local apprentices or unemployed individuals to enable them to apply for appropriately (un)skilled vacancies that arise).	To comply with Falkirk Council's Sustainable Procurement Strategy				
PHH6	Procurement	Ensure potential for disruption to business activity is addressed in liaison with business owners and other potentially affected parties (i.e. consultation to understand concerns, and the measures to best mitigate those concerns will be included in the contractual requirements of the Contractor).	To avoid/reduce disruption to business activity.				
PHH7	Operation	Ensure a robust inspection and maintenance regime is implemented and maintained over the 100-year lifespan of the Scheme.	To mitigate effects not considered				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		- Ensure access routes to every section of the flood defences are maintained and cleared of obstructions and overgrowing vegetation to facilitate inspection and repair following any disaster such as a significant flood event or an earthquake. - Ensure emergency (evacuation) procedures and access / egress routes (outwith the refinery) are revised once the final Scheme design has been prepared and the flood warning system updated in consultation with SEPA and in accordance with the Civil Contingencies Act 2004 and Control of Major Accident Hazards (COMAH) Regulations. - Ensure emergency response protocols are updated to respond effectively to flood events greater than the Scheme standard of protection (i.e. > 1 in 200-year event), such as holding emergency response and evacuation drills to maintain civil preparedness. The FRM Strategy highlights the further actions the Council will take in future including awareness raising, self-help, flood warning, emergency plans/ response, etc. and all these will also help to mitigate the residual risk from these exceedance events. - Ensure means to continue the standard of protection to address climate change effects are implemented as required, driven by future Flood Risk Management strategies. - Explore options for e.g. property level protection with landowners at continued risk of flooding. - Undertake further investigation into surface water flood risk and apply measures accordingly. - Ensure appropriate signage and emergency egress options are provided at key locations.	significant for these factors.				
PHH8	Detailed design	Ensure a Landscape and Ecological Habitat Management Plan is produced at detailed design to maximise the biodiversity, amenity and landscape potential of areas requiring reinstatement post construction.	To maximise the biodiversity, amenity and landscape potential of areas requiring reinstatement post construction.				
PHH9	Detailed design	Ensure amenity trees are replaced in situ with appropriately sized (heavy standard) examples, with woodland areas being replaced at a 3:1 ratio in suitable locations in the vicinity of the loss or elsewhere.	To reduce landscape and amenity impacts.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
PHH10	Detailed design	Ensure the reinstatement of affected areas takes cognisance of future aspirations for Core Path and Active Travel Network improvements (possible partnering opportunities and funding may be sought with interested parties such as Sustrans).	To maintain and improve Core Paths and the Active Travel network.				
EIA Report Chapter 7: Biodiversity							
E1	Pre-construction phase	Prior to construction the contractor will develop, update, and maintain a Construction Environmental Management Plan (CEMP) which must, along with the final detailed design of the Scheme, be approved by Falkirk Council. The CEMP will include an Ecological Management Plan (EMP). The contractor will develop the EMP in consultation with the relevant stakeholders, including NatureScot. The EMP will include Species Management Plans which, as a minimum, will include the following: - the scope of pre-construction surveys required prior to and during construction, in accordance with Mitigation Item E5, to verify and, where required, update the baseline ecological conditions set out in the EIA Report and associated HRA for the Scheme. - details of proposed mitigation measures and any required exclusion zones to avoid or reduce potential impacts and any unnecessary encroachment into adjoining areas of nature conservation. - restrictions on the timing of construction works to avoid or reduce impacts on protected species, for example vegetation clearance will avoid the nesting bird season and works within watercourses will avoid the sensitive period for fish, where possible. - appropriate watching briefs during construction as detailed in the role and expectation of the ECoW (see Mitigation Item E2). - details of proposed post-construction monitoring requirements to ensure mitigation measures are implemented and are functioning as expected during the operational phase. The EMP will be informed by pre-construction surveys and updated as appropriate with additional mitigation measures where required (including protected species licence conditions where relevant). The EMP will also include a Biosecurity Plan, developed in line with SEPA guidance on INNS, to avoid the spread of INNS and manage their removal and disposal during construction, and a Landscape and Ecological Habitat Management Plan (LEHMP) (see Mitigation Item E21 for details of LEHMP).	To ensure compliance with protected species licence conditions, legislation and commitments within the EIA Report and associated HRA for the Scheme.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
E2	Pre-construction phase	Prior to construction a suitably qualified (or team of suitably qualified) Ecological Clerk of Works (ECoW) will be appointed and will be responsible for implementation of the Ecological Management Plan. The ECOW will: - provide ecological advice over the entire construction programme; - undertake or oversee pre-construction surveys for protected species in the areas affected by the Scheme; - ensure mitigation measures are implemented to avoid and reduce impacts on ecological features; and - monitor the implementation of the mitigation measures during the construction phase to ensure compliance with protected species licence conditions, legislation and commitments within the EIA Report and associated HRA for the Scheme. The ECOW will be a member of the CIEEM and will have previous experience in similar ECOW roles. 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.	To ensure compliance with protected species licence conditions, legislation and commitments within the EIA Report and associated HRA for the Scheme.				
E3	Pre-construction phase/ Construction phase	A construction lighting plan and method statement will be developed and implemented by the contractor. The plan will detail specific mitigation requirements taking into account guidance on lighting (e.g. Bat Conservation Trust (2009); Institution of Lighting Professionals (2011) and The Royal Commission on Environmental Pollution (2009)). The construction lighting design will take into account the need to avoid illuminating sensitive habitats in locations such as sensitive bird or bat habitats, adjacent to watercourses, known commuting routes and where known protected species activity has been identified through pre-construction ecological surveys (refer to Mitigation Item E1). Where working in or near watercourses is required during the hours of darkness, the contractor will fit temporary lighting with a cowl to limit light spill, angle light away from the watercourses and keep light within the footprint of the construction works where possible to avoid disturbance to migratory fish and otter. Where this is not possible the contractor will agree any exceptions with the ECOW.	To minimise disturbance to sensitive species such as birds, bats, otter and migratory fish.				
E4	Construction phase	'Soft-start' techniques will be implemented for all activities predicted to be particularly noisy, to avoid sudden and unexpected disturbance of protected species. Noise levels will be gradually increased over a period of 30 minutes to allow protected species to relocate. Where construction methods and equipment that can reduce noise are available, these will be implemented where possible.	To minimise disturbance to protected species and ensure compliance with commitments within				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
			the EIA Report and associated HRA for the Scheme.				
E5	Pre-construction phase	Pre-construction surveys will be undertaken to verify and, where required, update the baseline ecological conditions set out in the EIA Report. The scope of the pre-construction surveys will be confirmed with Falkirk Council (and NatureScot where required) prior to them being undertaken. The results of these surveys will be detailed within the Species Management Plans and will be used to inform protected species licences and any additional mitigation requirements.	To update the baseline and inform protected species licences and any additional mitigation requirements.				
E6	Pre-Construction / construction phase	Tree felling and vegetation clearance will be reduced as far as practicable and undertaken outside the core bird breeding season (01 March to 31 August) to avoid damage/destruction of active nests or disturbance/harm to breeding birds. If this cannot be achieved, works within the core bird breeding season will require an inspection of vegetation or suitable ground nesting habitat for nesting birds by a suitably qualified ecologist no more than 24 hours prior to any works being undertaken. If any active nests are identified during the survey, they will be left in situ for their entire nesting period until the young birds have fledged or the nests have failed due to natural reasons. Alternative approaches to the work will need to be proposed e.g., implementing an exclusion zone around the nest to avoid disturbance. All cleared vegetation will be rendered unsuitable for nesting birds, for example, by covering or chipping depending on the end purpose of the vegetation or will be removed from the works area.	To avoid damage or destruction of occupied nests or harm to breeding birds.				
E7	Construction phase	Any tree felling and vegetation clearance will be carried out by experienced contractors to reduce potential direct impacts on protected species. Felling will be carried out according to felling methods agreed between contractors and the ECoW.	To minimise impacts to protected species.				
E8	Construction phase	Trenches, holes and pits will be kept covered at night or a means of escape will be provided (such as a ramp) for terrestrial vertebrates that may become entrapped.	To avoid direct mortality of protected species.				
E9	Construction phase	Temporary mammal-resistant fencing and gates will be provided around construction compounds in the vicinity of habitat where badger and otter are known to be present. Fencing and gates will meet a specification based on current best practice and agreed through the EMP. Gates will be closed at night.	To minimise impacts to protected species.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
E10	Construction phase	Should a new otter resting site, badger sett or great crested newt breeding pond be found within 100 m of piling works during pre-construction surveys, NatureScot will be consulted on licensing requirements and how to proceed.	To minimise impacts to protected species.				
E11	Construction phase	Where practicable, works will not be conducted on both banks on the same section of watercourse at the same time to ensure that at least one bank of a watercourse will be passable by otter at all times.	To maintain otter passage.				
E12	Construction phase	Where direct impacts on protected species or their resting habitat cannot be avoided, and where such impacts would cause an offence under applicable conservation legislation, derogation licences will be obtained by the contractor from the relevant statutory body (e.g., NatureScot) in advance of the works proceeding. The contractor will comply with the requirements or conditions of any licences granted.	To minimise impacts to protected species.				
E13	Construction phase	Placement of construction compounds, storage areas, temporary access tracks etc. will be at least 10 m from watercourse banks in line with SEPA PPGs.	To minimise risk of pollution incidents.				
E14	Construction phase	Best practice construction methods (CIRIA 2015, SEPA 2009) and Guidance for Pollution Prevention for works and maintenance in or near water (GPP 5) (Netregs 2018) will be followed to minimise impacts on aquatic habitats and species.	To minimise risk of pollution incidents.				
E15	Construction phase	Where the contractor identifies areas within the Site Boundary not required for building the Scheme, temporary barriers will be provided to minimise damage to habitats and potential disturbance or mortality to protected species within these areas.	To minimise impacts to habitats and protected species.				
E16	Construction phase	Fish will be removed by suitably qualified personnel prior to creation of in-water working platforms or dry works areas above the tidal limit. Qualified personnel will be on site during the creation of dry works areas in tidal reaches to remove any fish that become stranded.	To minimise impacts on fish.				
E17	Construction phase	Unless there is agreement with SEPA and the Forth District Salmon Fisheries Board, no in-stream works will be undertaken between October and May inclusive above the tidal limit on the River Carron, River Avon, Grange Burn, Millhall Burn and Westquarter Burn, to avoid the sensitive fish migration, spawning and emergence periods in these watercourses. In-stream works include establishment and removal of working platforms or dry works areas. Once established, works can continue within dry areas/working platforms throughout the sensitive period although continuous periods	To avoid the sensitive fish migration, spawning and emergence periods in these watercourses and minimise impacts on fish.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		of 'noisy' activities such as piling will be avoided unless timing/programme of piling works is agreed with SEPA/FDSFB. The contractor will comply with the conditions of CAR licences and best practice guidelines during works within or in proximity to watercourses.					
E18	Construction phase	Fish passage will be maintained throughout the works using temporary culverts or maintaining a partial open channel.	To maintain fish passage.				
E19	Construction phase	If over-pumping is required, appropriately sized screens will be used to prevent fish from being drawn in.	To minimise risk of injury/mortality to fish.				
E20	Pre-construction/ Construction phase	Visual and noise screening will be installed prior to construction along the temporary works areas adjacent to the estuary where possible, to screen the movement of vehicles, plant and site personnel from birds. The screening will remain in place for the duration of the works. To minimise disturbance to qualifying species of the Firth of Forth SPA and Ramsar site, it has been stipulated in the HRA that construction works along the estuary within Flood Cells 3 and 6 will not be concurrent. During construction, a suitably qualified ecologist or ornithologist will undertake monitoring surveys following the methods for wetland bird Through the Tide Count surveys. These surveys will be used to determine if there is any significant disturbance to qualifying species of the SPA, Ramsar or SSSI, as well as other species of birds present in the survey area. Bird behaviour which constitutes a significant disturbance event, and additional mitigation required in response to this, will be agreed in advance with NatureScot and documented in the Bird Species Management Plan. Should disturbance be identified, works will stop immediately and further mitigation in line with those outlined in the Bird Species Management Plan will be implemented by the ECoW. Whilst significant disturbance to birds during works will be avoided where possible, it is acknowledged that disturbance could occur during construction; therefore, compensatory habitat has been provided.	To minimise disturbance impacts to birds.				
E21	Operation phase	Methods for mitigating habitats lost or damaged during construction will be detailed in the Landscape and Ecological Habitat Management Plan (LEHMP) developed as part of detailed design.	To mitigate habitats lost or damaged during construction.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		An outline LEHMP (OLEHMP) and associated figures have been developed by Jacob's landscape architects and ecologists in agreement with Falkirk Council (see Appendix B9.9). This provides an overview of the habitat restoration requirements and indicative mitigation sites for woodland and wetland mitigation (significant impacts identified) within the Site Boundary. Additional woodland mitigation sites beyond the boundary will be identified at detailed design in consultation with Falkirk Council and detailed in the LEHMP. Post-construction monitoring of habitats will be detailed in the LEHMP. Monitoring will be undertaken by a suitably qualified ecologist over a five year period to determine success of habitat restoration and inform whether further remedial action is required to ensure successful establishment. Monitoring will be undertaken at years one, three and five post construction. The results of the monitoring, including recommendations for remedial action where issues with establishment are identified, will be provided in a report following each year of monitoring.					
E22	Operation phase	Reprofile and landscape the banks of Grange Burn/ Westquarter to restore morphological diversity and improve suitability for protected species, including otter and kingfisher, along the sections outlined in mitigation item W27 and W31 of Chapter 10: Water and Environment. Where practicable, other watercourse banks will be reprofiled and landscaped to provide suitable habitat for protected species	To improve the suitability of watercourses for protected species.				
E23	Operation phase	Where bat roosts are identified in buildings/structure/trees to be demolished during the baseline and pre-construction surveys, the loss of roosting habitat will be mitigated by the provision of bat boxes mounted on nearby buildings or trees in the area. Bat boxes should be installed prior to construction on suitable trees more than 30 m from the Site Boundary to avoid disturbance during works. Indicative locations for bat boxes include Zetland Park and local wildlife sites in proximity to the Scheme. Additional bat box locations beyond the Site Boundary will be identified at detailed design in consultation with Falkirk Council. Bat boxes should be constructed with durable materials such as concrete mixed with sawdust and polystyrene (e.g., Schwegler boxes). The dimensions and box design will be determined by the type of roost being mitigated. If a significant roost such as a maternity colony is found during pre-construction, then a dedicated bat mitigation structure, such as a bat house, may be required. At years one, three and five post-construction, detailed monitoring will be undertaken by an appropriately experienced and licensed bat ecologist to determine if the	To mitigate the loss of bat roosting habitat.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		mitigation has been installed correctly (year one only) and record any damage or use by nesting birds and document uptake by bats. At years 10, 15, 20, 25 and 30 post construction, simple checks will be undertaken to record and replace any bat boxes which have become damaged or destroyed as replacement planting will not provide suitable roosting habitat until trees have matured (30+ years). A report will be provided following each year of monitoring including recommendations for any issues identified (for example, replacing damaged boxes or cleaning out those used by nesting birds outwith the nesting bird season). Any issues identified will be resolved within six months of issues being reported.					
E24	Operation phase	Revetments along the River Carron will be constructed with loosely packed rock armour stone, which will provide shelter opportunities for otter.	To provide shelter opportunities for otter.				
E25	Operation phase	To ensure habitat connectivity for badger along the estuary edge and ensure individuals do not get trapped between the petrochemical plant fence line and flood defences (applicable within Flood Cells 6 and 3), ramps or earth bunds will be installed from the flood defence access track which tie in with the rock armour revetment. Installation of the ramps or earth bunds will be supervised by a suitably qualified ecologist to ensure they are installed in the correct location and function as intended.	To ensure habitat connectivity for badger and that badger do not become trapped. To ensure ramps or earth bunds are installed and function correctly.				
E26	Detailed design	A Positive Effects for Biodiversity Management Plan (PEBMP) will be developed at detailed design stage, which will be updated and maintained by the contractor. This will detail the enhancement measures to be implemented and managed in the long-term to ensure PEB are achieved and can be evidenced.	To secure positive effects for biodiversity.				
EIA Report Chapter 8: Noise and Vibration							
NV1	Construction phase	A noise and vibration monitoring plan will be drawn up, agreed with Falkirk Council and implemented during the construction phase. The monitoring plan will include the following locations as a minimum: 1-1 Stirling Road: Residential receptors on Stirling Road.	To determine whether the noise and/or vibration levels arising from the works would exceed or are likely				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		1-2 Carron Bridges: Residential receptors on Burder Park, Beaumont Drive, and Farm Street. 1-3 Chapel Burn: Residential receptors on Waters End, Bryce Avenue, Duncan Avenue, Halket Crescent and Rae Court. 1-4 Dock Street: Residential receptors on Dock Street, Wardlaw Place, Gilfillan Place, The Avenue (including Carron House Lodge). Noise levels must be monitored according to the methods set out in Annex G of BS 5228-1. All measurements must be made on a sound level meter complying Class 1 as defined within BS EN 61672-1:2013 (British Standards Institution, 2013). Vibration monitoring should be undertaken following the guidance contained in BS 6472-1:2008 on measurement of vibration for assessing human disturbance and for building damage in BS ISO 4866:2010.	to exceed the agreed limits with the Falkirk Council.				
NV2	Construction phase	Adopt Best Practicable Means (BPM) under Section 72 of the Control of Pollution Act 1974 and good practice under BS 5228 Part 1: Noise and Part 2: Vibration including: - Restriction of working hours to between 8:00 and 18:00 Monday to Friday, and no working on Saturday, Sunday or Public Holidays; - Programming the works to restrict impacts to the minimum possible time; - Keeping local residents and property owners fully informed about the nature and timing of the works, including traffic controls, via such means as newsletters or individual contact, where appropriate; - Having a representative available on site during working hours to answer queries or address any concerns expressed; - The quietest available plant or machinery should be used where practicable. For example, any compressors brought to site will be super-silenced or sound reduced models fitted with acoustic enclosures or any pneumatic tools fitted with silencers or mufflers, wherever practicable; - Ensure that all plant and equipment is properly maintained and operated in accordance with manufacturers' recommendations and in such a manner as to avoid causing excessive noise; - Start-up plant and equipment sequentially rather than all together; - Ensure that equipment is shut down when not in use for a period longer than 5 minutes; - Use of temporary construction noise screens / barriers around particularly noisy activities and stationary plant such as generators;	To reduce acoustic and vibrational disturbance as far as practicable.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		- Setting for vibration compaction plant to a low amplitude mode or using smaller plant items when operating in close proximity to sensitive receptors to minimise the vibration levels; - Using rotary piling wherever possible to minimise the impact from vibratory piling; - No vehicles will wait or queue on public highways with engines running and care will be taken when unloading deliveries, and - The Contractor on site should carry out a risk assessment to determine the most appropriate mechanism of noise management for reversing alarms. The use of reversing alarms should not be considered as a default position in lieu of a proper risk assessment. The noise control for reversing alarms should consider; design traffic routing and vehicle selection to avoid / minimise the requirement for vehicle reversing, switch off alarms and introduce a banksman where feasible. Where vehicle reversing alarms are required, they should be designed to cause the lowest practical environmental impact; preferably these should be directional broadband noise emitters or automatically adjusted to ambient noise levels.					
Chapter 9: Landscape and Visual							
LV01	Detailed Design phase	Refine the extent of the required working areas and review the locations of construction compounds at detailed design to avoid features of biodiversity, landscape and amenity interest.	To avoid features of biodiversity, landscape and amenity interest.				
LV02	Construction phase	Restore habitats lost or damaged to facilitate construction to the same or better condition as the original habitat.	To offset damage to habitats.				
LV03	Construction phase	Use sensitive hoarding to reduce the visual impact of the construction works.	To reduce the visual impact of the construction works.				
LV04	Construction phase	Provide advanced planting of offset vegetation, including the establishment of alternative amenity sites and planting of trees in open parkland to offset amenity greenspace and tree loss.	To offset amenity greenspace loss.				
LV05	Construction phase	Provide opportunities for local communities to be consulted to help minimise disruption at key locations or during key events.	To encourage local communities to be				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
			involved in the Scheme and understand the wider benefits. To avoid/reduce disruption at key locations or during key events.				
LV06	Construction phase	Appoint an Environmental Clerk of Works to ensure that all the contractors robustly implement all committed mitigation at the appropriate time and to the appropriate specification.	To ensure that all contractors robustly implement all committed mitigation at the appropriate time and to the appropriate specification.				
LV07	Construction phase	Meet requirements of BS 5837:2012 - Trees in relation to design, demolition and construction: To ensure the appointed (sub-) contractors take full care to avoid impacts on trees to be retained. Any tree felling and vegetation clearance to be carried out by experienced contractors and in accordance with the guidance	To ensure the appointed (sub) contractors take full care to avoid impacts on trees to be retained.				
LV08	Construction phase	Meet requirements of BS 3882:2015 - Specification for topsoil: Any new planting to be installed in appropriate soil (import as required).	To ensure the soil is of the correct quality, so plants will thrive.				
LV09	Construction phase	Meet requirements of BS 8601:2013 - Specification for subsoil and requirements for use:	To ensure all soils are lifted, transported, stored and spread carefully to avoid damage during handling.				
LV10	Construction phase	Meet requirements of BS 4428:1969 - Code of practice for general landscape operations (excluding hard surfaces).	To ensure current appropriate techniques,				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
			equipment and materials for general landscape operations are adopted.				
LV11	Construction phase	Meet requirements of Construction Design and Management (CDM) Regulations 2015. Site accesses, compounds and working areas must be kept clean and tidy to avoid any visual disruption and temporary lighting controlled to avoid light spill into adjacent landscape and visual receptors.	To avoid visual disruption and light spill into adjacent landscape and visual receptors.				
LV12	Construction phase	Meet requirements of CDM Regulations, 2015 - Provision of any diversion routes which would be required for all cycle/footpath/road closures.	To maintain use of active travel routes.				
LV13	Pre-construction phase	Review of the LVIA baseline at the pre-construction stage and an assessment made of how any changes to the local environment, which have occurred since this LVIA was undertaken, will affect the outcome of this LVIA.	To ensure no greater significance of effects in relation to the LVIA.				
LV14	Operational phase	Replacement planting on riverbanks which have been cleared as part of the Scheme works where possible, which will also form a screening element to reduce the long-term effects of the walls/embankments. The riverbanks will be vegetated by a mixture of natural regeneration of riverbank vegetation and careful planting of native species of wetland, grassland, low shrubs and scrub cover to support the biodiversity of the designated nature conservation sites. This will be established rapidly to maintain a wildlife corridor and minimise visual impact in the short term.	To reduce the long-term effects of the flood defence walls/embankments and support the biodiversity of the designated nature conservation sites.				
LV15	Construction phase	Replacements of trees (project policy, as agreed with the Local Authority): 1 for 1 basis in sensitive areas using large replacement trees 3 for 1 basis, either individual trees or measured in hectares for woodland, of replacement trees/woodland trees either within the site areas or in areas nearby. Offsite areas to address cumulative impacts on biodiversity, landscape, views, amenity, and greenspace provision.	To offset impacts of tree loss.				
LV16	Construction phase	Review the side from which the walls will be constructed (i.e. from the river or the land), to reduce the effect on existing vegetation where possible, although the final	To reduce the effect on existing				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		decision on this may lie with the contractor (unless there is a particularly sensitive area which needs protecting).	vegetation where possible.				
LV17	Construction phase	Addition of coir matting along the riverbanks, instead of a basic earth finish, as part of bank erosion protection and planting.	To encourage vegetation of the riverbanks.				
LV18	Detailed design	Ensuring a softening of the river's edge in certain areas with additional planting, or wetland habitat creation to improve the riverside's visual appearance, improved habitat connectivity, and to support recreation and education benefits, subject to further design and consultation during detailed design stage.	To soften the river's edge in certain areas, improve the riverside's visual appearance, improve habitat connectivity, and to support recreation and education benefits.				
LV19	Detailed design	Replacement trees will include a percentage of larger tree stock to augment smaller whip and feathered tree planting.	To ensure a degree of vegetative maturity at the earliest opportunity.				
LV20	Detailed design	For embankment slopes, the gradient to be amended to be as shallow and varied as possible using the land available, thereby reducing the landscape and visual impact of it within the space (this will be subject to further design and consultation during detailed design stage).	To reduce landscape and visual impacts of embankments.				
LV21	Detailed design	Identification of appropriate wall materials and bridge finishes, as agreed with the Local Authority (and HES where appropriate), to integrate the walls and bridges into the local landscape and reduce the visual effect of the scheme, as well as protect the setting and qualities of designated landscapes – refer to Appendix B9.9 for a list of proposed wall and bridge finishes.	To integrate the flood defence walls into the local landscape and reduce the visual effect of the Scheme, as well as protect the setting and qualities of designated landscapes.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
LV22	Detailed design	It is important that the finish of the walls is appropriate to its location and context. It is advised that a limited palette of materials and cope details be agreed as a design guide to ensure this is achieved – refer to Appendix B9.9 for a list of proposed wall finishes.	To ensure the finish of the flood defence walls is appropriate to their location and context.				
LV23	Detailed design	Provision of higher boundary treatments in locations where residents require privacy and where the proposed flood wall boundaries are lower than 1.8m high (standard privacy fence height). This would likely be a fence next to the flood wall, to be agreed with Falkirk Council and affected residents.	To mitigate impacts on residents' privacy.				
LV24	Detailed design	Use of art or artistic elements to help integrate the Scheme into the townscape/landscape to be considered and agreed with Falkirk Council.	To reduce potential landscape and visual impacts.				
LV25	Detailed design	Widen pavements, where possible to reduce the feeling of enclosure.	To reduce the feeling of enclosure.				
LV26	Pre-construction phase	The outline Landscape and Ecological Habitat Management Plan (LEHMP; Appendix B9.10 of the EIA Report) details the overall soft landscaping requirements for the Scheme as well as laying out the associated maintenance and management operations. The aim of the LEHMP is to mitigate/offset potentially significant (cumulative) adverse effects on amenity, trees, open/greenspace provision, recreation opportunities, views and landscape, woodland/scrub habitat, biodiversity, channel morphology, water quality, surface water flooding and climate change and includes any relevant secondary mitigation, as noted in Chapter 9: Landscape and Visual of the EIA Report. The final LEHMP will cover a 10-year maintenance period following implementation. This will be prepared alongside the general arrangement drawings and associated soft landscape details and specification, as part of detail design. These will form the client's documentation on future maintenance of the Scheme.	To mitigate/offset potentially significant adverse effects on amenity trees, open/greenspace provision, recreation opportunities, views and landscape, woodland/scrub habitat, biodiversity, channel morphology, water quality, surface water flooding and climate change.				
LV27	Detailed design	To make sure there is continuity throughout the Scheme and to help reduce potential adverse landscape and visual effects, specific designed elements need to have connectivity and structure along the length of the Scheme. The key to the good	To make sure there is continuity throughout the Scheme and to help				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		design of these elements is appropriateness and robustness. The elements should be in harmony with their environment yet provide the service that they are designed for. The following designed elements will require to be considered at detailed design, as follows: 1) Flood Walls, Gates and Bridges - Types and Finishes: Key information on the finishes and types of flood protection walls and bridge finishes to be fully designed so that their appearance, finish and detailing is appropriate to the character of the adjacent landscape – refer to Appendix B9.9 of the EIA Report for a list of proposed wall finishes. 2) Embankments: slope gradients, seed types/vegetation, constraints on planting for operation/maintenance activities. 3) Footpaths and Hard Landscape: High quality yet robust and durable surface finishes are important to respond to or create the appropriate setting for the rivers and other watercourses. The paths will need to accord with active travel/Core Path expansion aspirations to avoid abortive design/construction work. Co-ordination with Falkirk Council will be key to achieving this. 4) Soft Landscape: New planting will be important for the integration of the Scheme into the adjoining landscape and will help to re-establish soft landscaped areas which have been affected by the construction of the Scheme. Replacement planting will comprise native species of local provenance where possible.	reduce potential adverse landscape and visual effects.				
Chapter 10: Water Environment							
W1	Pre-construction phase	Preparation of a Construction Environmental Management Plan (CEMP), which will incorporate all applicable individual mitigation measures set out in this Chapter 10 Water Environment of the EIA Report, prior to the commencement of works.	To address nuisance impacts including but not limited to the timing of works, dust, mud, visual impacts, noise, contamination risk and traffic disruption.				
W2	Construction phase	Suitably qualified and experienced Environmental Clerk of Works and Geomorphological Clerk of Works will be appointed to oversee the implementation of mitigation and monitoring of water environment during construction.	To ensure that all contractors robustly implement all committed				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
			mitigation at the appropriate time and to the appropriate specification.				
W3	Construction phase	Any material added to the channel to aid construction (i.e., during the formation of temporary in water working areas) will be of a geological composition similar to that of the existing sediment (i.e. derived from local borrow pits). The material will be clean and not contain high quantities of silt. Where possible, the added material will be removed at the end of the works. Post excavation, natural bed material will be physically separated from construction fill to stop mixing. Imported sediment to aid construction will be of a size that is unlikely to mobilise during a flood event or will be configured such that it cannot be mobilised. Natural bed material will be reinstated post construction.	To reduce the impacts on fluvial geomorphology.				
W4	Construction phase	Implementation of measures to reduce the extent of fine sediment transportation, such as: - minimising the extent of in-water working, and work from the bank side as far as practicable to reduce disturbance and damage to riverbeds and addition of excess sediment to the channel; - putting in place mitigation such as 'silt skirts' where construction must take place in or near areas of fine-grained sediments; and - disturbance of areas of fine-grained, easily transportable (by water) material would be avoided as far as practicable	To reduce the impacts on fluvial geomorphology.				
W5	Construction phase	Separating the working areas from the channel with working platforms which allow flow to bypass the works and minimise the width of the temporary working platforms within the channel, to allow single plant access with occasional passing places rather than a continuous 'two-lane' platform.	To reduce the impacts on fluvial geomorphology.				
W6	Construction phase	Works will be undertaken (as far as practicable) during periods of low flow. All in-water works will be undertaken outwith fish spawning seasons.	To reduce the impacts on fluvial geomorphology.				
W7	Construction phase	Limit the removal of vegetation from the riparian corridor and retain trees on banks and bank top as far as practicable during construction. Retain fallen trees and large wood on banks and in-water margins where practicable; retain root balls as a minimum during construction to aid the stability of the banks.	To reduce the impacts on fluvial geomorphology.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
W8	Construction phase	Bank reinstatement following bank disturbance due to excavation of embankments, flood wall piling and shallow ground improvements.	To reduce the impacts on fluvial geomorphology. To reinstate the bank to a suitable condition and be in-keeping with the local landscape.				
W9	Construction phase	Regular monitoring of any change to the channel bed and banks will be undertaken, particularly in the vicinity of the working platforms throughout the construction process. This will be undertaken using fixed point photography, with site surveys should any change be identified. If change does occur this will be reported to SEPA. If required, any mitigation will be agreed with SEPA.	To reduce the impacts on fluvial geomorphology.				
W10	Construction phase	A detailed methodology and accompanying construction method statement for the restoration of the channel bed to the previous levels, including existing forms, will be created. The methodology statement will include detailed reconnaissance and topographic survey undertaken before the works commence and the full methodology will be agreed with SEPA. Bed restoration will be implemented as soon as possible during or after the period of works.	To reduce the impacts on fluvial geomorphology.				
W11	Construction phase	The Contractor(s) will implement the following mitigation measures during construction: - in-water working areas will be agreed with SEPA and Marine Scotland through the production of method statements, with the design, timing and location of works aiming to reduce the impact on flood risk, water flows and levels as far as practicable; - develop a flood response plan for all activities to be located within the functional floodplain (defined here as the 0.5% AEP (200-year) flood extent); - any temporary works within the functional floodplain will be made resistant or resilient to flood impacts; - if reasonably practicable, plant and material will be stored outside the 10% AEP (10-year) flood extent; and - In advance of extreme flood events (e.g., 0.5% AEP (200-year), in-water working areas will be evacuated and allowed to flood to prevent any increases in flood levels from constriction of flows.	To reduce potential impacts on flood risk.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
W12	Construction phase	Water quality monitoring on affected watercourses will be undertaken one year prior to construction and during construction. The monitoring regime will include (but not be limited to) monthly laboratory analysis of determinants to be agreed in consultation with SEPA and visual inspections. Water quality criteria and standards to be achieved for all site discharges during construction, and sampling locations, will be agreed in consultation with SEPA.	To reduce potential impacts on surface water quality.				
W13	Construction phase	In relation to construction site runoff and sedimentation, the Contractor(s) will produce and adhere to Pollution Prevention Plans which will include, but may not be limited to: • avoid unnecessary stockpiling of materials and exposure of bare surfaces, limiting/phasing topsoil stripping wherever practicable; • use of silt fences, bunds, filter trenches, check dams, settlement lagoons, soakaways and other sediment trap structures as appropriate; • use an appropriate grade of material on temporary haul routes and in-water working areas that will be clean and will be durable under heavy trafficking; • monitor, maintain and regrade routes where necessary; • limit the amount of tracking adjacent to watercourses and avoid creation of new flow paths; • provision of wheel washes at appropriate locations (in terms of proposed construction activities) and >10 m from water features where practicable; • protocols will be developed for ceasing or reducing construction activities during periods of high rainfall to reduce the risks of erosion, sedimentation and pollution; • protection of soil stockpiles using bunds and silt fencing, locate stockpiles >10 m from water features where practicable; • concrete mixing and washing areas will be located > 10 m from water features (where practicable), have settlement and re-circulation systems for water reuse; and have a contained area for washing out and cleaning of concrete batching plant or ready-mix lorries; • chemical, fuel and oil storage will be undertaken within a site compound, which will be located on stable ground at a low risk of flooding and > 10 m from any watercourse, where practicable; • quick setting products (cement, concrete, and grout) will be used for structures that are in or near to watercourses; and • equipment and materials will be removed wherever possible from the in-river working platforms. The Contractor(s) will provide sufficient security to minimise	To reduce potential impacts on surface water quality.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		the risk of vandalism to equipment and materials which may release pollutants into the water environment. These Plans will form part of the CEMP and will be submitted to SEPA for approval prior to construction as part of the CAR Construction Site License authorisation or CAR License process.					
W14	Construction phase	During replacement of the lock gates, a dry working area will be established, where possible to minimise the risk of disturbance, resuspension, and migration of potentially contaminated bed material into the eastern channel or into the Middle Forth (which is a SSSI and SPA). Where practical, this bed material will be dredged/excavated and disposed of at an appropriately licensed facility. Should dredging be required prior to the establishment of a dry working area, this will be undertaken in calm conditions and avoid surge conditions. Booms or silt curtains will be deployed to prevent the migration of dredged material. This may include one or more booms and/or bubble screens and/or silt curtains at each entrance and exit of the locks. Consultation with Marine Scotland may be required, see Mitigation Item W15 below.	To reduce potential impacts on surface water quality.				
W15	Construction and pre-construction phase	For works within areas identified as potentially containing contaminated land and sediment the Contractor(s) will reduce the risk of surface water pollution to an acceptably low level through: - further site investigation to determine the level of contamination prior to start of construction; - the installation of temporary treatment facilities to enable removal of pollutants from surface waters; and - further consultation with Marine Scotland and Forth Ports may be required subject to the results of any further site investigation in areas where sediment may be dredged and disposed of. This includes (but is not limited to) the area surrounding the lock gate replacement at the entrance to the Eastern Channel at Grangemouth Docks, where potentially contaminated bed sediments may be present. Assessment of any site investigation results (bed sediment samples) against Marine Scotland Action Levels (Marine Scotland, 2017) may be required.	To reduce potential impacts on surface water quality.				
W16	Construction phase	In relation to service diversions and to avoid damage to existing services from excavations and ground penetration, including temporary severance of public and	To reduce potential impacts on private				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		private water supplies through potential damage to infrastructure, the Contractor(s) will: - locate and map all private or public water supply assets and other service infrastructure prior to construction; - take measures to prevent damage to services and to avoid pollution during service diversions, excavations and ground works; and - liaise with Scottish Water to request suitable mitigation is implemented if services are disrupted or diverted by the works.	water supplies and abstractions.				
W17	Construction phase	Where artesian groundwater conditions have been identified, the design depth of sheet piles will terminate above bedrock, to avoid the release of artesian groundwater during construction. Based on the outcome of the detailed dewatering and groundwater flow assessments as well as findings associated with contamination outlined in the Chapter 11: Soils, Geology and Land Contamination of the EIA Report, additional mitigation measures may be required to treat groundwater. If a requirement for additional mitigation measures is identified, proposed measures will be discussed with SEPA prior to finalisation.	To reduce potential impacts on groundwater.				
W18	Construction phase	Detailed assessment of potential settlement effects on buildings at risk. Where further assessment establishes a potential subsidence risk to buildings, the Contractor(s) would carry out monitoring during construction and implement appropriate mitigation where necessary.	To reduce potential settlement effects on buildings at risk.				
W19	Detailed design	Additional National Vegetation Classification (NVC) survey will be undertaken for GW22 and GW12 to improve the characterisation and confirm the presence of Groundwater Dependent Terrestrial Ecosystems (GWDTE). This will include the exact delineation of the GWDTE vegetation. Detailed design should avoid encroaching or keep to a minimum direct footprint onto GWDTE vegetation.	To reduce potential impacts on GWDTE.				
W20	Construction phase	A risk assessment for the use of cementitious materials within 50 m of any excavations or highly permeable areas, which may lead to seepage into groundwater aquifers. To reduce the potential effect on groundwater quality, concrete will be batched off-site where practical.	To reduce the potential impacts on groundwater quality.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
W21	Construction phase	Groundwater abstracted to facilitate excavations will be returned to watercourses immediately downstream of the works.	To reduce the potential impacts on groundwater quality.				
W22	Construction phase	Adherence to appropriate guidance outlined in Chapter 10: Water Environment Table 10-27 of the EIA Report.	As part of good practice undertaken by the Contractor(s) to reduce impacts to the water environment during construction.				
W23	Construction phase	Compliance with the conditions of the Marine Licence and any CAR Construction Site Licence authorisation.	As part of good practice undertaken by the Contractor(s) to reduce impacts to the water environment during construction.				
W24	Operation phase	A separate program of river restoration measures on Grange Burn/Westquarter Burn shall be committed to, which will identify and undertake measures to improve the morphological diversity of the channel banks and bed, encourage natural recovery and improve riparian habitat. Subject to further investigation, design and consultation with SEPA and other relevant stakeholders, potential measures may include (but not be limited to) removing or softening existing bank protection where present, reprofiling of the banks, creation of alternate berms and planting of riparian vegetation in highly modified reaches of the watercourse, such as the reach from approx. NGR NS 92685 80288 to NS 92827 81371.	To reduce potential impacts on fluvial geomorphology.				
W25	Operation phase	Soften existing hard bank protection (e.g., willow spiling) and appropriate marginal planting on the Grange Burn/Westquarter Burn from Zetland Park to Bo'ness Rd, between NGR NS 92827 81371 to NS 92993 81990.	To encourage the natural recovery of the watercourse.				
W26	Operation phase	Monitoring of the watercourses should be carried out to identify if there are any operational geomorphological issues associated with the Scheme, such as any impacts on watercourse stability (e.g., areas of excessive erosion or deposition) triggered by the Scheme. This will enable any such issues identified to be investigated and	To reduce potential impacts on fluvial geomorphology.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		remediated as early in the operational phase as possible. Further details are provided in Appendix C 10.1 – Fluvial Geomorphology.					
W27	Operation phase	Soften banks on the Grange Burn (3300-Grange Burn/Westquarter Burn) during reinstatement from Bo'ness Rd to the estuary, between NGR NS 92993 81990 and NS 94587 82541. Soft bank protection includes pre-planted coir matting or rolls which supports riparian vegetation to quickly re-establish.	To reduce potential impacts on fluvial geomorphology.				
W28	Operation phase	Reprofile the banks on the Grange Burn / Westquarter Burn along Grange Burn Road between NGR NS 93036 82090 and NGR NS 94587 82541 to restore morphological diversity to the channel. Slope reprofiling extent will limit the impact on tree and shrub cover on the north bank.	To restore morphological diversity to the channel.				
W29	Operation phase	Further pluvial modelling will be undertaken at the detailed design stage to inform the impact of surface water flooding on receptors. Where necessary, additional surface water drainage will be implemented, for example additional storage, higher capacity drainage or pumping stations. Any detailed assessment will also consider the interaction of proposed flood defences with existing surface water drainage and the Scottish Water network.	To inform the impact of surface water flooding on receptors.				
W30	Operation phase	Discussions have taken place with stakeholders which may be impacted due to increases in tidal and fluvial peak flood depths or extent during the 0.5% AEP (200-year) event during the development of the Scheme. Ongoing consultation will take place after publication of the Scheme and through further detailed design to assess appropriate mitigation.	To reduce the significance of impacts of increased flood risk during operation.				
W31	Operation phase	A detailed hydrological – hydrogeological assessment of the terrestrial portion of the Firth of Forth SSSI, SPA and Ramsar will be carried out prior to construction. In particular, the detailed assessment will investigate the proportion of groundwater and run-off that contributes to sustaining this protected environment, with a view to adjust the design detailed of the proposed direct defence (with below ground structure) east of the existing treatment work. If required, a Water Compensation Strategy will be put in place to redirect lost water towards the impacted area. Subject to the outcomes of this assessment, monitoring may be required.	To reduce the potential for hydrological and hydrogeological impacts.				
W32	Operation phase	A detailed hydrogeological assessment of baseflow groundwater contributions to the River Carron in Flood Cell 1 will be undertaken to support the re-direction of	To reduce the potential for hydrological and				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		groundwater abstracted during temporary works to the River Carron and compensate baseflow losses. Based on the outcome of the detailed dewatering and groundwater flow assessments as well as findings associated with contamination outlined in the Chapter 11: Soils, Geology and Land Contamination chapter, additional mitigation measures may be required to treat groundwater. If a requirement for additional mitigation measures is identified, proposed measures will be discussed with SEPA prior to finalisation.	hydrogeological impacts.				
W33	Operation phase	To mitigate against a potential increase in groundwater level reaching the ground surface, filter drains will be placed on the upgradient side of the defences to intercept rising groundwater, should it occur, with gravity outfalls to the nearest watercourse. The filter drains will be regularly maintained to ensure they are operational at all times. The filter drains will be sized to ensure they evacuate groundwater volumes sufficiently so that no new groundwater flooding events occur as a result of the Scheme. The detailed design stage will therefore need to be supported by a more detailed groundwater flow and level risk assessment. Based on the outcome of the detailed dewatering and groundwater flow assessments as well as findings associated with contamination outlined in the Chapter 11: Soils, Geology and Land Contamination of the EIA Report, additional mitigation measures may be required to treat groundwater. If a requirement for additional mitigation measures is identified, proposed measures will be discussed with SEPA prior to finalisation.	To ensure additional mitigation measures are implemented as required to treat groundwater.				
W34	Operation phase	An updated NVC survey and a hydrogeological survey will be carried out for potential GWDTE sites GW16, GW22 and GW24 to confirm the areas of GWDTE and support a detailed site characterisation.	To mitigate against a potential increase in groundwater level reaching the ground surface.				
W35	Operation phase	Additional ground investigation and groundwater level monitoring will be carried out along the proposed sheet pile section to the southwest of GW24. This investigation will extend further west, outside the footprint of the proposed sheet piles, to enable a robust characterisation of the groundwater flow component feeding GW24.	To avoid or reduce impacts on GWDTE.				
W36	Operation phase	Using information collected in W34 and W35, a detailed CSM complemented by a freshwater balance will be undertaken for GW24. A Water Compensation Strategy will	To enable a robust characterization of the groundwater flow				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		be developed to ensure that freshwater groundwater flow losses are compensated by water being redirected towards GW24.	component feeding GW24.				
W37	Operation phase	Sheet pile detailed design will be developed in cognisance of information gathered in W34, W35 and W36 to allow a sufficient proportion of groundwater to reach GW16, GW22 and GW24.	To ensure that freshwater groundwater flow losses are compensated by water being redirected towards GW24.				
W38	Detailed design	Detailed design of any permanent culverts will ensure adherence to relevant design standards and good practice guidance, such as SEPA WAT-SG-25: Engineering in the Water Environment Good Practice Guide – River Crossings (SEPA, 2010), wherever practical	To reduce the significance of impacts of flood risk during operation.				
W39	Detailed design	Watercourse crossing designs will take account, but not be limited to the following: - appropriate hydraulic design to mitigate flood risk impacts, as assessed against an appropriate flood event; - appropriate design of culvert structures and watercourse modifications (e.g., realignments) with respect to fluvial geomorphology, and riparian and aquatic ecology; - an experienced fluvial geomorphologist will input into the design of all watercourse crossings and associated engineering activities where appropriate; - the design of culverts and associated watercourse modifications will incorporate, wherever practical: - the channel cross section through culverts will be profiled to replicate the existing channel shape (and width) up to the predicted QMED water level where appropriate; - maintenance of the existing channel gradient to avoid erosion at the culvert inlet and outlet; - avoidance of reduction of watercourse length through shortening of watercourse planform; - where possible, culvert lengths will be kept to a minimum and will align with the existing watercourse; and - implementation of energy dissipation (e.g., stilling basins) and sediment retention measures where necessary; depressing the invert of culverts to allow	As part of good practice to reduce impacts to the water environment.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		for reinstatement of natural bed with embedment of the culvert invert to a depth of at least 300mm. - wherever practicable the re-planting of vegetation around culverts where required shall be undertaken. Vegetation will tie in with natural vegetation, where the trees are removed during construction, re-planting is of particular importance; and - post-scheme construction appraisal will be undertaken to identify if there are issues that can be addressed as early in the operation phase as possible.					
W40	Operation	Operation of the Scheme would include tertiary mitigation in the form of good practice undertaken by the maintenance workers to reduce impacts to the water environment. These should include adherence to the following appropriate guidance: - C786 Culvert, screen and outfall manual Culvert Design and Operation Guide (CIRIA, 2019); - C720 Culvert design and operation guide supplementary technical note on understanding blockage risks (CIRIA, 2013); - C763 River Weirs – Design, maintenance, modification and removal (CIRIA, 2016); and - WAT-SG-44 - Engineering in the Water Environment Good Practice Guide: Riparian Vegetation Management (SEPA, 2009c).	As part of good practice to reduce impacts to the water environment.				
Chapter 11: Soils, Geology and Land Contamination							
G1	Pre-Construction phase	Prior to construction and where potential land contamination sources have been identified, further ground investigations and ground gas/ groundwater monitoring sufficient to determine the extent and type of contaminants present will be undertaken to inform detailed risk assessments, identification of appropriate construction methods and procedures, as well as any additional mitigation or remedial measures that may be required. This will include completion of the currently ongoing ground investigations, a detailed assessment of the findings and implementation of any additional investigation and monitoring work that may be deemed necessary in accordance with the regulatory guidance prevalent at the time of assessments.	To inform detailed risk assessments, identification of appropriate construction methods and procedures, as well as any additional mitigation or remedial measures that may be required.				
G2	Construction phase	In the event that unexpected soil or water contamination is encountered, works would be stopped, and the working procedures (see Mitigation Item G9) re-assessed to confirm the working methods remain appropriate.	To manage risks to construction and maintenance staff working with/ near				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
			land potentially affected by contamination and neighbouring site users/ land users.				
G3	Construction phase	Construction staff will be trained to identify asbestos containing material and any other hazardous contaminants potentially present, and appropriate training will be provided for personnel involved in all earthworks activities, to enable implementation of a watching brief to identify presence of unexpected soil or water contamination.	Mitigating the risk working with land potentially affected by contamination for construction and maintenance staff.				
G4	Pre-Construction phase Construction phase Post-construction (if necessary)	Should ground gas or vapour issues be identified during further ground investigations or monitoring, appropriate working methods will be developed and adopted during below ground site construction works (including piling works and excavations) and should include as a minimum, monitoring undertaken prior to any entry into excavations, confined spaces or below ground structures and the use of personal protective equipment (PPE) as a last resort. If similar issues are identified during construction, further post-construction monitoring will be undertaken if necessary.	To manage ground gas or vapour risks associated with land potentially affected by contamination.				
G5	Construction phase	Storage of excavated soils and made ground will be minimised on site (spatially and in duration) to what is only practicably necessary and storage areas will be appropriately lined, with adequate drainage management in place and appropriate stand-offs from watercourses.	To manage risks to human health, water environment ecological and built environment/property receptors from uncontrolled storage of excavated soils and made ground.				
G6	Construction phase	Standing water within excavations will be controlled where possible and pumped out if necessary. Any water encountered within excavation areas will be assessed for licensed removal or discharge. Containment facilities and discharge locations for abstracted water during construction will be defined taking water quality characteristics into account.	To manage risks to human health, water environment, ecological and built environment/property receptors from				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
			uncontrolled storage/discharge of standing water within excavations.				
G7	Pre-Construction phase	Where buildings/structures are to be demolished the appointed demolition contractor will undertake asbestos surveys of the structures as appropriate prior to any demolition works commencing and identify appropriate management and disposal routes.	To reduce the risks to human health in relation to the potential release of asbestos containing materials during demolition works.				
G8	Pre-Construction phase	Prior to construction and alongside Mitigation Item G1, consultation will be undertaken with Falkirk Council and SEPA (as necessary) regarding works in relation to land affected by contamination to support the obligations set out in 'Planning Advice Note 33: Development of Contaminated Land' (Scottish Government, 2017). Any remedial action undertaken in relation to land affected by contamination will be carried out under the appropriate remediation licencing.	To support the obligations set out in 'Planning Advice Note 33: Development of Contaminated Land' (Scottish Government, 2017).				
G9	Pre-Construction phase	Prior to construction, appropriate health, safety and environment procedures for working with potentially contaminated soils and water will be established. This will include provision to manage risks to construction and maintenance staff working with/ near contaminated land and neighbouring site users/ land users. Consideration will be given to the adoption of appropriate systems of work, including dust-suppression and air monitoring measures where necessary and the use of PPE. Reference should be made to the relevant Health and Safety Executive Approved Code of Practice and Guidance Notes including HSE Guidance Note MS31 (HSE, 2012). These procedures will be implemented as appropriate during construction.	To follow best practice in relation to soil management and re-use of site won materials to manage risks to human health, water environment, ecological and built environment/property receptors.				
G10	Pre-Construction phase	To prevent cross contamination and pollution from piling works undertaken in areas of land affected by contamination, Piling Risk Assessments will be undertaken to inform appropriate piling techniques and designs, which should adhere to appropriate guidance including the 'Piling and Penetrative Ground Improvement Methods on Land	To prevent cross contamination and pollution from piling works undertaken in				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		Affected by Contamination: Guidance on Pollution Prevention, National Groundwater and Contaminated Land Centre Report NC/99/77' (Environment Agency, 2001).	areas of land potentially affected by contamination.				
G11	Pre-Construction phase	The appointed Contractor will develop a Site Waste Management Plan (SWMP) in consultation with SEPA, to identify, prior to the start of construction, the types and likely quantities of waste that may be generated and set out, in an auditable manner, how waste will be prevented, re-used, recycled and otherwise recovered in accordance of the principles of the 'Waste Hierarchy' as set out Article 4 of the revised Waste Framework (Directive 2008/98/EC) (European Parliament, 2018).	To determine how waste will be prevented, re-used, recycled and otherwise recovered.				
G12	Pre-Construction phase	To maximise the reuse of site-won materials on-site (and minimise the need for disposal of waste in line with the principles of the 'Waste Hierarchy') whilst ensuring that no risks are posed to human health, the water environment or other receptors, a soil re-use assessment will be undertaken prior to construction. The soil re-use assessment will identify any potential risks from potentially contaminated soils re-used throughout the Scheme. The soil re-use assessment will take cognisance of SEPA guidance document Land Remediation and Waste Management Guidelines (SEPA, undated).	To maximise the reuse of site-won materials on-site and minimise the need for disposal of waste whilst managing the risks to human health, water environment, ecological and built environment/property receptors.				
G13	Pre-Construction phase	Waste management procedures will take account of inter alia Waste Management Licence (Scotland) Regulations 2011 (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016).	To manage the risks to human health, water environment, ecological and built environment/property receptors from incorrect disposal of waste materials associated with the project.				
G14	Construction phase	If excavated soils are deemed unsuitable for re-use they will be assessed in line with the 'Waste Classification: Guidance on the Classification and Assessment of Waste'	To manage risks to human health, water				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		(Technical Guidance WM3) (Natural Resources Wales et al, May 2021) prior to disposal, to determine whether they are hazardous or non-hazardous. This will establish the most appropriate and cost effective waste stream for the waste materials. Any waste materials removed from the site must be disposed of in accordance with the Waste Management Licensing (Scotland) Regulations 2011 (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016) (Scottish Statutory Instruments, 2016).	environment, ecological and built environment/property receptors from incorrect disposal of waste materials associated with the project and to establish the most appropriate and cost effective waste stream for the waste materials.				
G15	Construction phase	Any recovered waste materials imported to site (such as imported soils) must be stored and used only in accordance with a waste management licence or exemption under the Waste Management Licensing (Scotland) Regulations 2011 (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016) (Scottish Statutory Instruments, 2016).	To manage risks to human health, water environment, ecological and built environment/property receptors from use of imported soils.				
G16	Detailed Design phase	Where concrete materials are proposed to be used, appropriate guidance such as 'Building Research Establishment (BRE) SD1:2005' (BRE Construction Division, 2017) and 'British Standard (BS) BS8500' (British Standards Institution, 2020) will be followed to ensure that ground conditions are appropriate for the use of concrete at each given location.	To ensure that ground conditions are appropriate for the use of concrete at each given location.				
Chapter 12: Air Quality and Climate Change							
AQ01	Construction phase	Dust Management Plan (DMP) to include dust management and control measures, and to be approved by Falkirk Council prior to construction commencing. DMP to include measures as recommended by the IAQM guidance for the following dust emission categories/sources: - Demolition - Earthworks - Construction - Trackout	To manage the potential risk of dust on site.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		General dust management and communications – mitigation measures based on Medium risk (i.e. based on the highest risk from any of the specific dust emission sources above). (see Section 12.6.1.1 and Table 12-18 in Chapter 12: Air Quality and Climate of the EIA Report for further detail).					
CC01	Construction phase	Use of lower carbon concrete: Concrete to be used for construction of the Scheme is proposed to be low-carbon concrete where possible, e.g. changing the cement concrete in the flood walls from RC 32/40 MPa 15% cement replacement to RC 32/40 50% cement replacement. For this example, the use of the higher cement replacement content in the carbon calculations resulted in an overall 13% lower GHG emissions per tonne of material compared to concrete with lower cement replacement.	To reduce greenhouse gas (GHG) emissions				
CC02	Construction phase	Use of lower carbon steel: It is proposed that the sheet piles which form the core of most of the flood defences would be specified in the carbon calculations as lower carbon steel where practicable.	To reduce greenhouse gas (GHG) emissions				
CC03	Construction phase	Use of lower carbon aluminium: It is proposed that the flood barriers, gates and flow control could be constructed from recycled aluminium instead of virgin aluminium.	To reduce greenhouse gas (GHG) emissions				
CC04	Construction phase	A Carbon Management Plan (CMP) is being developed by Falkirk Council to reduce the whole life carbon emissions for the Scheme. The Scheme-specific CMP assists in delivery of the wider carbon reduction objectives of Falkirk Council. The CMP for the Scheme aims to adhere to the principles of PAS 2080 (although not seeking official accreditation), the British industry standard for managing infrastructure carbon (British Standards Institute, 2023) and, in summary, will include the following steps: - Calculate the anticipated carbon footprint of the Scheme based on the current outline design information and use this information to assess the potential to reduce carbon across the design, construction and operational phases; - Identify the key carbon 'hotspots' of the Scheme (i.e. those elements of the Scheme which are likely to result in the greatest carbon impacts and therefore offer the greatest potential for reduction); - Set out carbon reduction targets against the carbon baseline; - Set out roles and responsibilities to successfully implement the Scheme-specific CMP and achieve carbon reduction targets;	To reduce greenhouse gas (GHG) emissions				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		- Specify the steps needed to reduce carbon through the design, construction and operational stages; and - Identify the carbon actions and opportunities which will be considered moving forward and prior to construction completion.					
CC05	Construction phase	Consideration of the use of construction materials with superior properties (such as increased tolerance to fluctuating temperatures, extreme temperatures and increased solar radiation) to be included within detailed design.	To increase the Scheme's resilience to climate change.				
CC06	Construction phase	Implementation of an appropriate asset management strategy by the Scheme operator to proactively identify and, where necessary, rectify potential climate related impacts (e.g. additional visual inspections of the Scheme's assets after extreme weather events).	To increase the Scheme's resilience to climate change.				
Chapter 13: Cultural Heritage							
CH1	Pre-Construction phase	A photographic survey (Historic England 2016 Understanding Historic Buildings: a guide to good recording practice; ALGAO, Scotland 2019 Historic Building Recording Guidance for Curators, Consultants and Contractors) of the following assets will be undertaken to record the assets in their current condition and setting prior to construction: - Grangemouth Road, Avon Bridge (Asset 12) - Sacred Heart RC Church Dalratho Road and Drummond Place (Asset 21) - Ronaldshay Crescent and Park Road Grange Church and Church Hall (Asset 24) - Zetland Park War Memorial And Park Gates, Grangemouth (Asset 29). Refer to Chapter 13: Cultural Heritage of the EIA Report.	To mitigate impacts on the setting of the Cultural Heritage assets.				
CH2	Pre-Construction phase	A Level 2 archaeological earthwork record (Historic England, 2017) of Zetland Park (Asset 59), will be undertaken prior to construction.	To mitigate the construction impact on Zetland Park.				
CH3	Pre-Construction phase	A watching brief will be undertaken during the ground work excavations for the Scheme at the Westquarter Burn near the Antonine Wall World Heritage Site (Asset 1) and the details of this are to be agreed with Historic Environment Scotland. A watching brief will also be maintained during ground work excavations for the formed concrete wall and flood gate in the vicinity of Jinkabout Mill (Asset 61) and the bare sheet pile wall in the vicinity of Avon Bridge Toll House (Asset 156). A further watching brief will be maintained during any groundwork excavations in the vicinity of Grangemouth Public Institute (Town Clock) (Asset 72), Bowhouse Mill (Asset 74),	To identify and recording archaeological remains encountered during construction				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		Grangemouth United Presbyterian Church (Asset 86) and Grangemouth Police Station (Asset 87). These shall be in accordance with 'ClfA's Standard and guidance for archaeological monitoring and recording' (ClfA 2023).					
CH4	Pre-Construction Construction phase	To mitigate the potential impact on Grangemouth Road, Avon Bridge (Asset 12) vibration monitoring transducers will be installed around the bridge in locations advised by a vibration specialist and a base log of vibration information gathered. These transducers will also be used to monitor vibration and ensure works remain below an appropriate threshold to be determined by the appointed Contractor.	To reduce vibrational impacts on assets.				
CH5	Construction phase	A watching brief shall be undertaken on areas of archaeological potential within the Scheme, in order to identify and record archaeological remains. This shall be in accordance with 'ClfA's Standard and guidance for archaeological monitoring and recording' (ClfA 2023). The areas requiring a watching brief will be agreed with Historic Environment Scotland and Falkirk Council.	To mitigate the potential impact on previously unknown archaeological remains.				
CH6	Pre-Construction Construction phase	Ground works and construction traffic are to be avoided or minimised as much as possible within the Scheduled Monument boundary at Antonine Wall and Mumrills fort, Sandy Loan to A905, Falkirk (Asset 6). A Scheduled Monument Method Statement will be produced by the contractor to accompany the Scheduled Monument Consent as the Scheme progresses through the detailed design and construction planning stages. The Scheduled Monument Method Statement is to be agreed with Historic Environment Scotland before any work commences within the Scheduled boundary.	To mitigate potential impacts on the Scheduled Monument.				
Chapter 14: Traffic and Transport							
TT1	Detailed design	The active travel measures identified in Chapter 14: Traffic And Transportation Table 14-33 of the EIA Report will be implemented, taking into account the following. To minimise delay, optimise safety and mitigate amenity impacts for active travel route users, including disabled users, the level of provision of crossing facilities will require further assessment at the detailed design stage taking anticipated traffic volumes into account. Temporary paths will be created during construction where existing routes need to be closed to accommodate construction works. The routes of these temporary measures will be investigated further at the detailed design stage.	To minimise disruption and maintain safety of users of active travel routes and crossings.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
TT2	Construction phase	Consideration of the roads network, its physical characteristics and location of potentially sensitive receptors along the various routes, has been undertaken to develop mitigation measures aimed at reducing the impacts of construction traffic, including preferred routes to and from the Scheme site compounds and routes to/ from the individual construction sites (see Section 14.5.1 in Chapter 14: Traffic and Transportation of the EIAR). These preferred routes are summarised in Table 14-17 in Chapter 14. It is imperative that construction traffic use the trunk road network to the nearest junction where it then must diverge to reach the destination construction compound. Where practical, construction traffic must use trunk or A-class roads, with little or no traffic calming or traffic management measures, which are designed to be able to accommodate significant HGV movements between the individual construction compounds and construction sites, only deviating where necessary e.g. to reach individual sites.	To reduce the impacts of construction traffic.				
TT3	Construction phase	In addition to the specification of preferred access routes and the anticipated phasing of construction traffic (see Table 14-14) in Chapter 14: Traffic and Transportation of the EIAR), additional tertiary mitigation measures and initiatives may be introduced to minimise the intrusive impacts of construction related traffic. Potential measures include the following (in summary here, see Section 14.6.3 in Chapter 14: Traffic and Transportation of the EIA Report for detail): • regulated site working hours • where appropriate, additional warning and speed control signs • a wheel wash facility and road sweeper • a construction liaison committee to communicate and update on forthcoming activities and deal with issues arising, likely to comprise representatives of Falkirk Council, the construction contractors, the local community, and, if appropriate, the Police. • potential temporary parking restrictions, and alternative parking arrangements, to be discussed with Falkirk Council when construction vehicle access routes are confirmed. • the temporary closure of public rights of way to facilitate construction activity will be discussed with Falkirk Council Access Officer(s) at an early stage during the detailed design of the Scheme and suitable diversions agreed. All rights of way will be reinstated to their original state, or better. Considering the potentially long-term nature of some closures, suitable consideration will be given to providing alternatives, which may necessitate due consideration of suitable	To reduce the impacts of construction related traffic.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		crossing facilities, to extant standards, that minimise delay and optimise safety for all users. - the stationing of a 'Stop-Go' banksman with appropriate communications with construction vehicle drivers. A Construction Traffic Management Plan (CTMP) and Transport Statements will be developed and implemented by construction contractors, detailing ways to reduce the construction traffic impact, including: - Avoiding transit at school arrival and departure times. - A communications protocol to avoid delays with emergency vehicle traffic. - A diary of proposed delivery movements to liaise with the communities to avoid key dates such as festivals etc. - The publication of notices and provision of advice to the public and employers in the area where the likely increased driver delay may result. - Working with local businesses to ensure that construction traffic does not interfere with deliveries or normal business traffic. A construction specific Travel Plan is also proposed (to be drafted and implemented by the contractor, following approval by Falkirk Council) to provide the mechanism to support and promote sustainable travel for staff, contractors and visitors travelling to the work sites. The Travel Plan would seek to eliminate the barriers preventing users of the site from accessing via sustainable travel modes, improving travel choices, and managing single occupancy car use. An appropriate traffic management strategy (to be drafted and implemented by the contractor, following approval by Falkirk Council) will also be necessary to accommodate proposed temporary partial road closures to accommodate the construction works. Careful consideration and liaison with bus operators and appropriate Falkirk Council officers will also need to be undertaken to address impacts on bus services and access to bus stops while also considering appropriate alternative pedestrian routes between alternative bus stops.					
HRA							
HRA1	Pre-construction phase	An Outline Construction Environmental Management Plan (CEMP) will be prepared and made available prior to confirmation of the Scheme. Prior to construction the contractor will develop, update, and maintain the CEMP, which must be approved by Falkirk Council. The CEMP will include an Ecological Management Plan (EMP). The contractor will develop the EMP in consultation with the relevant stakeholders,	To ensure compliance with legislation and commitments within the HRA.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		including NatureScot. The EMP will include Species Management Plans which, as a minimum, will include the following: - the scope of pre-construction surveys required to verify and, where required, update the baseline ecological conditions set out in this HRA. The scope of these surveys will be confirmed with Falkirk Council (and NatureScot where required) prior to them being undertaken. - details of proposed mitigation measures and any required exclusion zones to avoid or reduce potential impacts on the qualifying species and any unnecessary encroachment into adjoining areas of the Firth of Forth SPA/Ramsar site. - restrictions on the timing of construction works to avoid or reduce impacts on the qualifying species of the Firth of Forth SPA/Ramsar site. (HRA5 provides some additional details) - appropriate watching briefs during construction as detailed in the role and expectation of the ECoW - details of proposed post-construction monitoring requirements to ensure mitigation measures are implemented and are functioning as expected during the operational phase. The EMP will be informed by pre-construction surveys and updated as appropriate with additional mitigation measures where required. The EMP will also include a Landscape and Ecological Habitat Management Plan (LEHMP).					
HRA2	Pre-construction phase/ Construction phase	Monitoring surveys will be undertaken by the employer's ecologist across Sectors 4-11 for the winter period prior to construction works adjacent to the Firth of Forth SPA/Ramsar site. Surveys are expected to follow the Through the Tide Count (TTC) method, but the exact survey method will be determined prior to commencement, in consultation with NatureScot.	To update the baseline data collected for the Scheme, which can then be used to monitor bird responses to construction activities.				
HRA3	Pre-construction phase/ Construction phase	Prior to construction a suitably qualified (or team of suitably qualified) ECoW will be appointed by the Contractor and will be responsible for implementation of an Ecological Management Plan. The ECoW will: - provide ecological advice over the entire construction programme; - undertake or oversee a bird watching brief for works conducted in the vicinity of the Firth of Forth SPA/Ramsar site. See HRA7 for more details. (Separate construction monitoring is detailed in HRA8 and pre-construction monitoring is detailed in HRA2);	To ensure compliance with legislation and commitments within the HRA.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		- ensure mitigation measures are implemented to avoid and reduce impacts on qualifying species; and - monitor the implementation of the mitigation measures during the construction phase to ensure compliance with legislation, and commitments within this HRA and the EIA Report for the Scheme. The ECoW will be a member of the Chartered Institute of Ecology and Environmental Management (CIEEM) and will have previous experience in similar ECoW roles. All ECoWs will be approved by Falkirk Council to be appropriately qualified for the role and compliance will be monitored by an employer's ecologist acting on behalf of Falkirk Council. The ECoW will be appointed in advance of the main construction programme commencing to ensure any advance mitigation measures required are implemented, in collaboration with the employer's ecologist.					
HRA4	Pre-construction phase/ Construction phase	Any temporary lighting arrangements installed for the construction phase will be designed to ensure minimal light spill outwith the boundary of the construction sites and associated site compounds. The ECoW will monitor construction site lighting to identify any potential adverse impacts on birds. Preventative measures (e.g. installation of shields) will be taken if any adverse impacts are detected.	To avoid or reduce light disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.				
HRA5	Construction phase	Any works undertaken adjacent to the Firth of Forth SPA/Ramsar site within Flood Cells 3 and 6 will be undertaken independently of each other, with at least one winter in between.	To avoid or reduce noise and visual disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.				
HRA7	Construction phase	The ECoW will undertake or oversee a watching brief of works adjacent to the Firth of Forth SPA/Ramsar site to observe construction activities and any notable reaction of the qualifying species as a result of these. The ECoW will determine when to stop works and the potential requirement for any further mitigation in line with those outlined in the Bird Species Management Plan. Whilst significant disturbance to birds during works will be avoided where possible, it is acknowledged that disturbance could occur during construction; therefore, compensatory habitat has been provided.	To determine if there is any notable disturbance to qualifying features of the Firth of Forth SPA/Ramsar site and implement appropriate mitigation where necessary.				
HRA8	Construction phase	During construction, each winter where there are works adjacent to the Firth of Forth SPA/Ramsar site, monthly monitoring surveys will be undertaken by the employer's ecologist across Sectors 4-11. Surveys are expected to follow the Through the Tide	To compare survey results with baseline data and determine if				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
		Count (TTC) method, but the exact survey method will be determined prior to commencement, in consultation with NatureScot.	there are any changes in abundance and distribution of SPA qualifying species within Sectors 4 – 11.				
HRA9	Construction phase	Plant and personnel will be constrained to a prescribed working corridor to minimise the damage to habitats and potential direct mortality and disturbance to birds located adjacent to the Scheme Site Boundary.	To avoid or reduce habitat loss and disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.				
HRA10	Construction phase	Where safe to do so, 2m noise and visual barrier screens will be installed prior to construction along the works areas adjacent to the estuary in front of the breakwater and sheltered bay. The barriers must be appropriately positioned to help reduce noise and visual disturbance and will remain in place for the duration of works in these areas.	To avoid or reduce noise and visual disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.				
HRA11	Construction phase	Within 300m of the Firth of Forth SPA, the ECoW will advise the contractor where a 'soft-start' to machinery is required to avoid sudden and unexpected disturbance during construction. Each time machinery 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. For the first seven days after the commencement of works in each area, the soft-start must be applied each time the machinery is stopped, even if this is only for very short periods. Subject to ECoW assessment of bird responses to the activity, the duration of periods of inactivity requiring a soft-start will be increased incrementally over this seven-day period and after seven days a soft-start will only be required at the start of works each day or after an extended period of inactivity.	To avoid or reduce noise and vibration disturbance to qualifying features of the Firth of Forth SPA/Ramsar site.				
HRA12	Construction / Post-construction	On completion of the temporary works all access tracks and working platforms will be removed in their entirety from the SPA.	To ensure compliance with legislation and commitments within the HRA.				

Mitigation Item	Timing of Measure	Description	Purpose/Objective	Responsible Party for Overseeing Implementation	Consultation / Approval Required	Monitoring / Compliance	Completion Record
HRA13	Post-construction	The LEHMP will include measures to reduce damage and restore the intertidal areas temporarily lost. Post-construction monitoring will be undertaken, in accordance with the LEHMP, to demonstrate effectiveness of the restoration.	To ensure compliance with legislation and commitments within the HRA.				

Appendix 2: Additional information

This appendix contains the following supporting information:

- Annex A: Key Environmental Constraints
- Annex B: Relevant Management Plans
- Annex C: Environmental Method Statements
- Annex D: Emergency Procedures and Record of Any Environmental Incidents
- Annex E: Copy of Evaluation of Change Register
- Annex F: Final Environmental Investigation and Monitoring Reports
- Annex G: Risk Register
- Annex H: Construction Programme

Annex A: Key Environmental Constraints Figure

[To be prepared by the Contractor]

Annex B: Relevant Management Plans

As noted in Section 6.3, the Contractor will be required to produce environmental management plans including, but not limited to, those listed below. Further information on the method statements can be found in Appendix 1: Record of Environmental Actions and Commitments. For ease of reference, the relevant REAC Mitigation Item number is provided in brackets where applicable.

- Ecological Management Plan (E1, E5);
- Species Management Plans (E1, E5, E20);
- Biosecurity Plan (E1);
- Landscape and Ecological Habitat Management Plan (E1, E21, PHH8, LV26);
- Positive Effects for Biodiversity Management Plan (PEBMP) (E26);
- Construction Lighting Plan; (E3);
- Carbon Management Plan (CC04);
- Construction Traffic Management Plan (TT1);
- Pollution Prevention Plans (W13);
- Site Waste Management Plan (G11);
- Dust Management Plan (AQ01);
- Noise and Vibration Monitoring Plan (NV1); and
- Construction Traffic Management Plan (PHH4, TT3).

This Annex should be updated with these management plans where available and appropriate.

[Note: Contractor to update]

Annex C: Environmental Method Statements

Prior to construction, the Contractor will develop environmental method statements, as required. These will include, but not be limited to, those listed below. Further information on the method statements can be found in Appendix 1: Record of Environmental Actions and Commitments. For ease of reference, the relevant Mitigation Item number from the REAC is provided in brackets where applicable.

- Scheduled Monument Method Statement (CH6);
- Watercourse Channel Bed Restoration Method Statement (W10);
- In-Water Working Method Statements (W11);
- Water Compensation Strategy (W31, W36);
- Soils, Geology and Land Contamination Method Statement (G1);
- Construction Lighting Method Statement (E3); and
- Transport Statements (TT3).

[Note: Contractor to update

Annex D: Emergency Procedures and Record of Any Environmental Incidents

In the event of an accidental release of hazardous materials, information regarding those materials, spill containment materials and spill response equipment shall be clearly stated on site. The Pollution Prevention Plan (as detailed in the ROEC) should be adhered to and updated at the time of any incidents.

All environmental incidents will be recorded on an incident report form.

Consultation will be taken with consultees, e.g. NatureScot and SEPA, as required.

Environmental incidents that require to be recorded include:

- spill of material to ground or watercourses;
- ecological incident, i.e. involving a protected species;
- discovery of contaminated land not previously identified;
- large dust emission e.g. related to cement silo works; and
- plant/equipment leak.

Lessons learnt shall be fed back to site staff through safety and environmental briefings and used by the Contractor and the ECoW to amend procedures and update the CEMP accordingly.

Emergency procedures shall be tested routinely by the Contractor and results reported to the Project Manager.

[Note: Contractor to populate]

Annex E: Copy of Evaluation of Change Register

[Note: Contractor to populate]

Annex F: Final Environmental Investigation and Monitoring Reports

[Note: Contractor to populate]

Annex G: Risk Register

[Note: Contractor to populate]

Annex H: Construction Programme

[Note: Contractor to populate]