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C PROTECTED SPECIES LEGISLATION SUMMARY

A European Protected Species (EPS) is a species listed in the EC Directive (92/43) The Conservation of Natural Habitats and of Wild Flora and Fauna (the "Habitats Directive"), which is transposed into UK law through the Conservation (Natural Habitats &c.) Regulations 1994 (the "Habitat Regulations") as amended by The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007. Under this legislation an EPS (*e.g.* otter) are protected from:

(a) Deliberate or reckless capture, injuring or killing;

(b) deliberate or reckless

(i) harassment of an animal or group of animals;

(ii) disturbance of such an animal while it is occupying a structure or place which it uses for shelter or protection;

(iii) disturbance of such an animal while it is rearing or otherwise caring for its young;

(iv) obstructing access to a breeding site or resting place of such an animal, or otherwise denying the animal use of the breeding site or resting place;

(v) disturbance of such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs; or

(vi) disturbing such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young;

(c) deliberate or reckless taking or destroying the eggs of such an animal; or,

(d) damaging or destroying a breeding site or resting place of such an animal.

(e) any person:

(i) possessing or controlling;

(ii) transporting;

(iii) selling or exchanging; or

(iv) offering for sale or exchange,

any live or dead animal or part of an animal or anything derived from such an animal which has been taken from the wild and which is of a species or subspecies listed in Annex IV(a) to the Habitats Directive – unless the animal from which the part or the thing in question is derived, was lawfully taken from the wild (i.e. taken from the wild in the European Union without contravention of appropriate domestic legislation and before the implementation date of the Habitats Directive (in that Country e.g. 1994 in UK) or if it was taken from elsewhere).

European Protected Species Licensing

For a licence to be issued these three tests must be satisfied:

1. That the development is 'in the interests of public health and public safety, or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment';

2. That there is 'no satisfactory alternative'; and

3. That the derogation (i.e. any permission/licence granted) is 'not detrimental to the maintenance of the populations of the species concerned at a favourable conservation status in their natural range'.

To obtain a licence a Method Statement is required that identifies the activities to be undertaken, the location of all resting sites), the potential effects and details of the proposed mitigation.

Technical Appendix 5-2: Marine Mammal Protection Plan

Edinburgh Marina Granton Harbour Ltd

Edinburgh Marina
Technical Appendix 5-2: Marine Mammal Protection Plan

September 2018

Edinburgh Marina
Technical Appendix 5-2: Marine Mammal Protection Plan

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1 INTRODUCTION

1.1 Remit

EnviroCentre Limited was commissioned on behalf of Edinburgh Marina Granton Harbour Ltd to undertake a Marine Mammal Protection Plan (MMPP) to inform an Environmental Impact Assessment (EIA) in relation to the development of Edinburgh Marina, Granton.

In the absence of a finalised detailed method statement, the following Marine Mammal Protection Plan has been designed in reference to Joint Nature Conservation Committee (JNCC) guidance 'Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise' (August 2010)[1], previous marine mammal mitigation designed by EnviroCentre for similar projects; and the Statutory Nature Conservation Bodies (SNCB) position statement on "The use of Acoustic Deterrents for the mitigation of injury to marine mammals during pile driving for offshore wind farm construction

1.2 Scope of Report

The Marine Mammal Protection Plan (MMPP) will comprise two mitigation protocols, depending on the timings of the works carried out;

- A standard MMO protocol as per JNCC guidance which will be implemented during impact piling operations in optimal sea states and during times of optimal visibility; and
- An Acoustic Deterrent Device (ADD) protocol which will be implemented during hours of low visibility (i.e. winter working in darkness) and when the sea state exceeds 2.

The MMPP will be designed to protect harbour porpoise as they are known to be present in the vicinity of Granton and, generally speaking, high frequency hearing species of cetacean are the most sensitive to underwater noise and therefore reflect a worst-case scenario. Bottlenose dolphin, minke whale and humpback whale are also observed frequently in the zone of influence and it is assessed that the mitigation designed to protect harbour porpoise will be also be sufficient to protect these species.

Although not an EPS, as good practice and as they are known to be present in the general area, this will also extend to pinnipeds including harbour seal and grey seal.

The way in which noise affects marine mammals is dependent on several factors, including the type of noise generated, the noise level, the species of marine mammal and the distance between the animal and the source of the noise. The National Oceanic and Atmospheric Administration (NOAA) describes how different groups of marine mammals hear and are affected by sounds, which can be found in the *'Guidance for Assesing the Effects of Anthropogenic Sound on Marine Mammal Hearing'*[2]. The effects can be described as either a Permanent Threshold Shift (PTS), where an animal experiences irreversible damage to their hearing which can in turn affect their ability to forage and reproduce and in extreme circumstances result in death; or a Temporary Threshold Shift (TTS) which an animal can recover from, but may experience 'masking' which reduces its ability to communicate with other animals and locate prey, resulting in fatigue[3].

[1] It should be noted that this protocol does not document measures to mitigate disturbance effects, but has been developed to reduce to negligible levels of risk of injury or death to marine mammals in close proximity to piling operations.
[2] NOAA guidance available at: http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm last accessed 22/05/18
[3] JNCC UK Marine Noise Registry: Information Document available at: http://jncc.defra.gov.uk/pdf/MNR__Draft_InfoDoc_V1_20160808.pdf last accessed 06/06/2018

2 MARINE MAMMAL BASELINE

2.1.1 Marine Mammals

Baseline information, to determine how marine mammals utilise the zone of influence of the proposed works, was collated from the following sources:

- The Joint Nature Conservation Committee (JNCC)[4 & 5];
- Seawatch Foundation[6];
- Scottish Natural Heritage (SNH)[7]; and
- Whale and Dolphin Conservation (WDC)[8];

A range of marine mammals are known to be active in the Firth of Forth but the available data[9] has not presented any records of marine mammals within the site boundary.

2.2 Disclaimer

It should be noted that the baseline is limited by the reliability of third party information and the geographical availability of biological and/or ecological records and data. The absence of species from biological records cannot be taken to represent actual absence. Species distribution patterns should be interpreted with caution as they may reflect survey/reporting effort rather than actual distribution.

2.3 Marine Mammal Distribution and Sightings

2.3.1.1 Bottlenose Dolphins

The most commonly sighted cetacean in the Firth of Forth, more specifically the area surrounding Granton, appears to be bottlenose dolphin, however there are scarce estimates of the temporal and/or spatial distribution of the species in The Firth of Forth available. Very high numbers of sightings of bottlenose dolphins *(Tursiops truncatus)* exist on the northeast and eastern coast of Scotland; namely within the Moray Firth SAC which is designated for bottlenose dolphin. Generally however, the frequency of sightings decreases once reaching the Firth of Forth and surrounding area. Nonetheless it is thought that the range of the population of bottlenose dolphin, resident of the Moray Firth, extends as far down as the Firth of Forth, and in which case would still be protected as a feature of the SAC whether in the site or not.

There are occasional sightings of bottlenose dolphins in the Firth of Forth and East Lothian area, particularly between May and December. During summer of 2017, 38 individual bottlenose dolphin sightings were recorded, the closest of which was from Portobello beach, approximately 6km east of Granton where ten animals were observed. However, the majority of sightings come from further along the coast to the east, towards Gullane and Dunbar where the Firth becomes much wider. Since July 2018, 24 bottlenose dolphin sightings have been recorded within 40km of the site; 8 animals off the coast of Kinghorn approximately 9km

[4] JNCC Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (2010) available at: http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Piling%20protocol_August%202010.pdf last accessed 19/03/2018
[5] Reid, J B, Evans, P G H, and Northridge, S P. JNCC Atlas of Cetacean Distribution in north-west European waters (2003) available at: http://jncc.defra.gov.uk/page-2713#download
[6] Seawatch Foundation Cetaceans of Western Scotland available at: http://seawatchfoundation.org.uk/wp-content/uploads/2012/07/WesternScotland.pdf last accessed 19/03/2018
[7] SNH About Scotland's Nature: Marine Mammals available at: http://www.snh.gov.uk/about-scotlands-nature/species/mammals/marine-mammals/ 06/02/2018
[8] WDC species guides available at: http://uk.whales.org/species-guide last accessed 19/03/2018
[9] Seawatch Foundation Recent Sightings available at: http://www.seawatchfoundation.org.uk/recentsightings/ last accessed 07/09/2019

north, one animal approximately 47km north east off the Isle of May, 8 and 15 off the coast of Anstruther, approximately 40km north.

2.3.1.2 Harbour Porpoise

Harbour porpoise *(Phocoena phocoena)* are occasionally observed in the south east of Scotland where they occur in small numbers in nearshore waters along the coasts of Tayside and East Lothian, and in the Firth of Forth. Most sightings occur between July and September, although no sightings were recorded within or in proximity to The Firth of Forth via Sea Watch Foundation during summer 2017 or 2018.

2.3.1.3 Minke Whale

Minke whale *(Balaenoptera acutorostrata)* are recorded in small numbers in the Firth of Forth and offshore between June and September. One sighting of an individual minke whale was recorded in July 2017, the animal was identified from The Isle of May which is approximately 47km to the north east of Granton. The closest recorded sighting of minke whale to the site since during the summer of 2018 was off the coast of Pitenween, approximately 39km to the north east of Granton.

2.3.1.4 Humpback Whales

Humpback Whales have been sighted in the Firth of Forth in the same locations for the last two years, between Kinghorn and Inchmickery Island, which is approximately 6km north west of Granton, likely foraging on sprats and herring.

2.3.1.5 Grey Seal

Grey seal pup production in the Firth of Forth is steadily increasing; in 2010 approximately 2000 pups were born on the Isle of May 40km to the north east, approximately 1700 on the coast at Fast Castle 60km (straight line) to the east and approximately 250 on Inchkeith Island 7km to the north.

2.3.1.6 Harbour Seal

Harbour seal numbers along the east coast are thought to be declining and they are not frequently observed in the Firth of Forth. However, because seals range widely in their search for food (40-50km), single seals of either species might be spotted anywhere along the Scottish coastline.

2.3.1.7 Firth of Forth Banks Complex MPA

The Firth of Forth Banks Complex MPA lies approximately 47km offshore, to the north east of the site and covers a highly productive and biologically rich area of sand and gravel banks which are considered significant to the health of Scotland's seas by supporting populations of small fish and creating conditions ideal for several types of fish to breed. This source of food attracts many larger types of fish, seabirds, and marine mammals such as dolphins and porpoises.

Taking into account the lack of information regarding distribution of cetaceans within the Firth of Forth as well as the potential of The Firth of Forth Banks Complex to attract marine mammals, it is suggested that the following species have the potential to be present within the zone of influence of the development: Bottlenose dolphin, harbour porpoise, grey seal, harbour seal and minke whale.

3 MARINE MAMMAL PROTECTION PLAN

3.1 Increased Vessel Movement

During construction, there will likely be a small increase in vessel movement in and out of the harbour; the increase in vessel capacity at Granton Harbour post-development will also lead to an increase in vessel traffic post-construction. It is not currently known what the predicted increase in vessel movements will be as a result of the development.

The increase in the number of vessels travelling to the Granton Harbour, both during construction and operation, would increase the noise. There is also the risk of collision with marine mammals, potentially resulting in death or injury to individuals.

Disturbance caused by an increased human presence can have a negative impact on seals, seals that are on land are usually resting to conserve energy or may be nursing young, disturbing seals into the water costs them energy, creates stress and can lead to impacts on health[10]. Stampeding adults can also injure pups. As the nearest seal haul-out site is 4km to the north west of Granton, it is unlikely that seals will be negatively impacted to a population level. Individual animals foraging around Granton Harbour may be temporarily disturbed by an increase in vessel traffic.

3.2 Marine Mammal Mitigation Protocol

3.2.1 Marine Mammal Observer Protocol – Impact Piling

Marine Mammal Observer

A suitably qualified Marine Mammal Observer (MMO), competent in the identification of marine mammals at sea, will be present during the impact piling. The MMO will undertake observation for marine mammals within the mitigation zone before and during impact piling and will be dedicated to that one task for the duration of any watch. The MMO will advise the contractors and crews on the implementation of the procedures set out in the agreed protocol, to ensure compliance with those procedures.

The JNCC guidance provides the following definitions of an MMO:

MMO: Individual responsible for conducting visual watches for marine mammals. It may be requested that observers are trained, dedicated and/or experienced.

Trained MMO: Has been on a JNCC recognised course.

Dedicated MMO: Trained observer whose role on board a vessel is to conduct visual watches for marine mammals.

Experienced MMO: Trained observer with three years of field experience observing for marine mammals, and practical experience of implementing the JNCC guidelines.

[10] Scottish Natural Heritage: A Guide to Best Practice for Watching Marine Wildlife available online at: https://www.nature.scot/sites/default/files/2017-06/Publication%202017%20-%20A%20Guide%20to%20Best%20Practice%20for%20Watching%20Marine%20Wildlife%20SMWWC%20-%20Part%202%20-%20April%202017%20%28A2263517%29.pdf last accessed 13/06/2018

The MMO will be land based and will be Trained. The identity and credentials of the MMO will be agreed with Marine Scotland.

3.2.2 MMO Equipment

The MMO will be equipped with binoculars (10X42 or similar) and/or a spotting scope (20-60 zoom or equivalent), a copy of the agreed protocol and the Marine Mammal Recording Form (MMRF), which is a Microsoft Excel spreadsheet containing embedded worksheets named Cover Page, Operations, Effort and Sightings. A Microsoft Word document named Deck forms is also available, and the MMO may prefer to use this when observing before transferring the details to the Excel spreadsheets. Although these forms were developed for seismic surveys, they can be used for piling operations, although many columns will not be applicable. The ability to determine the range of marine mammals is a key skill for MMOs, therefore a hand-held rangefinder will be used to verify the range.

All MMO forms, including a guide to completing the forms; and instructions on how to make a rangefinder are available on the JNCC website: http://jncc.defra.gov.uk/marine/seismic_survey

3.2.3 Communication

The contractor will be responsible for the communication channels between those providing the mitigation service and the crews working on the piling. A formal chain of communication from the MMO to the contractor, who will start/stop piling, will be established. In order to confirm the chain of communication and command the MMO will attend any relevant pre-mobilisation meetings.

3.2.4 Mitigation Zone

The JNCC guidance defines the mitigation zone as a pre-agreed radius around the piling site prior to any piling. This is the area where a MMO keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected). The extent of this zone represents the area in which a marine mammal could be exposed to sound that could cause injury and will be determined by factors such as the pile diameter, the water depth, the nature of the activities (for example whether drilling will also take place) and the effect of the substrate on noise transmission.

The radius of the mitigation zone should be no less than 500 metres, and this is measured from the pile location. The mitigation zone is calculated following a review of underwater noise modelling; and reflects the risk zones of PTS and TTS for the species of concern, therefore cannot be defined at this time.

The MMO should be located on the most appropriate viewing platform to ensure effective coverage of the mitigation zone, during periods of rough seas, an elevated vantage point would be beneficial.

3.2.5 Impact Piling Protocol

The standard JNCC protocol is outlined below[11] (please see the Acoustic Deterrent Device (ADD) protocol to be followed during times of sea states exceeding 4 (or 2 if deemed necessary by the MMO) or during periods of darkness and/or low visibility i.e. fog):

1. The MMO will not initiate this protocol during periods of darkness or poor visibility (such as fog) or during periods when the sea state is not conducive to visual mitigation (above sea state 4 is considered not

[11] There is a 'variation of standard piling protocol' allowed in the guidance if required.

conducive[12]) as there is a greater risk of failing to detect the presence of marine mammals. Harbour porpoise have small dorsal fins, therefore the MMO shall take additional precautions if the sea state exceeds 2. As works will occur over the winter period it is likely that sea state 2 will be exceeded on a regular basis. An elevated platform for the MMO to monitor from would be beneficial when the sea state is 2 or above, the impact piling works could also be scheduled on a day where the sea is expected to be calm.

2. The mitigation zone will be monitored visually by the MMO for an agreed period prior to the commencement of piling. This will be a minimum of 30 minutes.

3. The MMO will scan the waters using binoculars or a spotting scope and by making visual observations. Sightings of marine mammals will be appropriately recorded in terms of date, time, position, weather conditions, sea state, species, number, adult/juvenile, behavior, range etc. on the JNCC standard forms. Communication between the MMO and the contractor and the start/end times of the activities will also be recorded on the forms.

4. Piling will not commence if marine mammals are detected within the mitigation zone or until 20 minutes after the last visual detection. The MMO will track any marine mammals detected and ensure they are satisfied the animals have left the mitigation zone before they advise the crew to commence piling activities.

5. A soft-start will be employed, with the gradual ramping up of piling hammer power incrementally over a set time period until full operational power is achieved. The soft-start duration will be a period of not less than 20 minutes. This will allow for any marine mammals to move away from the noise source.

6. If a marine mammal enters the mitigation zone during the soft-start then, whenever possible, the piling operation will cease, or at least the power will not be further increased until the marine mammal exits the mitigation zone and there is no further detection for 20 minutes.

7. When piling at full power this will continue if a marine mammal is detected in the mitigation zone (as it is deemed to have entered voluntarily[13]).

8. If there is a pause in the piling operations for a period of greater than 10 minutes, then the pre-piling search and soft-start procedure will be repeated before piling recommences. If a watch has been kept during the piling operation, the MMO should be able to confirm the presence or absence of marine mammals, and it may be possible to commence the soft-start immediately. If there has been no watch, the complete pre-piling search and soft-start procedure will be undertaken.

To prevent the need for the pre-piling search and therefore delays to the piling operations a noise generator could be deployed, which is a metal, spring loaded hammer device which creates a continuous underwater noise, mimicking the sound of the impact hammer; which would in turn deter marine mammals from entering the mitigation zone. This should be used for no longer than 1 hour, or in exceptional circumstances 2 hours (i.e. a breakdown of machinery), after which the standard soft-start procedure will commence. All uses of the noise generator should be logged and handed to the MMO to include in the deck forms.

Passive Acoustic Monitoring (PAM) is of little value for monitoring species with low vocalisation rates, such as seals and baleen whales, including minke whales which are often encountered in inshore waters, which is why ADD are recommended in this instance.

[12] Detection of marine mammals, particularly porpoises, decreases as sea state increases. According to the JNCC guidance ideally sea states of 2 or less are required for optimal visual detection.
[13] The guidance states that there is no scientific evidence for this voluntary hypothesis; instead it is based on a common sense approach. Factors such as food availability may result in marine mammals approaching piling operations; in particular, the availability of prey species stunned by loud underwater noise may attract seals into the vicinity.

3.2.6 Reporting

As per the JNCC guidance, reports detailing the piling activity and marine mammal mitigation (the MMO reports) will be sent to Marine Scotland at the conclusion of piling activity. Reports will include:

- Completed MMRFs;
- Date and location of the piling activities;
- A record of all occasions when piling occurred, including details of the duration of the pre-piling search and soft-start procedures, and any occasions when piling activity was delayed or stopped due to presence of marine mammals;
- Details of watches made for marine mammals, including details of any sightings, and details of the piling activity during the watches;
- Details of any problems encountered during the piling activities including instances of non-compliance with the agreed piling protocols; and
- Any recommendations for amendment of the protocols.

3.2.7 Acoustic Deterrent Device Protocol – Impact Piling

JNCC guidance states that *'The above protocol (MMO protocol) is considered to represent current best practice for a typical piling operation. Developers may, however, feel that the protocol is unduly restrictive, particularly in respect of restrictions on night-time/low visibility piling. In such cases, the burden of proof lies with the developer to demonstrate that effective mitigation can be delivered using an amended protocol. A distinction should be made here between piling which commences during times of good visibility (and subject to the above provisions) and continues into a period of poor visibility/ night-time, and piling that commences during times of poor visibility (including night-time conditions). Assuming that the operations are continuous the first scenario would not need additional mitigation. The second, scenario would, however, require enhanced mitigation measures. Each request for variations from the protocol should be considered on its merits and, to ensure consistency across projects and other marine industries, in close liaison with JNCC and other statutory nature conservation agencies.'*

Acoustic Deterrent Devices (ADDs) are devices consisting of a control unit and a transducer (sound head). The control unit contains a pulse generator and an amplifier and transmits random burst of audio frequency signals to the transducer, where they are converted into sound. Marine mammals display avoidance reactions to these sounds.

The use of the following (ADD): http://www.lofitech.no/en/seal-scarer.html to provide piling mitigation has been reviewed by the Statutory Nature Conservation Bodies (SNCB) including Scottish Natural Heritage, Natural Resources Wales and Natural England[14]. It was concluded that:

The SNCBs consider the evidence presented to date shows that the Lofitech ADD device can elicit behavioral responses from harbour porpoise and harbour seal, displacing the majority of animals by hundreds of metres. Therefore the SNCBs consider that certain types of ADDs have the potential to be used as an alternative to the mitigation provided by MMOs and PAM for harbour porpoise, harbour seals and potentially for grey seals. SNCB advice on cases applying to use ADDs as an alternative to MMOs/PAM will be considered on a case-by-case basis.

Passive Acoustic Monitoring (PAM) is of little value for monitoring species with low vocalisation rates, such as seals and baleen whales, including minke whales which are often encountered in inshore waters, which is why ADD are recommended in this instance.

[14] Joint Statutory Nature Conservation Bodies (2016) Position Statement

Following this statement, further research has been undertaken[15] which highlights that the Lofitech ADD is effective at evoking a deterrence response in minke whales.

The following protocol has been designed for use when:

- Impact piling operations are to commence during hours of low visibility/night-time; and
- The sea state exceeds 2.

1. The ADD will be deployed by a pre-agreed operative(s) who will be solely responsible for the device during its use across the project, this person could also be the MMO, however a two person team may be more appropriate should works during the day and during times of low visibility overlap. MMOs and ADD operators should keep in regular contact during piling works and ensure that where possible (i.e. visibility/sea state allows) the MMO protocol is followed; reducing the time underwater noise is introduced into the environment as much as possible.

2. The ADD should be positioned so that the sound is not masked or blocked, i.e. off the side of a vessel facing out towards open water. Before commencing the protocol, the device should be checked by the operative to ensure it is producing a noise once placed into the water and that it has sufficient battery life/spare batteries.

3. The ADD will be deployed for a duration determined by how fast a species flees from a source of disturbance[16]: It should be activated for at least as long as it takes for a marine mammal to swim twice the distance of the injury zone at the onset of soft-start piling. Of the species of concern, harbour porpoise is considered the slowest swimming (1.4 m/s[17]) therefore will be used as standard to represent a worst-case scenario.

   An example is shown below assuming that the PTS zone for a harbour porpoise is 500m (the PTS/TTS zones cannot be defined without site specific underwater noise modelling). If it were possible to start the soft-start at 1% hammer power (which is recommended), the time that the ADD is deployed would be 5 minutes, which is not considered long enough to introduce significant underwater noise disturbance to the surrounding environment.

Impact hammer power	Max PTS range	Minutes to travel to max PTS range	Total time running the ADD before commencement of soft start
100%	~ 500m	12	24
10%	~ 300m	7	14
1%	**~ <100m**	**2.5**	**5**

4. Once the time running the ADD has elapsed, the soft start for impact piling can commence, as per the soft start outlined in the MMO protocol. After which, piling can continue and the ADD turned off.

5. Should there be a pause in piling operations for a period of greater than 10 minutes, the protocol outlined in Section 3.2.5 (8) should be followed. If visibility/sea state has improved between piling operations and visual monitoring is possible; the ADD operative will inform contractors they should revert back to the MMO protocol.

[15] RPS (2017) ORJIP Project 4 Phase 2 Understanding the Effectiveness of Acoustic Deterrent Devices on Minke Whale
[16] Herschel et al (2013) ORJIP Project 4, Phase 1 Use of Deterrent Devices and Improvements to standard Mitigation during Piling Research Summary
[17] Scottish Natural Heritage (2016) Guidance Note: Assessing Collision Risk Between Underwater Turbines and Marine Wildlife

6. The timings and duration of the use of the ADD will be recorded in a log and kept up to date throughout the project. It will be submitted once piling works have ceased, if required, along with the JNCC MMO Deck Forms.

4 MARINE MAMMAL LICENSING

European Protected Species (EPS) are animals and plants (species listed in Annex IV of the Habitats Directive) that are afforded protection under The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017. All cetacean species (whales, dolphins and porpoise) are European Protected Species. If any activity is likely to cause disturbance or injury to a European Protected Species a licence is required to undertake the activity legally.

The licensing of Marine European Protected Species in Scotland is shared between several regulators depending on the purpose and location of the activity in question. For activities taking place within 12 nautical miles of the coast (the Scottish Territorial Sea), EPS are protected under the 1994 Regulations. For commercial activities, including geophysical or seismic surveys (including those related to oil and gas), port and harbour developments and the installation of renewable energy devices Marine Scotland (on behalf of the Scottish Ministers) is the licensing authority under the 1994 Regulations: Regulation 39 (1) (a). For activities relating to scientific research or conservation, Scottish Natural Heritage is the licensing authority.

A licence may be granted to undertake such activities if certain strict criteria are met:

- There is a licensable purpose.
- There are no satisfactory alternatives.
- The actions authorised will not be detrimental to the maintenance of the population of the species concerned at favourable conservation status[18] in their natural range.

The flowchart in Figure 4-1 below shows the decision-making process for licensing, taken from the Marine Scotland guidance[19].

[18] The ultimate objective of the Habitats Directive is to ensure that the species covered reach what is called a 'Favourable Conservation Status' and that their long-term survival is deemed secure across their entire natural range within Europe. Article 1(i) of the Habitats Directive defines Favourable Conservation Status (FCS) of a species as follows:
"Conservation status of a species means the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within its natural range.
The conservation status will be taken as 'favourable' when:
- population dynamics data on the species concerned indicates that it is maintaining itself on a long-term basis as a viable component of its natural habitats; and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis."

[19] Guidance for Scottish Inshore Waters: The Protection of Marine European Protected Species from injury and disturbance. Marine Scotland 2014.

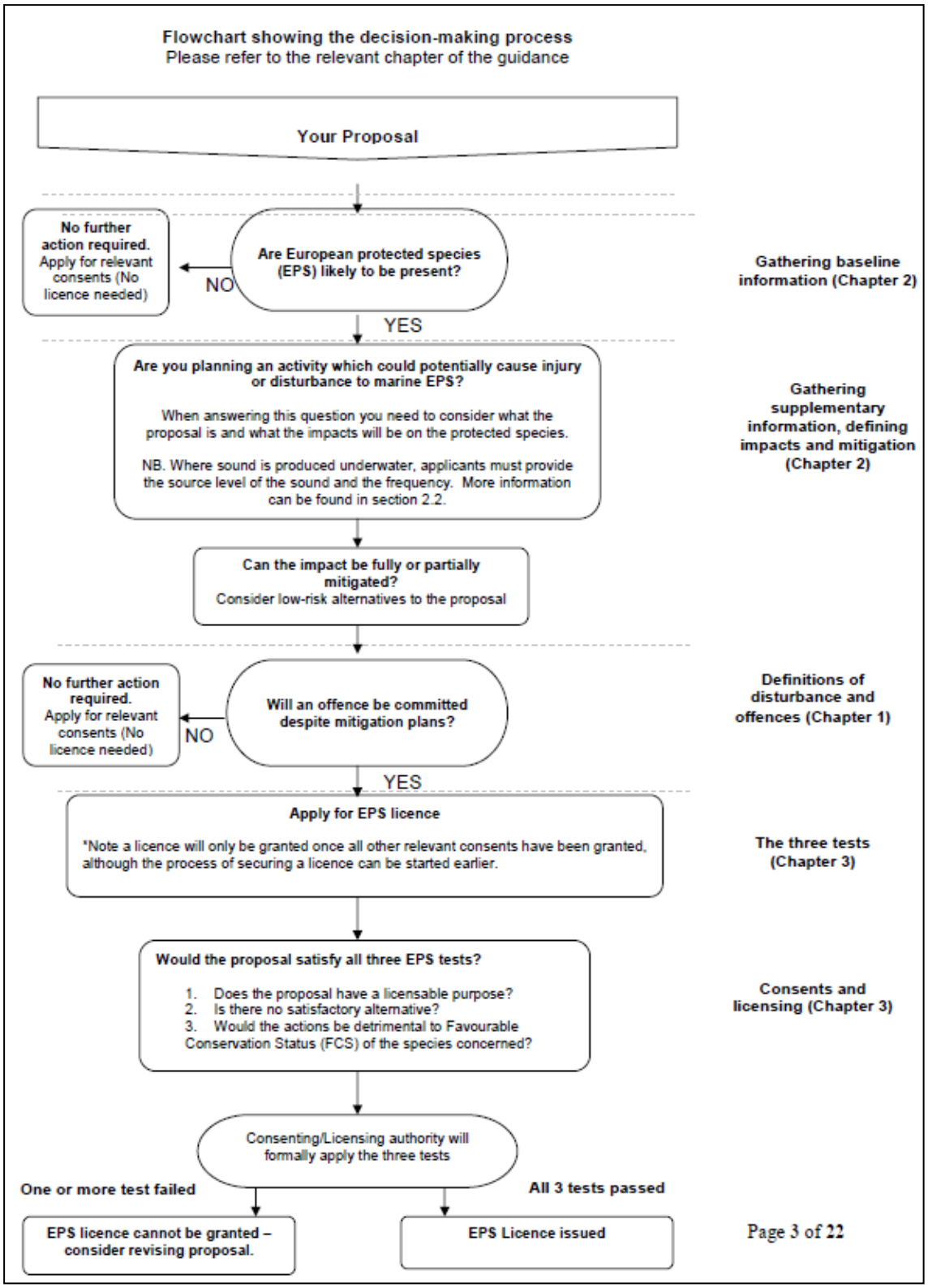

Figure 4-1: EPS Licencing Procedure

Impact piling has the potential to produce underwater noise at levels which could cause injury and disturbance to cetaceans. If the mitigation in section 3 is employed effectively, it is predicted that there will be no risk of injury, however, the mitigation measures cannot fully protect against disturbance from piling noise. As highlighted in Section 3 the risk of disturbance is greater than that of injury, with TTS (disturbance) occurring over a much wider area than PTS (injury). **Therefore an EPS licence will be required for potential disturbance from impact (hammer) piling.**

APPENDICES

A SITE LOCATION

Legend

Site Boundary

Do not scale this map

Client

Cameron Planning

Project

Edinburgh Marina

Title

Figure 1: Site Location Plan

Status

FINAL

Drawing No.	Revision
770288-001	

Scale		Date
1:15,000	A3	19 Feb 2017

Drawn	Checked	Approved
GV	GV	IB

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B VESSEL MOVEMENT: SPEED RESTRICTIONS AND CODES OF CONDUCT

On the sea

Seeing wildlife is a great bonus to any boat trip, and increasing numbers of people are taking advantage of dedicated wildlife watching boat tours. There is a great deal of wildlife around, and it is often easy to see, even from a distance – especially if binoculars are used.

This guidance applies to anyone out in a boat of any kind who encounters wildlife, intentionally or otherwise. Although the Code should be followed at all times where practical, remember that the first responsibility of the skipper of a vessel is the safety of passengers and crew. Do not put yourself, crew or passengers in danger.

- Follow any locally available advice about avoiding disturbance to wildlife. This may include local marine codes, byelaws and wildlife management schemes.
- Keep a good lookout and don't get too close. Use binoculars to get a better view. Tour operators often provide their passengers with binoculars to assist with this.
- As soon as you see wildlife, assess the situation. What are the animals doing? Where are they going? How can I avoid disturbing them?
- If you are passing close to wildlife, reduce your speed to the safest minimum. Make sure that your movements are steady and predictable and approach at an oblique angle – direct or head-on approaches are more threatening. Depart with equal caution.

- Do not cut off an animal or group of animals by moving across their path, and do not approach them from behind.
- Let the animals decide how close they want you to be. If you see signs of disturbance (such as sudden movements or flight, aggressive behaviour, "heads up", bunching together, tail slaps) then you should move away and if possible take an alternative route or wait for the animals to move on.
- If animals are moving in a consistent direction, maintain a steady parallel course and where possible keep above the recommended minimum distances discussed in the Guide.
- If marine mammals decide to approach you (for example to bow ride), try to maintain a steady speed and course. Try not to present your propellers to approaching animals.
- Make sure the animals are not surrounded. If other people are watching, try to stay on the same side. Avoid corralling or boxing animals in against the shoreline or in sea lochs or bays.
- If you can see one animal at the surface, others may well be nearby, just below the surface out of sight. Keep a careful lookout at all times.
- Remember that with more boats and people about, the likelihood of disturbance will be greater.
- Take extra care during sensitive times of year in places where animals may be feeding, resting, breeding or with their young:
  - Do not intentionally break up or put up rafts of birds or flush seals into the sea.
  - Avoid landing or entering the sea adjacent to designated seal haul-out sites.
  - Be careful not to split up groups, or mothers and young, and never approach apparently lone young animals.
  - Watch out for basking sharks at tidal fronts where different water bodies meet (often marked on the surface of the water by lines of debris or foam) as they may be feeding and not be aware of your presence.
- If watching whales, dolphins or porpoises, switch off your echo sounder if it is safe to do so. These animals are particularly sensitive to underwater noise and it may interfere with their communication, navigation and foraging.
- Avoid using flash photography – check the default setting on your camera.
- Do not throw litter into the sea.

If you are using an engine:

- Avoid sudden unpredictable changes in speed, direction and engine noise.
- Keep your engine and propeller well maintained to minimise noise.

If you are under sail, paddling or rowing:

- Do not take advantage of your ability to approach quietly – it may result in wildlife being suddenly startled by your proximity.
- Be aware of any wildlife around your vessel so that you can act as quickly as possible to minimise disturbance.
- Remember that small craft are vulnerable. Getting too close to marine animals may put you at risk.
- If you are under sail, avoid tacking, gybing and flapping sails close to marine wildlife, if possible.
- When seals are hauled out on the shore, they are particularly prone to disturbance from passing kayaks. If paddling, give haul-out sites a wide berth.

Personal water craft (sometimes known as "jet skis") are not recommended for viewing marine wildlife. They are fast, noisy, and low in the water. Their speed and limited range of visibility means that collisions may occur and can be serious for both parties.

- Keep a good lookout at all times, and keep away from marine wildlife where possible.
- If you have an unexpected encounter with marine wildlife, slow down and move away steadily to 100 metres or more.

See **A Guide to Best Practice for Watching Marine Wildlife** for more detailed advice on different species groups.

Technical Appendix 5-3: Marine Non-native Species Survey

Edinburgh Marina Granton Harbour Ltd

Edinburgh Marina
Technical Appendix 5-3 Marine Non-Native Species Survey

September 2018

Edinburgh Marina
Technical Appendix 5-3 Marine Non-Native Species Survey

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Contents

Appendices

Tables

1 INTRODUCTION

1.1 Background

EnviroCentre Limited was commissioned by Edinburgh Marina Granton Harbour Ltd, to undertake a survey for marine non-native species (NNS) survey within Granton Harbour, Edinburgh. The survey was required to inform an Ecological Impact Assessment (EcIA) for re-development works.

No definitive site boundary was available prior to survey design, therefore the 'site' was considered to be the physical extents of the harbour and the survey effort was extended to a 250m buffer upstream and downstream, where accessible. A survey plan is presented in Appendix A.

1.2 Aims and Objectives

The aim of the survey was to establish the ecological baseline in terms of marine NNS present. The main objectives of the survey were as follows:

- Search for field evidence of marine NNS;
- Identify suitable habitat for marine NNS in the survey area; and
- Identify the potential impacts and outline appropriate mitigation methods; and
- Make recommendations for any further survey and/or species licensing requirements.

1.3 Site Description and Proposed Development

The site is within Granton Harbour, north Edinburgh and fronts on to the Firth of Forth. The larger Leith docks is situated approximately 1.3km to the east of Granton Harbour. Granton Harbour consists of an east and west harbour which are separated by a middle pier. Much of the western harbour has been lost to land reclamation in the past.

The proposed development includes the creation of a new marina, extension and backfilling of the quay wall, extension of the western breakwater and dredging. The development received outline planning permission in 2003 as part of the larger Granton Harbour regeneration project.

The harbour, and that adjacent to the east of the development, is currently used by Royal Forth Yacht Club. Visiting vessels from other locations may also be moored there.

Site photographs are presented in Appendix B.

1.4 Marine Non-Native Species

A NNS which threatens native biodiversity, human health or economic activity is often referred to as an invasive non-native species (INNS). Very little is known about NNS in the marine environment and their existing or potential impact, making it difficult to differentiate between non-native species which are clearly invasive and species which may become invasive (effectively all other non-native species). Both are referred to as NNS in this report.

More than 90 marine NNS have been identified in British and Irish waters (including Republic of Ireland and Northern Ireland), of which 17 are now established in Scotland. Their introduction is believed to be

predominantly due to shipping, including ballast waters and sediments, fouling of hulls and other associated hard structures, and imported consignments of cultured species. Most marine NNS in Britain originate from parts of the world with a similar latitude to ourselves (e.g., North Pacific, North-west Atlantic) (Payne *et al.*¸2014). Movement of vessels and equipment can cause both the introduction of a new NNS or the spread of a NNS already established at a site to new locations.

INNS can have a damaging impact on native plants, animals and ecosystems - by spreading disease, competing for habitat and food and direct predation. INNS also affect economic uses of our environment and can add significant management costs, as plants that grow profusely can cause damage to buildings and infrastructure, block waterways while some species can damage riverbanks. Without mitigation the introduction of NNS could have a detrimental effect on the integrity of Priority Species and designated sites in the Firth of Forth.

1.5 Legislative Context

The principal legislation is the Wildlife and Countryside Act 1981 (the 1981 Act). The 1981 Act contains provisions on:

- Release or planting of all non-native species;
- Sale of invasive species;
- Notification of non-native species; and
- Species Control Agreements and Species Control Orders.

Under the Act it is an offence to:

- Cause an animal to be in a place outwith its native range; and
- Plant or cause any plant species to grown in the wild outwith its native range.

The 1981 Act includes a number of offences relating to the list above, some subject to a defence of having taken all reasonable steps and exercised all due diligence to avoid committing the offence.

European and national legislation and policy relevant to this report include:

- The Wildlife and Countryside Act 1981 (as amended);
- Environment Liability (Scotland) Regulations 2009;
- The Wildlife and Natural Environment (Scotland) Act 2011 (WANE);
- Code of Practice on Non-native Species[1];
- The UK Biodiversity Action Plan (UKBAP);
- The Scottish Biodiversity List (SBL);
- Edinburgh Biodiversity Action Plan (EBAP) 2016-2018);
- Scottish Planning Policy (2014); and
- Edinburgh Local Development Plan (2016).

1.6 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre.

[1] https://www.gov.scot/Publications/2012/08/7367/0

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

2 METHODS

All survey work was undertaken and verified by an experienced and competent ecologists who are Members of the Chartered Institute of Ecology and Environmental Management (CIEEM). This section provides details of the methods adopted.

2.1 Desk Study

In order to anticipate the potential ecological sensitivities at the site through the introduction of NNS, a desk study was conducted in advance of the survey in August 2018. The following sources of information were used:

- Reponses to Screening Opinion Under Part 2, Regulation 11 of the Marine Works (Environmental Impact Assessment) regulations 2017 (Amended) for Granton Central Development Ltd (per Cameron Planning) - Granton Harbour Development – Granton, Edinburgh;
- Data on designated sites available through Scottish Natural Heritage (SNH) Sitelink website (SNH, n.d.) (up to 5km from the site);
- Existing data on non-statutory designated sites up to 2km from the site, available through the Edinburgh Local Development Plan (LDP) (City of Edinburgh Council, 2016);
- NBN Atlas[2] for marine NNS records within 5km of the site – only records created within the last 10 years and which are licenced for commercial use are reported;
- EBAP 2016-2018 (City of Edinburgh Council, 2016) for priority habitats and species;
- UKBAP (JNCC, n.d.); and
- SBL (Scottish Government, 2013).

2.2 Marine NNS Survey

The field survey was carried out by Lorna Wilkie on 15th August 2018. The weather conditions were sunny with scattered showers and a light breeze, and the temperature was 15 degrees centigrade.

The survey area encompassed the splash zone and intertidal zone within the site boundary and 250m up-stream and down-stream of the site. The species looked for were:

- Japanese kelp, or Wakame (*Undaria pinnatifada*);
- Japanese wireweed (*Sargassum muticum*);
- Darwin's barnacle (*Austrominius modestus*);
- Green sea-fingers (*Codium fragile subsp. fragile*);
- Red algae (*Heterosiphonia japonica*);
- Japanese skeleton shrimp *(Caprella mutica*);
- Leathery sea squirt (*Syela clava*);
- Carpet sea-squirt *(Didemnum vexillum*);
- Pacific oyster (*Crassostrea gigas*); and
- Zebra mussel (*Dreissena polymorpha*).

[2] NBN Atlas available from: https://nbnatlas.org (Accessed: 13/08/2018)

2.3 Assessment Limitations

Desk Study

It should be noted that the desk study is limited by the reliability of third party information and the geographical availability of biological and/or ecological records and data. This emphasises the need to collate up-to-date, site-specific data based on field surveys by experienced surveyors. The absence of species from biological records cannot be taken to represent actual absence. Species distribution patterns should be interpreted with caution as they may reflect survey/reporting effort rather than actual distribution.

Field Study

Access to internal harbour walls to the south and east and external walls to the north and east were limited due to water depth. These areas were viewed from a distance using binoculars.

3 RESULTS

3.1 Desk Study

The results of the desk study are provided in Table 3.1. No marine NNS have previously been recorded at the site or within a 5km radius. The Screening responses included a statement that the marine INNS Japanese kelp, or Wakame (*Undaria pinnatifada*), has been recorded at Port Edgar Marina, 11.5 km west and upstream of Granton Harbour, and this record is available on the NBN. This species can rapidly form dense stands on any available hard surfaces and out-compete native kelp and other algal species and epibenthic animals[3].

Table 3-1: Pre-Survey Data Search Results

Source	Information Provided			
SiteLink	**Site name**	**Designation[4]**	**Distance and orientation (closest)**	**Features**
	Firth of Forth	SSSI SPA RAMSAR	0.06km east 0.1km west 2.87km north east	Eider (*Somateria mollissima*) Ringed plover *(Charadrius hiaticula*) Shelduck (*Tadorna tadorna*) Waterfowl assemblage
	Imperial Dock Lock, Leith	SPA	3.82km east	Common Tern (*Sterna hirundo)*
	Forth Islands	SPA	0.5km north west	Arctic tern (*Sterna paradiaea)* 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*) Seabird assemblage Shag (*Phalacrocorax arisotelis*)
	Inchmickery	SSSI	3.84km north west	Fulmar (*Fulmarus glacialis)* Herring gull (*Larus argentatus)* Lesser black-backed gull (*Larus fuscus)* Shag (*Phalacrocorax arisotelis)*
Edinburgh Local Development Plan	Granton Harbour area is listed as an International and National Natural Heritage Designation (Natura 2000 Site and/or SSSI). Within the development plan is proposed to become a new local centre and obtain an overall regeneration including new green space, cycle/footpaths, a new major street and a tramline safeguard. Approximately 1,980 homes are proposed to be built within this area plus properties for commercial-led mixed use.			
UKBAP	UKBAP Priority Habitats: • Supralittoral sediment: Coastal Vegetated shingle; • Littoral Rock: Littoral Chalk; • Littoral sediment: Coastal saltmarsh, mudflats, seagrass beds (Zostera marina), sheltered muddy gravels; and • Inshore subittoral sediment: seagrass beds (Zostera marina), Maerl beds, Saline lagoons, mud in deep water, Serpulid reefs.			
SBL	Priority Habitats: • Coastal saltmarsh; and • Coastal vegetated shingle.			
EBAP	Priority Habitats: • Coastal habitats; • Intertidal habitats; and • Marine			

[3] http://www.nonnativespecies.org/factsheet/factsheet.cfm?speciesId=3643 (Accessed 07/09/2018)
[4] Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Special Areas of Conservation (SAC), Local Nature Reserve (LNR)

3.2 Field Study

The area covered by the field survey is shown in Appendix A and site photographs are provided in Appendix B.

No marine NNS were found at Granton Harbour or 250m upstream or downstream of the site. Potential habitat for NNS to colonise is present in the forms of soft intertidal sediments, and hard surfaces such as stone harbour walls, metal sheet piling and pillars.

4 EVALUATION OF ECOLOGICAL FEATURES AND POTENTIAL IMPACTS

4.1 Evaluation

Although no NNS were observed, soft intertidal sediments and hard surfaces such as stone harbour walls, metal sheet piling and pillars may provide potential habitat for NNS to colonise. The harbour is already in use by the Royal Forth Yacht Club and the frequency of use and number of visiting vessels from other locations will increase with the development of the marina. Incoming vessels increases the risk of the introduction of NNS. Outgoing vessels increase the risk of spreading invasive species further.

4.2 Potential Impacts

Below is a list of the potential impacts of the development:

- Development may disturb sediment where spores of NNS may be buried/dormant;
- Removal of dredged sediment may increase the risk of NNS spreading elsewhere within the Firth of Forth; and
- Increased boating traffic may increase the risk of NNS in Granton Harbour.

5 FURTHER SURVEY, LICENSING & MITIGATION

5.1 Further Survey and Licensing

Ecological data is considered valid for a period of 12 months. Providing that works commence before August 2019, no further survey work in relation to marine NNS is considered necessary. Pre-works checks, as outlined in Section 5.2 below, will be required for NNS. If the site boundary was to change, further survey work may be required.

A Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) Licence would be required to carry out any dredging at the site. Any dredged spoil would require to go to a licensed disposal site. Information regarding this can be obtained through SEPA[5].

5.2 Mitigation

Works should adhere to the Code of Practice on Non-Native Species (2012). Assuming the following mitigation is applied, no introduction or spread of NNS is anticipated to occur that could significantly affect the ecological integrity of the site:

- Development and implementation of a Marine Biosecurity Plan specific to construction and also operation of the completed development;
- An Environmental/Ecological Clerk of Works (ECoW) team will be appointed to monitor compliance, produce auditable records and provide onsite advice;
- All relevant staff receive a copy of the site/ operation biosecurity plan summary and instructions sheet;
- ECoW to receive training in NNS identification;
- Identification of commonly found NNS will also be outlined in toolbox talks given to staff by the ECoW;
- All staff will be encouraged to report any 'suspect' marine plant or animal to the Environmental Manager or EcoW;
- Measures will be in place to preserve water quality and prevent watercourse pollution following SEPA Guidelines for Pollution Prevention (GPPs);
- Routine inspections of equipment and vessels for NNS and biosecurity measures taken if NNS found at site or on equipment; and
- Inspection of any 'high risk' vessels or materials entering the harbour during construction and operation.

[5] https://www.sepa.org.uk/regulations/water/guidance/#dredging

REFERENCES

Payne, R.D., Cook, E.J. and Macleod, A. (2014). Marine Biosecurity Planning – Guidance for producing site and operation-based plans for preventing the introduction of non-native species. Report by SRSL Ltd. in conjunction with Robin Payne to the Firth of Clyde Forum and Scottish Natural Heritage.

Scottish Government. (2012). Code of Practice on Non-Native Species.

APPENDICES

A MARINE NON-NATIVE SPECIES SURVEY PLAN

Legend

- Site Boundary
- Survey Area

Do not scale this map

Client
Edinburgh Marina Granton Harbour Ltd

Project
Edinburgh Marina

Title
Invasive Non-Native Species Survey Results

Status
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B SITE PHOTOGRAPHS

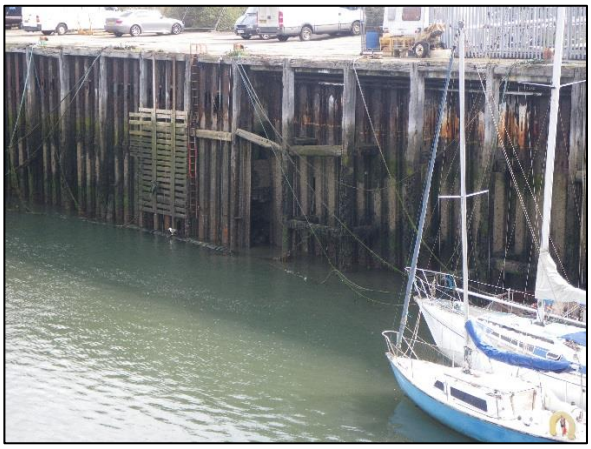
Photograph 1: North harbour wall (internal).

Photograph 2: North Harbour wall (external).

Photograph 3: South harbour wall (internal).

Photograph 4: West harbour (internal).

Photograph 5: Harbour wall to east of site (external).



Photograph 6: East harbour wall (internal).

Technical Appendix 5-4: Habitat Regulations Appraisal

Edinburgh Marina Granton Harbour Ltd

Edinburgh Marina
Technical Appendix 5-4: Habitats Regulations Appraisal

September 2018

Edinburgh Marina
Technical Appendix 5-4: Habitats Regulations Appraisal

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EXECUTIVE SUMMARY

EnviroCentre Limited has been commissioned by Edinburgh Marina Granton Harbour Ltd to undertake a Habitats Regulations Appraisal (HRA) for the proposed Edinburgh Marina Development which is part of the wider Granton Harbour regeneration development. The proposed works would include the creation of a new marina, extension and backfilling of the quay wall, extension of the western breakwater (also known as the north mole) and dredging.

Due to the proximity of works to European designated sites, a HRA is required to determine the effect of the proposed development on the qualifying features of the following designated sites:

- Firth of Forth Special Protection Area (SPA);
- Firth of Tay and Eden Estuary Special Area of Conservation (SAC)
- Forth Islands SPA;
- Imperial Dock Lock, Leith SPA;
- Outer Firth of Forth and St Andrews Bay Complex proposed SPA (pSPA);
- Isle of May SAC;
- Berwickshire and North Northumberland Coast (SAC); and
- River Teith SAC.

It was only possible to rule out Likely Significant Effects (LSEs) of all the qualifying features of Firth of Tay and Eden Estuary SAC during the HRA screening process. Therefore the effects on the qualifying features for the other seven sites were taken forward for further consideration in the next HRA stage, an Appropriate Assessment.

The Appropriate Assessment concluded that if mitigation measures outlined within the EIA Report (EIAR) are adhered to, along with the pollution prevention mitigation described in section 13 of this report, then there will be no significant effects on the integrity of the designated sites with regard to the conservation objectives for the sites' qualifying features.

Contents

Appendices

Figures

Tables

1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Limited has been commissioned by Edinburgh Marina Granton Harbour Limited, to undertake an Environmental Impact Assessment (EIA) for the proposed development of Edinburgh Marina in Granton. The Scoping Opinion received from Marine Scotland (Marine Scotland, 2018) highlighted that the proposed works could have Likely Significant Effects (LSEs) on Berwickshire and North Northumberland Coast Special Area of Conservation (SAC); Firth of Forth Special Protection Area (SPA); Forth Islands SPA; Imperial Dock Lock, Leith SPA; Isle of May SAC; Outer Firth of Forth and St Andrews Bay Complex pSPA; and River Teith SAC. Therefore, a Habitats Regulations Appraisal (HRA) would be required to determine the effect of the proposal on the qualifying features of these designated sites.

1.2 Scope of Report

It is the responsibility of the competent authority (in this case Marine Scotland) to conduct the HRA, however, this document aims to provide the information necessary for them to undertake the appraisal by:

- Providing an outline of the proposed works and any integral mitigation;
- Identifying European designated sites which are connected to and/or could potentially be affected by the proposed works;
- Identifying how works may impact the qualifying features of the designated site(s), the test of LSE;
- Giving consideration to other projects which may have an 'in combination' effect on European designated sites;
- Recommending sites which need to be taken forward for further assessment if LSEs for the qualifying features of the European designated site cannot be ruled out;
- Conducting an 'Appropriate Assessment' for qualifying features of sites for which LSE cannot be ruled out; and
- Propose further mitigation which would be required to avoid adverse impacts on the qualifying features of the European designated sites.

1.3 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

1.4 Legislative Context

The Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (hereafter called the Habitats Directive) requires 'appropriate assessment' of plans and projects that are likely to have a significant effect on European designated Natura 2000 sites.

Article 6(3) establishes the requirement for Appropriate Assessment (AA):

"Any plan or project not directly connected with or necessary to the management of the [Natura 2000] site but likely to have a significant effect thereon, either individually or in combination with other plans and projects, shall be subjected to appropriate assessment of its implications for the site in view of the site's conservation objectives. In light of the conclusions of the assessment of the implication for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public".

Article 6(4) goes on to discuss alternative solutions, the test of 'imperative reasons of overriding public interest' (IROPI) and compensatory measures:

"If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of a social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted".

Should a decision be reached to the effect that it cannot be said with sufficient certainty that the development will not have any significant effect on the Natura site, then, as stated above, it is necessary and appropriate to carry out an Appropriate Assessment of the implications of the development for the sites in view of their conservation objectives.

The EEC (2001) guidance for Appropriate Assessment states (Section 3.2 pg. 25):

"It is the competent authority's responsibility to carry out the Appropriate Assessment. However, the assessment process will include the gathering and consideration of information from many stakeholders, including the project or plan proponents, national, regional and local nature conservation authorities and relevant NGOs. As with the EIA process, the Appropriate Assessment will usually involve the submission of information by the project or plan proponent for consideration by the competent authority. The authority may use that information as the basis of consultation with internal and external experts and other stakeholders. The competent authority may also need to commission its own reports to ensure that the final assessment is as comprehensive and objective as possible.

In this stage, the impact of the project or plan (either alone or in combination with other projects or plans) on the integrity of the Natura 2000 site is considered with respect to the conservation objectives of the site and to its structure and function."

1.4.1 Special Areas of Conservation (SACs)

SACs are designated under Article 3 of the Habitats Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, as part of the Natura 2000 network. It is transposed into Scottish law through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). This network comprises

Annex I habitats - *"natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation"* and the habitats of Annex II species - *"animal and plant species of community interest whose conservation requires the designation of Special Areas of Conservation"*. Candidate SACs (cSACs) are sites that have been submitted to the European Commission, but not yet formally adopted. They are given the same level of protection as SACs.

1.4.2 Special Protection Areas (SPAs)

SPAs are designated under Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds (the Birds Directive), transposed into Scottish law through the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). Under the Directive, Scotland is obliged to protect the habitats of birds which are vulnerable to habitat change or due to their low population numbers i.e. rarity, especially species on Annex 1 of the Directive. Aspects of habitat protection are in the context of pollution, deterioration of habitat and disturbance. Proposed SPAs (pSPAs) are sites that have been submitted to the European Commission, but not yet formally adopted. They are given the same level of protection as SPAs. SPAs and pSPAs, together with SACs and cSACs, form what is known as the "*Natura 2000 Network*".

1.4.3 Conservation Objectives

The overriding objective of the Habitats Directive is to ensure that the habitats and species covered achieve 'Favourable Conservation Status' and that their long-term survival is secured across their entire natural range within the European Union (EU). In its broadest sense, favourable conservation status means that an ecological feature is being maintained in a satisfactory condition, and that this status is likely to continue into the future. Definitions as per the EU Habitats Directive are given below.

Favourable Conservation Status as defined by Articles 1 (e) and 1(i) of the Habitats Directive

The conservation status of a natural habitat is the sum of the influences acting on it and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species. The conservation status of a natural habitat will be taken as favourable when:

- its natural range and areas it covers within that range are stable or increasing; and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; and
- the conservation status of its typical species is favourable'.

The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' when:

- the population dynamics data on the species concerned indicate that it is maintaining itself on a long term basis as a viable component of its natural habitats; and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and
- there is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

Site-specific conservation objectives define the desired condition or range of conditions that a habitat or species should be in, in order for these selected features within the site to be judged as favourable. At site level, this state is termed 'favourable conservation condition.' Site conservation objectives also contribute to the achievement of the wider goal of biodiversity conservation at other geographic scales, and to the achievement of favourable conservation status at national level and across the Natura 2000 network.

2 METHODOLOGY

2.1 The Habitats Regulations Appraisal Process

The HRA is a four-stage process with specific issues and tests outlined at each stage. An important aspect of the process is that the outcome at each successive stage determines whether a further stage in the process is required. The stages are summarised in Table 2-1.

Table 2-1 Key Stages in the HRA Process

Stage 1	
Screening for Likely Significant Effect (LSE)	- Identify international sites in and around the project area. - Examine conservation objectives of the interest feature(s) (where available). - Review plan policies and proposals and consider potential effects on Natura 2000 sites (magnitude, duration, location, extent). - Examine other plans and programmes that could contribute to 'in combination' effects.
	- If no effects likely – report no likely significant effect. - If effects are judged likely or uncertainty exists – the precautionary principle applies, proceed to Stage 2. - If following screening the policies are reviewed and include sufficient mitigation which will ensure no likely significant effects, then no further Appropriate Assessment needed.
Stage 2	
Appropriate Assessment (AA)	- Complete additional scoping work including the collation of further information on sites as necessary to evaluate impact in light of conservation objectives. - Agree scope and method of AA with the competent authority. - Consider how the project 'in combination' with other projects will interact when implemented (the Appropriate Assessment). - Consider how effects on integrity of the site could be avoided by changes to the project and the consideration of alternatives. - Develop mitigation measures (including timescale and mechanisms). - Report outcomes of AA including mitigation measures.
	- If the project will not adversely affect European site integrity proceed with plan, but ensure that policies are monitored. - If effects or uncertainty remain following the consideration of alternatives and development of mitigation proceed to Stage 3.
Stage 3	
Alternative Solutions	- Consider alternative solutions, delete from project or modify. - Consider if priority species/habitats affected- identify 'imperative reasons of overriding public interest' (IROPI), economic, social, environmental, human health, public safety (only applicable in highly exceptional circumstances).
Stage 4	
Imperative Reasons of Overriding Public Interest (IROPI)	- Stage 4 is the main derogation process of Article 6(4) which examines whether there are imperative reasons of overriding public interest (IROPI) for allowing a plan or project that will have adverse effects on the integrity of a Natura 2000 site to proceed in cases where it has been established that no less damaging alternative solution exists. - The extra protection measures for Annex I priority habitats come into effect when making the IROPI case. Compensatory measures must be proposed and assessed. The Commission must be informed of the compensatory measures. Compensatory measures must be practical, implementable, likely to succeed, proportionate and enforceable, and they must be approved by the Minister.

2.2 Screening

With reference to the SNH Guidance (SNH, 2015) the screening stage determines whether Appropriate Assessment is required, by:

- Determining whether a project (or plan) is directly connected with or necessary to the conservation management of any European sites;
- Describing the details of the project (or plan) proposals and other projects that may cumulatively affect any European sites;
- Describing the characteristics of relevant European sites; and
- Appraising likely significant effects of the proposed project on relevant European sites.

The guidance (SNH, 2015) gives the following definition of LSE:

"The test of significance is where a plan or project could undermine the site's conservation objectives. The assessment of that risk (of 'significance') must be made in the light, amongst other things, of the characteristics and specific environmental conditions of the site concerned."

*"A likely effect is one that cannot be ruled out on the basis of objective information. The test is a 'likelihood' of effects rather than a 'certainty' of effects. Although some dictionary definitions define 'likely' as 'probable' or 'well might happen', in the Waddenzee case the European Court of Justice ruled that a project should be subject to Appropriate Assessment "**if it cannot be excluded, on the basis of objective information, that it will have a significant effect on the site, either individually or in combination with other plans and projects**". Therefore, 'likely', in this context, should not simply be interpreted as 'probable' or 'more likely than not', but rather whether a significant effect can objectively be ruled out."*

2.3 Appropriate Assessment

The Appropriate Assessment establishes whether or not a project's LSE identified during the screening stage will have an adverse effect on the integrity of the affected site with regard to its conservation objectives. Based on the guidance provided by SNH (2015) the effects of the proposal on the designated sites' qualifying features will determined by:

- Gathering information required to assess impacts (from site documents, scientific literature, EU and UK guidance on impact assessment and impact assessments from similar projects);
- Predicting the type and nature of impacts e.g. direct or indirect, short or long term;
- Assessing whether there will be adverse effects on the integrity of the site as defined by the conservation objectives and the status of the site. The precautionary principle must be applied at this stage. If it cannot be demonstrated with supporting evidence that there will be no adverse effects then adverse effects will be assumed; and
- Ascertaining if it is possible to mitigate adverse effects.

3 DESCRIPTION OF THE PROPOSED DEVELOPMENT

3.1 Site Location

The proposed development is within Granton Harbour, north Edinburgh and fronts on to the Firth of Forth. The larger Leith docks is situated approximately 1.3km to the east of Granton Harbour. Granton Harbour consists of an east and west harbour which are separated by a middle pier. Much of the western harbour has been lost to land reclamation in the past. The proposed development will be situated within the western harbour. The extent of the proposed development can be seen in Appendix A.

3.2 Development Description

3.2.1 Dredging

The existing harbour bed consists of a top layer of soft alluvial silts which accumulate through sedimentation at a rate of 0.75m per year (Fairhurst, 2017). Dredging is required in order for the proposed marina to operate efficiently. Dredging will be carried out by a backhoe dredger. Where possible material will be used elsewhere within the construction but any excess will be removed to an approved disposal at sea site. The locations of the potential disposal sites are shown in Figure 3-1.

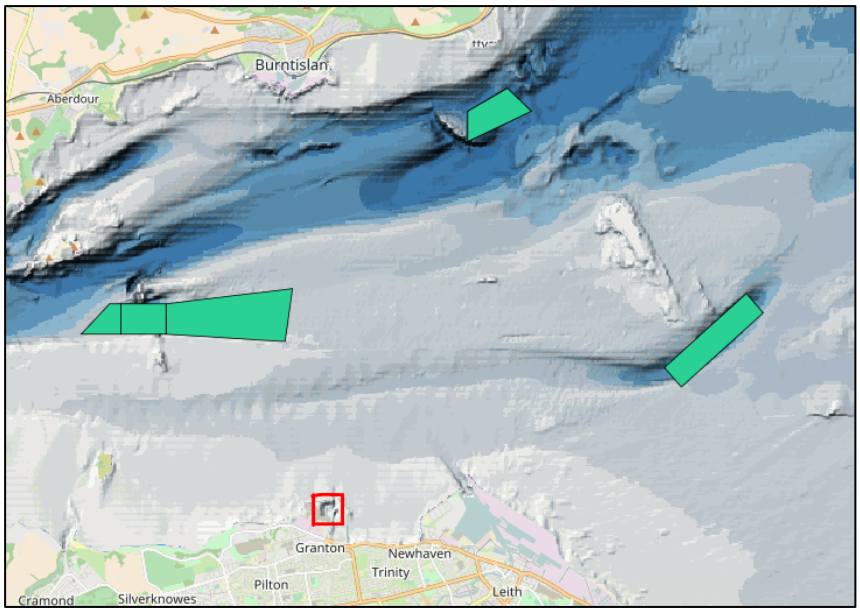

Figure 3-1 Location of possible dredging material disposal sites. Image taken from Marine Scotland Maps[1]

As this is Capital dredging (an area not dredged within the past 7 years) sediment analysis will be required prior to applying for a marine licence. The results of analysis will be included in a Best Practicable Environmental Option (BPEO) assessment to demonstrate that the material is suitable for disposal at sea. It is therefore not considered likely that impacts will arise due to the release of pollutants in disposed material. The transport of dredged materials between the site and the dredge disposal site has the potential to cause disturbance to marine mammals, fish and birds.

[1] http://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=712 (accessed 6/11/2017)

It is anticipated that dredging works will be undertaken during the early stages of construction. However, conditions and circumstances may dictate that some will occur in later in the construction programme and so options for phasing of these works will be clarified once a contractor has been appointed.

Sediment sampling was undertaken in November 2017 and discussions have been ongoing with Marine Scotland since this time regarding the various options available due to the presence of some contaminants of concern in exceedance of Revised Action Level 2. Sediments sampled within the proposed dredge area are reported as primarily silt.

With reference to the Granton Harbour Dredging 2018; BPEO Report (EnviroCentre Document Number 8192 (June 2018)), dredging will be undertaken within the western harbour to facilitate the development of the proposed marina.

Based on the dredging plan for the harbour volume split is as follows based on chemical quality (Table 3-1).

Table 3-1 Dredge Volumes

Dredge	Volume (m^3)	Comment
Total Dredge Nett Volume	241,365	Total proposed dredge volume
Dredge Volume for Areas for surface to 1.2m Dredge	86,980	Proposed for Sea Disposal
Dredge Volume from below 1.2mto base of dredge plus Area around VC8 & VC9 with Shallow Contamination	154,385	Land Based Disposal Options
Total Infill (Nett) Volume	19,322	

Multiple contaminants of concern were recorded above Revised Action Level1 including

- Metals
- PAHs
- PCBs
- Petroleum Hydrocarbons

Mercury was recorded in exceedance of Revised Action Level 2 in multiple locations.

Further review of the information and discussion with a view to segregating the material with exceedances above REV AL2 was undertaken and communicated with Marine Scotland. The key points being that if all material with mercury concentrations >RAL2 are excluded for sea disposal i.e. the material is dredged to a fixed depth of 1.6m the average concentration is 1.06 mg/kg which is also <RAL 2.

On this basis, it was proposed that the upper 1.2m of material would be dredged, excluding a large buffer around VC 8 and VC9 where shallow mercury contamination was also encountered with a view to disposing this material at sea on the basis that sufficient supporting evidence could be provided to justify this in the presence of REV AL1 exceedances. All remaining material would be taken to land for a land based disposal solution.

3.2.1.1 Backhoe Dredger

At the moment of writing it is advised, by Fairhurst Consulting Engineers, that Backhoe dredging will be utilised to effectively remove 'stiffer' consolidated material, as well as boulders and weathered/weaker rock outcrop and looser material will be dredged directly from the seafloor by the BHD. The dredged material would be deposited on a separate barge which would transport the dredged material to the reclamation and disposal area.

The dredging barge is stabilised on spud legs, so it does not require anchors and can be easily and rapidly moved.

Where it is not possible to reuse dredged materials elsewhere in the works, material will be disposed of at an approved disposal at sea site.

3.2.2 Quay Wall Construction

3.2.2.1 Description

On the west side of the marina basin, a quay wall is to be formed. This will be a continuation of the existing quay wall along the south boundary. The proposed form of construction is a tied sheet pile wall with *in situ* reinforced concrete capping beam with metal parapet. The form of construction will be similar to the existing.

3.2.2.2 Construction Methodology

The wall is formed from driven sheet piles. The existing sheet pile wall was installed from a barge and it is likely that the same methodology would be used for the additional length of wall. A barge would be positioned at high water and stabilised on jack up legs. From this platform, the sheet pile wall can be installed tying into the existing wall. Individual sheet pile sections are lowered vertically into the sea bed, interlocked with the adjacent pile sections. Piles are usually driven to staged depths to maintain the continuity and allow adjustments. After being driven to full depth, the top of the piles are cut off to the design level. At this stage, the piles will be free standing but not capable of being backfilled. Ties will be installed between the piles and a secure anchorage point on shore. These will be buried reinforced concrete blocks that will resist the thrust from the wall when it is backfilled.

The wall will be backfilled with suitable material available from elsewhere on the site. The top of the wall is completed by a reinforced concrete capping beam that is cast in-situ to tie the top of the piles together. It will also support to the metal pedestrian parapet that will provide edge protection.

3.2.3 North Mole Extension

3.2.3.1 Form of Construction

The North Mole extension requires a vertical internal face for a length of 50m to maximise space available for the marina. An inclined seaward face of rock armour will provide protection from wave action. Several forms of construction are possible for this structural layout but it is anticipated that a reinforced concrete wall would be formed, resting on the seabed with a natural rock faced revetment to the seaward side. The Reinforced concrete wall would be assembled from hollow pre-cast concrete boxes that can be filled on site with concrete and or ballast rock. The concrete wall will extend for 50m, beyond which a 25m rock revetment will provide additional protection.

3.2.3.2 Construction methodology

For the purposes of this method statement, it is assumed that all works will be carried out using marine based plant. However, subject to an assessment of the existing Esparto Wharf and North Mole it may be possible to create an access to allow some of the work to be undertaken by land, reducing marine based activity.

The overall steps in the construction process are

i. Locally reduce the level of the seabed to design dredge level.
ii. Excavate further to the design formation level for the concrete wall.
iii. Place a regulating layer of stone to land the concrete units on.
iv. Place precast concrete foundation blocks.
v. Build up the precast concrete wall units, sealing the joints as they are placed to control subsequent wet concrete placement.
vi. Place any binding reinforcement and drop in pre-formed reinforcement cages.
vii. Fill concrete units with underwater mix concrete.
viii. Backfill around concrete wall externally to revetment founding level, internally to bed level.
ix. Construct revetment on outer face of concrete wall, and for an additional 25m along the line of the wall.

3.2.3.3 Local Dredging

The area of the Western Harbour will be dredged to a finished dredge level sufficient for the planned operation of the marina. The depth varies across the marina with shallower waters for smaller craft closed to the shore.

Dredging in advance of the north mole is likely to be by backhoe dredger. Sediment testing has been undertaken across the marina site with some material identified as suitable for disposal at sea site at an approved site and the remainder brought ashore for disposed or treatment and reuse.

3.2.3.4 Base Formation

The wall of the breakwater is expected to be founded approximately 4.5m below final dredge level subject to geotechnical investigation and design. A trench will be excavated from the dredge level to the base formation level with sloped sides of a gradient dependent on the geotechnical properties of the bed material. Figure 3-2 below represents this construction phase.

A 250mm thick layer of Type 1 material will be placed on the base of the excavation and then levelled to allow placement of the reinforced concrete foundation units. These solid units provide a solid and stable foundation from which the wall can be supported. Divers will be employed to direct the placement and levelling of the units.

Once placed, a local bathymetric survey will be undertaken to confirm the base is at the correct level to receive the precast units making up the wall.

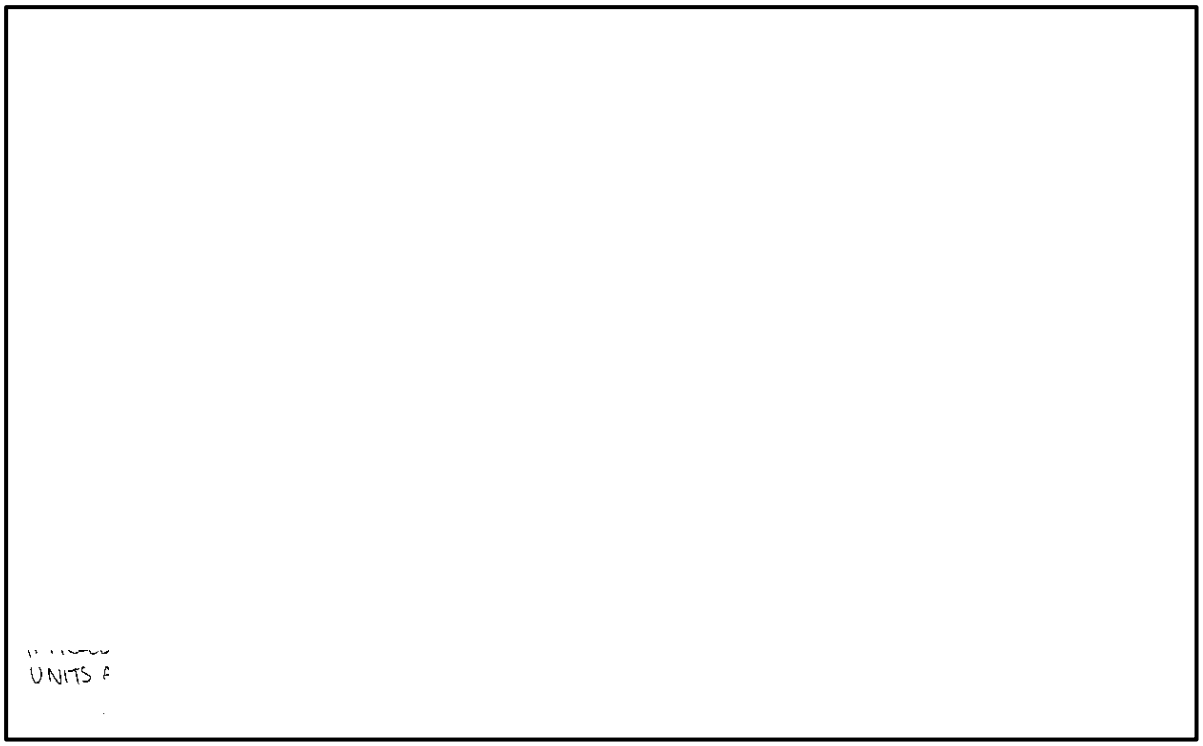

Figure 3-2 Potential construction within a trench to sound formation

3.2.3.5 Precast Unit Construction and Placement

In order to minimise the time of construction on site and the associated cost of marine based plant, the wall will be constructed from precast units, which can be fabricated off site. The units will be transported to site by road or sea, depending on the location of the fabrication site.

The wall consists a reinforced concrete foundation approximately 7.5m wide and totalling a length of 50m. This will be made up of individual precast units sized to suit placement by crane from a barge and will be keyed together. Hollow units to form the bulk of the wall will be lifted and placed by crane from a barge with divers

directing placement of the units, which lock together. This will form a sealed cofferdam into which concrete will be pumped in lifts.

3.2.3.6 Breakwater Construction

Following the construction of the breakwater wall, the rock infill forming the core of the revetment to the east of the wall will be placed using a long reach excavator from a barge. Some reinstatement of bed material may be possible if material properties permit prior to build up of the core of the breakwater.

Prior to placement of the secondary rock layer, consisting typically 300kg sized rock, divers will place a layer of geotextile to prevent material washout. The larger primary rock armour will then be placed on top to provide the full level of wave protection. The rock will be placed using a barge mounted long reach excavator. It is assumed that all rock will be delivered to site by sea and will be placed directly from the delivery barge to the revetment.

3.2.3.7 Wave Wall

In order to provide additional protection along the top of the structure, a precast reinforced concrete wave wall will be placed. The wave wall units will be lifted into place by barge mounted crane or telehandler and secure in place.

3.2.3.8 Finished Walkway

Behind the wave wall, a paved surface will be installed to form the walkway. Fixtures such as lighting can be installed, with service ducts having been cast into the final lift of precast concrete boxes.

3.2.4 Marina revetment

3.2.4.1 Description

The west boundary of the marina basin is formed with a natural stone faced revetment that will enclose and protect an area of reclaimed land. The core of the revetment is expected to be a combination of material recovered from elsewhere on the site and imported structural fill. The facing rocks will be imported to site by road. Along the top of the revetment, a concrete capping detail with integral channel for planting and parapet along the top provides the transition

3.2.4.2 Construction Methodology

The revetment can be constructed using land based plant and machinery working progressively along the line of the revetment until completed. The fill behind the revetment can be placed behind once the revetment is structurally sufficient to protect the infill.

The revetment needs to be founded on a sound strata and so the first operation will be excavation of the bed sediments down to a suitable formation level. The core can then be built up in layers before being sealed behind within a geotextile. This will protect the integrity of the core and prevent future washout of material. The rock armour facing will then be placed on the outer face of the revetment and if the bed was excavated below dredge level, some bed material can be reinstated up to this level. Infill behind the revetment will comprise material from elsewhere on the site that has been tested for suitability. The reclaimed area will be suitable for car parking and landscaping.

3.3 In-Combination Effects

There are likely to be in-combination effects arising from the other works planned as part of the wider Granton Harbour regeneration programme which includes; the formation of a new Marina office, retail and café space, community boatyard, hotel and serviced apartments. The wider Leith and Granton waterfront area has been zoned in the local development plan for housing led, mixed use development and the north and eastern docks

of Leith Harbour have been zoned for business and industrial use so there is a possibility of further developments in the nearby area (The City of Edinburgh Council, 2016).

The magnitude and/or duration of impacts resulting from construction activities may be increased as a result of in-combination effects due to areas being developed simultaneously or sequentially. The magnitude of disturbance once the development is completed may also be higher once in-combination effects are considered. Once the development as a whole is operational there will be increased number of people making use of the facilities. There is likely to be a higher volume of traffic in terms of vehicles accessing the site on land and a greater number of boats using the harbour.

There could also be in-combination effects from other coastal developments occurring within the Firth of Forth e.g. the Rosyth International Container Terminal.

4 POTENTIAL IMPACTS ON FEATURES OF INTEREST

4.1 Underwater noise descriptors: Measured or received levels

Noise descriptors that are commonly used in underwater acoustics to present measured or received levels include the following:

- Sound pressure level (SPL) – Average noise level over the measurement period expressed in dB re 1 µPa. For impulsive sources, such as impact piling and blasts, the measurement period is the time period that contains 90% of the sound energy (Southall et al. 2007). Continuous sources, such as vibropiling and shipping, are commonly described in terms of an SPL.
- Sound exposure level (SEL) – Total noise energy over the measurement period expressed in dB re 1 µPa2 ·s. The SEL is commonly used for impulsive sources because it allows a comparison of the energy contained in impulsive signals of different duration and peak levels.
- Peak level – Maximum noise level recorded during the measurement period expressed in dB re 1 µPa. The peak level is commonly used as a descriptor for impulsive sources.
- Peak-to-peak level – Difference between the maximum and minimum noise level recorded during the measurement period, expressed in dB re 1 µPa. The peak-to-peak level is used as a descriptor for impulsive sources.

SPLs and SELs can be presented either as overall levels or as frequency dependent levels showing the frequency content of a source.

Overall SPLs and SELs present the total average noise and energy level of a source within a given frequency bandwidth, which usually is the band that contains most of the signal's energy. Frequency dependent representations include spectral density levels, one-third octave band levels, or octave band levels. Spectral density levels give a greater frequency resolution, which is sometimes desirable for identifying narrowband sources such as rotating machinery, and are expressed in unit of dB re 1 μPa^2 /Hz. One-third octave and octave band levels are expressed in units of dB re 1 µPa.

4.2 Noise from anthropogenic sources

Marine construction noise is generated in the audible frequency range of fish and sea mammals. Acoustic impacts will occur due to the noise generated by vessel operations, dredging, placement of rock and piling.

It is anticipated that construction generated noise will be intermittent.

Vessel movements are predicted to be highest during the excavation of the marina basin, construction of the quay wall extension to the North Mole and placement of rock. During this period small vessels (e.g. a safety launch) will be active for approximately the same period.

Intensity will vary during this period but will peak during the dredging, piling and placement of rock when the noise generated by these activities will combine with that of construction vessel e.g. tenders and vessels.

The sound generated by such vessels will typically be the same as that given for other small vessels operating in the area e.g. in the range 151 to 170 (dB re 1µPa) at 0.037 to 50 KHz.

Excavation of sediment will be carried out with a backhoe dredger which will work for approximately three months on site. The extension to North Mole and rock placement will most likely be undertaken from the existing breakwater using terrestrial plant where possible.

The following discusses examples of underwater noise generated from marine plant during construction. Measurements of noise from a working trailer suction hopper dredger indicated that, whilst dredging, a sound level of 120 to 140 dB was recorded underwater (Clarke et al 2004)[2]. The operation of a clam dredger is estimated to peak at 124 dB re 1 µPa. Measurement of sound during construction work (drilling and excavation) in Fraserburgh Harbour, for example, recorded a mean sound level (SL) of 177.8 dB/µPa/m (Urquhart and Hall 2005)[3]. In the same study the peak SL recorded during rock blasting was estimated as 246.4 dB (relative to 1 µPa at 1 m) and the rms level for the whole 3.8 s period of the double blast as 238.1 dB. ***Blasting is not part of this project***, these data are therefore provided as a conservative worst case for noise disturbance as discussed below.

The broadband peak sound pressure level during pile-driving was 189 dB0-p re 1 µPa (SEL =166 dB re 1 µPa2. s) at 400 m distance, resulting in a peak broadband source level of 228 dB0-p re 1 µPa at 1 m (SEL = 206 dB re 1 µPa2. s at 1 m) (Thompson et al 2006)[4]. Piling methods are not yet known, but if piling is completed by vibropiling to 'refusal' (estimated at 60 minutes per pile) then a short period of impact piling directly (estimated at 1 minute per pile. Consequently the period of the highest noise generation will be for short period for each pile.

Noise can have a number of different effects on organisms as follows:

- Physical damage - e.g. permanent hearing threshold shift, temporary hearing threshold shift;
- Behavioural – e.g. gross interruption/modification of normal behaviour (i.e. behaviour acutely changed for a period of time) and behavioural modification, displacement from area (short or long term);
- Masking of communication with con-specifics and other biologically important noises;
- Interference with ability to acoustically interpret environment;
- Indirect – e.g. reduced availability of prey; and
- Increased vulnerability to predation or other hazards, such as collisions with fishing gear, strandings etc.

The severity of these effects depends on the character, frequency and power of the noise produced, local conditions which affect attenuation and the sensitivity of species.

4.3 Physical Damage due to Noise

Urquhart and Hall (2005) provide estimates of a 'danger zone' for bottle-nosed dolphins (*Tursiops truncatus*) of 1600m for blasting (as an example of extreme noise) and 280m for excavation and drilling within which temporary threshold shift (TTS)[5] may occur. In the case of the Edinburgh Marina it is unlikely that the construction will not generate noise of this magnitude. However these data give a conservative indication of the distances at which TSS may occur.

TTS in fish has been recorded at sound pressure levels of greater than 140 (dB re1µPa) for various species and permanent threshold shift at between 153 and 180 dB re 1 µPa in marine species including cod (*Gadus morhua)* and clupeids (the herring family) (Thompson et al 2006).

4.4 Behavioural Effects

The main behavioural effects of noise are startle behaviour and masking of vocalisations or echolocation. Based on the attenuation of in water pile driving noise with distance from the source the potential distances at which

[2] Clarke D, Dickerson C., Reine K. 2004 Characterisation of Sounds Produced by Dredgers US Army Corps of Engineers
[3] Urquhart D. and Hall C. 2005 A study of underwater noise generated during civil engineering works at Fraserburgh Harbour. Fisheries Research Services Collaborative Report No 07/05
[4] Thomsen F., Ludemann K., Kafemann R. And Piper W (2006). Effects of offshore wind farm nose on marine mammals and fish COWRIE Ltd
[5] Temporary alteration of hearing thresholds

fish may exhibit startle behaviours were estimated to range from 80m (source noise 144 dB re 1 µPa) to 800m (source noise =164 dB re 1 µPa) (Mitson and Knudson 2003)[6]. Noise effects due to pile driving have been investigated and Nedwell et al (2003b)[7] calculated theoretical zones where significant avoidance may occur as 1.4 km for salmon. In this case the piling noise will be attenuated significantly and these distances will be greatly reduced.

Construction noise may mask behaviourally important sounds in certain species e.g. salmon. Sound produced by fish is typically only detectable over short distances e.g. less than 100m. There is therefore potential for such sounds to be masked by the construction noise generated by vessel operations, excavations, rock placement and piling.

Hearing in fish is variable between species. Nedwell et al (2003) [8] estimates that significant avoidance reactions will occur generally in fish at 90 dBht (species) that is 90dB above the threshold of hearing for that particular species. Hearing thresholds for representative fish species are given below in Table 4-1.

Based on the attenuation of noise with distance from the source, the potential distances at which fish may exhibit startle behaviours have been estimated to range from 80m (source noise 144 dB re 1 µPa) to 800m (source noise =164 dB re 1 µPa) (Mitson and Knudson 2003) [9].

It is predicted that, particularly during peak construction period, sound levels from different construction activities e.g. piling, dredging, rock placement and vessel movement may combine be close to or occasionally in excess of the threshold at which avoidance behaviour is estimated to occur i.e. 90 dB re 1 µPa above the hearing threshold for a given species. Startle response is likely to be confined to immediate vicinity of the sound source.

There are no reported audiograms of lamprey. However, given that they lack specialist hearing structures, they are considered to be hearing generalists. There is potential however that lamprey may be able to hear infrasound. The hearing of lamprey is complicated by the fact that they do not have otolith organs and no known work has been undertaken on the response of lamprey to sound in relation to their statoliths or labyrinth organs. Work has been undertaken on cephalopods however, which also have statolith organs for the detection of linear accelerations including gravity (Packard et al., 1990)[10]. This investigation confirmed that cephalopods could detect the kinetic component of low frequency sounds and it is believed that the statoliths are the sensory organs involved (Packard et al., 1990). It was stated within this article that ' gross acceleration of the whole animal, as occurs in an underwater sound field, is an ideal stimulus for the statolith organ'. On this basis it is considered likely that lamprey will be sensitive to infrasound. Studies have however shown that sea lamprey respond to frequencies between 20 and 100 Hz (Lenhardt and Sismour, 1995)[11].

Table 4.1 Hearing Threshold for Representative Fish Species

Species	Hearing Threshold (dB re 1 µPa)
Sea Lamprey	75 at 100 Hz
Atlantic Salmon (*Salmo salar*)	95 at 160 Hz

[6] Mitson R.B. and Knudson H. P. 2003. Causes and effects of underwater noise on fish abundance estimation. Aquatic Living Resources Vol 16 p255-263

[7] Nedwell J. R. Langworthy J and Howell D (2003b) Assessment of sub sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife ; initial measurements of understated noise during construction of offshore Windfarms and comparison with background noise COWRIE report No 544 R 0424 68 pp

[8] Nedwell J., Turnpenny A., Langworthy J and Edwards B. 2003a. Measurements of underwater noise during piling at the Red Funnel Terminal Southampton and observations of its effect on caged fish. Subacoustech Ltd Report for Red Funnel

[9] Mitson R.B. and Knudson H. P.(2003). Causes and effects of underwater noise on fish abundance estimation. Aquatic Living Resources Vol 16 p255-263

[10] Packard, A., Karlsen, H. E., Sand, O., 1990. Low frequency hearing in cephalopods. Journal of Comparative Physiology A. Vol. 166, 501 - 505.

[11] Lenhardt, M.L. and Sismour, E., 1995. Hearing in the sea lamprey (Petromyzon marinus) and the long nose gar (*Lepisosteus spatula*). Assoc. Res. Otolaryngol. Abs: 259. The Association for Research in Otolaryngology.

Construction noise may mask behaviourally important sounds in certain species e.g. and salmon. Sound produced by fish is typically only detectable over short distances e.g. less than 100m. There is therefore potential for such sounds to be masked by the construction noise generated by piling, vessel operations and excavations.

It is anticipated therefore that there could be a local reduction in the abundance of fish and this would be greatest within 100 m. The study area is already subject to regular vessel movement so some degree of acclimatisation to vessel noise is anticipated.

Noise effects will be more significant for territorial species or species with a small range which closely associated with the mixed infralittoral sediment, relying on boulders and algae for shelter.

Cetacean echo location is at a higher frequency (120 – 150 kHz), than the majority of construction noise (e.g. vessel movement) (Thomsen et al 2006) except pile driving which is discussed below.

Pile driver noise could interfere with environmental sounds that cetaceans and seals listen to and underwater noise could startle or displace animals and prey as discussed above. Data analysed as part of an offshore wind development reported that – as a result of piling activities - harbour porpoises either avoided the construction area to a large extent or the animals used their echolocation signals much less due to noise from construction activities (Carstensen et al (2006)[12]. A review of noise effects of piling on harbour porpoise by (Thompson et al 2006) indicated that mild behavioural reactions can be expected to occur between 7 and 20 km distant from piling activity. At 9 kHz, pile driving noise is capable of masking strong vocalisations within 10–15km and weak vocalisations up to approximately 40 km (David 2006)[13]. The masking radius reduces as the frequency increases: 6 km at 50 kHz and 1.2km at 115 kHz. The impacts of masking are expected to be limited by the intermittent nature of pile driver noise which in this case will be greatly reduced due to the design and piling method, the dolphin's directional hearing, their ability to adjust vocalisation amplitude and frequency, and the structured content of their signals. Startle response due to sudden noise (e.g. from rock placement) cannot be discounted but is likely to be intermittent, occasional and of low importance.

Seals are not as sensitive to noise as cetaceans. Like cetaceans, seals use noise to communicate and to identify prey (by listening for prey generated noise) but they do not echolocate. Götz (2008)[14] identified that seals become habituated to continuous noise sources but are most affected by sudden noise which causes a startle response. Seal calls are however in the same frequency band as some construction generated noise and masking of seal calls is therefore possible.

Potentially seals may detect source level of 175 dB re 1µPa @ 1m at distances of 1.4 km to 2.9 km in low ambient noise conditions (Terhune et al. 2002)[15] although at these distances the sound it not likely to be sufficient to cause a startle response.

Based on the above behavioural effects on individual cetaceans and seals it is estimated to be confined to the duration of the construction operations and be intermittent. The most significant effects will be for animals that are within 500 m of the site. In addition the area where the most severe noise effects will occur is not recognised to be of particular importance for seals or cetaceans.

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[12] Carstensen J, Henriksen OD and Teilmann J (2006). *Impacts of offshore wind farm construction on* harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs) Marine Ecological Press Series, Vol. 321: 295–308

[13] David J.A (2006) Likely sensitivity of bottlenose dolphins to pile-driving noise. Water and Environment Journal 20 p48-54

[14] Götz, T., 2008 Aversiveness of sound in marine mammals : Psycho-physiological basis, behavioural Correlates and potential applications. Phd Thesis University of St Andrews

[15] Terhune, J.M., Hoover, C.L. & Jacobs, S.R. (2002) Potential detection and deterrence ranges by harbour seals of underwater acoustic harassment devices (AHD) in the Bay of Fundy, Canada. Journal of the World Aquaculture Society, 33, 176-183.

4.5 Effects on Prey Species

There may be a reduction in prey species available for cetaceans and seals in the immediate area of the development during construction due to avoidance of fish in the vicinity of the construction site.

4.6 Summary of Impacts

The construction program will be relatively short. The period of most intense noise is predicted to occur during the dredging of the marina basin and construction of the breakwater. This piling program will generally be confined to the period between 07.00 and 20.00, for a twelve week period.

The exact type of piling is as yet unknown, however it is expected that piling will be vibropiling with a comparatively short period of impact piling for every pile. The most significant underwater noise impact will therefore be intermittent and last for approximately three months.

However there is the potential for noise to affect cetaceans and migratory fish. For cetaceans such effects are predicted to only affect a small number of animals due to the low significance of the area. However the high value of these species justifies some mitigation as outlined below. Whilst there may be effects on seals, this area is not recognised as being of specific importance for seal species. In addition they are less sensitive to noise than cetaceans. The development area is considered to be of any particular importance for salmonids during the run however this period will be avoided.

Although there is the potential for UK BAP species such as salmon and sea lamprey to be affected, the study area is not recognised as being an important fish breeding or nursery area.

Once the construction is completed fish species will repopulate the area and so the impacts will be short term, intermittent and negligible. Noise during operation will be confined to intermittent vessel engine noise and maintenance dredging.

The effects of noise are therefore predicted to be Intermittent and most severe locally although of potentially some relevance over a moderate extent (e.g. 1 km from the marina) if however sensitive species such as salmon and cetaceans are present the effects could be of moderate magnitude. In recognition of the importance of these species mitigation will be implemented as outlined below.

4.7 Mitigation Impacts of Underwater Noise

The construction period during which underwater noise impacts will be generated is three months. During this period however construction activities will generally occur between 0700 and 1900 and so will be short term and intermittent. However as there is the potential for disturbance on cetaceans, basking sharks if present, the project will commit to following relevant provisions of the Guidelines For Minimising Acoustic Disturbance To Marine Mammals from Seismic Surveys (JNCC 2004)[16]. Principally this will include the following:

- Providing an observer who will monitor the surrounding sea area for indications of cetaceans and/ basking sharks.
- Noise generating activity will be suspended if sensitive species pass within 500 m of the site.
- Where practicable a soft start will be used when beginning potentially noisy underwater work.

[16] http://jncc.defra.gov.uk/pdf/Seismic_survey_guidelines_200404.pdf

The construction programme should take consideration of the most sensitive periods within the salmonid migration period of May to August in order to avoid disturbance. The programme will be agreed with the relevant regulator to minimise impacts.

5 SCREENING FOR APPROPRIATE ASSESSMENT

For LSEs to arise there must be a risk enabled by having a 'source' (e.g. construction works at a proposed development site), a 'receptor' (e.g. a European site or its qualifying interests), and a pathway between the source and the receptor (e.g. mobile species travelling between the proposed development site and a European site). The identification of a pathway does not automatically mean that LSEs will arise. The likelihood of LSEs will depend upon the characteristics of the source (e.g. duration of construction works), the characteristics of the pathway (e.g. what species and the number individuals travelling between the two sites) and the characteristics of the receptor (e.g. the sensitivities of the European site and its qualifying interests).

SNH (2015) guidance states that sites with mobile species should be considered within the screening process where there is a significant ecological link between the designated site and the proposed development site. It also states that for developments which could increase recreational pressures on designated sites, all sites within reasonable travel distance of the development should be considered for screening. It is also necessary to consider sites which are part of the same coastal ecosystem, where the proposed development may affect coastal processes.

5.1 Relevant European Designated Natura 2000 Sites

Screening opinions from SNH and MSLOT (Fraser, 2017 and Gooch, 2017) identified the following sites as having potential to be effected by the proposed works:

- Berwickshire and North Northumberland Coast SAC;
- Firth of Forth SPA;
- Firth of Tay and Eden Estuary SAC;
- Forth Islands SPA;
- Imperial Dock Lock, Leith SPA;
- Isle of May SAC;
- Outer Firth of Forth and St Andrews Bay Complex pSPA; and
- River Teith SAC.

These sites have therefore all been included within the screening for appropriate assessment. The location of the designated sites in relation to the development are shown in Appendix C. The assessment of likely significant effect for the designated sites qualifying features is presented in Table 5-1.

5.1.1 Berwickshire and North Northumberland Coast SAC

The Berwickshire and North Northumberland Coast SAC runs along the east coast, from St Abb's Head in the Scottish Borders down to Alnmouth in Northumberland. The site covers an area of approximately 65,000 ha and is approximately 67 km south east of the Granton Harbour development site. The site is designated for; grey seal (*Halichoerus grypus*), mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, reefs and submerged or partially submerged sea caves.

5.1.2 Firth of Forth SPA

The Firth of Forth is a complex of coastal and estuarine habitats which is situated on the east coast of central Scotland. It stretches from Crail, in the north east, along the fife coast and inland, through the Forth estuary, as far west as Cambus where the River Devon meets the River Forth. The site then runs along the south of the Firth

of Forth estuary to Dunbar in the east. In total the designated site covers 6318ha and encompasses a number of habitats including intertidal mud flats, rocky shores, saltmarsh, lagoons and sand dunes. The habitats create excellent feeding grounds for a number of European and internationally important bird species, for which the site is designated. The landward half of the east Granton harbour is within the SPA, as is the foreshore to the east and west of the harbour. The proposed development will be outside the designated site but within 100m at the closest point.

5.1.3 Firth of Tay and Eden Estuary SAC

The Firth of Tay and Eden Estuary comprises of two estuaries at the mouths of the River Tay and the River Eden. The designated site covers 15,441 ha and is situated on the east coast of Scotland. The designated area starts in Carnoustie in the north and follows the coast inland as far as Inchyra, where the River Earn joins the River Tay. The smaller Eden estuary is within the south of the site which stops just north of St Andrews. At its closest point, the designated site is around 70km from the proposed development. The Tay estuary is one of the least developed of the large east coast estuaries. The site is designated for a range of habitats and harbour seals (*Phoca vitulina*).

5.1.4 Forth Islands SPA

The Forth Islands SPA is formed of a number of Islands within the Firth of Forth area. The largest Island is the Isle of May which is situated in the outer Forth, approximately 8km from the mainland. Fidra, Lamb, Craigleith and Bass Rock are situated near North Berwick coast, to the east of the proposed development. The closest section of the SPA to the proposed development is within 1km. The islands of Inchmickery, Cow and Calves are situated within the inner Forth, to the west of the proposed development site. The islands are designated for a variety of breeding seabirds who nest on the island cliffs and feed in the wider Forth area, as well as further out in the North Sea.

5.1.5 Imperial Dock Lock, Leith SPA

The Imperial Dock Lock, Leith SPA is one of the smallest designated SPAs within Scotland at just 0.11ha. It comprises an artificial structure situated within the entrance to Imperial Dock, in the Port of Leith. The man made structure supports one of the largest breeding common tern colonies in Britain. The designated site is approximately 3km to the west of the proposed development.

5.1.6 Isle of May SAC

The Isle of May SAC encompasses the low lying north and south of the island and surrounding marine habitat up to 500m out. The island is primarily designated as it is home to one of the largest grey seal colonies in Scotland.

5.1.7 Outer Firth of Forth and St Andrews Bay Complex pSPA

Although the Outer Firth of Forth and St Andrews Bay Complex hasn't yet been fully designated, it is still required for consideration on the HRA process. The designated site covers a large area (272,068 ha) which stretches from St Andrews in the north to St Abb's in the south.

5.1.8 River Teith Special Area of Conservation (SAC)

The River Teith SAC is situated in central Scotland and encompasses the River Teith catchment from its origins in the Loch Lomond and The Trossachs National Park to its confluence with the River Forth, to the north west of Stirling. The river is primarily designated due to the presence of all three lamprey species. Atlantic salmon are also present within the watercourse. The designated site is situated approximately 65km to the north west of the proposed development as the fish swims; however, the migratory fish will enter the designated site via the Firth of Forth.

Table 5-1 Natura 2000 Sites, Qualifying Features and Screening Assessment for Likely Significant Effects

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
Berwickshire and North Northumberland Coast SAC	Grey seal (*Halichoerus grypus*)	Pathway for LSE identified Grey seals can travel considerable distances (>100km) whilst foraging and commuting between haul out sites. It is possible that seals and/or their prey will be present within the vicinity of the proposed works. Seals could be impacted directly in the short term during the construction phase of the development. Impacts could arise from underwater noise generated by construction activities (including piling) and if pollutants and/or sediments are released into the water environment during the construction or operation of the new development. The release of pollutants and/or sediments could also impact seals indirectly if their food source is affected. In the longer term seals may be impacted through increased marine traffic to the harbour. These impacts could result in disturbance, displacement, injury or death to individuals as well as reduce prey availability.	**Screened in**
	Habitats including: • Mudflats and sandflats not covered by seawater at low tide; • Large shallow inlets and bays; • Reefs; • Submerged or partially submerged sea caves	Pathway for LSE identified It is possible that sediment released during the dredging and disposal of material from Granton harbour or pollutants from construction activities could disperse in the water and reach the habitats within the Berwickshire and North Northumberland Coast SAC. Due to the distance between the designated site and the proposed development (c. 70km to the harbour and 60km to the nearest potential dredging disposal site) the volume of any sediment or pollutants reaching the habitat would be dilute and any effects on the habitat or the species within in it would be negligible.	**Screened out**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
Firth of Forth SPA	Bar-tailed Godwit (*Limosa lapponica*)	Pathway for LSE identified Bar-tailed Godwit could make use of the intertidal mud habitat within east Granton Harbour and the habitat to the east and west of the harbour for foraging. Although some are present for much of the year, accumulations are highest during the winter months. They could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and by noise and visual disturbance through increased movement (human, vehicular and vessels), and lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source within the intertidal mud habitat. Bar-tailed Godwit could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging birds and reduced availability of suitable foraging habitat.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Golden Plover (*Pluvialis apricaria*)	Pathway for LSE identified It is possible for Golden Plover to utilise the intertidal mud habitat within the east harbour and adjacent to the harbour on the east and west for roosting through the winter months (September – December). Golden Plover could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and by noise and visual disturbance through increased movement (human, vehicular and vessels), and lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source within the intertidal mud habitat. Bar-tailed Godwit could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging birds and reduced availability of suitable foraging habitat.	**Screened in**
	Knot (*Calidris canutus*)	Pathway for LSE identified Knot may use the intertidal mud habitat within east Granton Harbour and adjacent to the harbour on the east and west to forage. They could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and through increased noise and visual disturbance, or increased lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source (mainly mussels) within the intertidal mud habitat. Knot could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging birds and reduced availability of suitable foraging habitat.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Pink-footed Goose (*Anser brachyrhynchus*)	Pathway for LSE identified Pink-footed Geese may be present in the open water within the Firth of Forth during the winter months (September – April), particularly during October and March, when they use the Lothian coast as a stop-over on migration to and from their preferred overwintering sites in Norfolk. However, due to the wealth of agricultural foraging grounds south and east of Edinburgh, and historical roosting sites in the Pentland Hills, it is unlikely that the harbour or surrounding area will be used for roosting as roost sites are typically in quiet, secluded areas, and within 20km of foraging areas. If present in the Firth of Forth, they could be impacted directly in the short term if pollutants are released in to the water during the construction phase of the development or once the marina is operational. Pollutants could impact birds in the open water or potentially at roost sites if pollutants are carried there through dispersal, but it is considered unlikely for this species.	**Screened out**
	Redshank (*Tringa totanus*)	Pathway for LSE identified Redshank may use the intertidal mud habitat within east Granton Harbour for foraging. They may also use the surrounding intertidal mud habitats and rocky shores for foraging and roosting. Redshank could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and through increased noise and visual disturbance, or increased lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source within the intertidal mud habitat. Redshank could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging and roosting birds and reduced availability of suitable foraging and roosting habitat.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Red-throated Diver (*Gavia stellata*)	Pathway for LSE identified Red-throated Diver may utilise open water near the harbour. They could be impacted directly in the short term if pollutants are released in to the water during the construction phase of the development or once the marina is operational. They may also be impacted by pollutants indirectly, if prey species (mainly small fish) are affected. They may also be impacted through an increase in noise and visual disturbance during both the construction and operational phases with the increase in human, vehicular and vessel movements. These impacts could result in injury or death of individuals as well as reduced prey availability.	**Screened in**
	Sandwich Tern (*Thalasseus sandvicensis*)	Pathway for LSE identified Sandwich Tern will utilise the open water surrounding the harbour to forage in during the summer months (April – September). Sandwich Terns could be impacted directly in the short term if pollutants are released in to the water during the construction phase of the development or once the marina is operational. They may also be impacted by pollutants indirectly, if prey species (mainly small fish) are affected. As terns often rest (and roost) on the harbour walls, they may also be impacted through an increase in noise and visual disturbance during both the construction and operational phases with the increase in human, vehicular and vessel movements. These impacts could result in injury or death of individuals as well as reduced prey availability.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Shelduck (*Tadorna tadorna*)	Pathway for LSE identified Shelduck could utilise the intertidal mud area within the west harbour and to the east and west of the harbour for foraging. They may also be present within the open water surrounding the harbour. Shelduck could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and through increased noise and visual disturbance, or increased lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source (small molluscs including *Hydrobia* water snails) within the intertidal mud habitat. They could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging birds and reduced availability of suitable foraging habitat.	**Screened in**
	Slavonian Grebe (*Podiceps auritus*)	Pathway for LSE identified There is potential for Slavonian Grebe to make use of the open water surrounding Granton Harbour. Slavonian Grebe could be impacted directly in the short term if pollutants are released in to the water during the construction phase of the development or once the marina is operational. They may also be impacted by pollutants indirectly, if prey species (mainly small fish and crustaceans) are affected. These impacts could result in injury or death of individuals as well as reduced prey availability.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Turnstone (*Arenaria interpres*)	Pathway for LSE identified Turnstone may use the intertidal mud habitat within east Granton Harbour for foraging. They may also use the surrounding intertidal mud habitats and rocky shores for foraging and roosting. They could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and through increased noise and visual disturbance, or increased lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source (a variety of invertebrates) within the intertidal mud habitat. Turnstone could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging and roosting birds and reduced availability of suitable foraging and roosting habitat.	**Screened in**

	Waterfowl assemblage Qualifying species additionally include: Common Scoter (*Melanitta nigra*), Cormorant (*Phalacrocorax carbo*), Curlew (*Numenius arquata*), Dunlin (*Calidris alpina*), Eider (*Somateria mollissima*), Goldeneye (*Bucephala clangula*), Great Crested Grebe (*Podiceps cristatus*), Grey Plover (*Pluvialis squatarola*), Lapwing (*Vanellus vanellus*), Long-tailed Duck (*Clangula hyemalis*), Mallard (*Anas platyrhynchos*), Oystercatcher (*Haematopus ostralegus*), Red-breasted Merganser (*Mergus serrator*), Ringed Plover (*Charadrius hiaticula*), Scaup (*Aythya marila*), Velvet Scoter (*Melanitta fusca),*	Pathway for LSE identified There is potential for the birds included in the waterfowl assemblage to utilise the intertidal mud habitat within east Granton harbour and to the east and west of Granton Harbour for foraging and roosting. There is also potential for them to use the open water habitat surrounding the harbour for foraging. The waterfowl assemblage could be impacted directly in the short term if pollutants are released in to the water during the construction or operational phase of the development and through increased noise and visual disturbance, or increased lighting during construction. They could be impacted indirectly during construction if sediments released during dredging and/or pollutants affect their food source (a variety of invertebrates) within the intertidal mud habitat. They could also be impacted in the longer term through increase marine and human traffic, noise and lighting once the development is in operation. These impacts could result in disturbance, injury or death to foraging and roosting birds and reduced availability of suitable foraging and roosting habitat.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Wigeon (*Anas penelope*).		
Firth of Tay and Eden Estuary SAC	Habitats including: • Estuaries • Intertidal mudflats and sandbanks • Subtidal sandbanks	Pathway for LSE identified It is possible that pollutants released during the construction and operation phase of the proposed development and/or sediments from dredging and disposal of dredged material could reach the habitats within the designated site through dispersion. Due to the distance between the proposed development site and the closest dredging disposal site and the Firth of Tay SAC (c. 70km and 65km respectively) any materials reaching the designated site would be dilute and the effects on the habitats would be negligible.	**Screened out**
	Harbour seal (*Phoca vitulina*)	Pathway for LSE identified Harbour seals are mobile species which will travel in order to find prey and move between haul out sites. Harbour seals from the Firth of Tay and Eden Estuary could be present within the water near Granton Harbour and the proposed dredging disposal sites. Harbour seals could be impacted directly in the short term due to increased marine traffic and noise associated with the proposed development (including piling) and by any release of pollutants in the water. They could also be impacted in the longer term through increased marine traffic using the harbour once it is operational. They could be impacted indirectly if sediments released during dredging and/or pollutants affect their food source (mainly small fish). These impacts could result in disturbance, injury or death to individuals. However, according to SNH (2016) harbour seals generally have a limited daily foraging range of 20km. Given that there are c.70km between the designated site and Granton Harbour and c.65km between the designated site and the proposed dredged material disposal site, the number of individuals potentially affected would be negligible. Any pollutants dispersing to the site would be dilute and have insignificant effects on the seals and their prey.	**Screened out**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
Forth Islands SPA	Arctic Tern (*Sterna paradisaea*), Common Tern (*Sterna hirundo*), Roseate Tern (*Sterna dougallii*), Sandwich Tern	Pathway for LSE identified Tern species may utilise the open water surrounding the harbour to forage in from April – September. Terns could be impacted directly in the short term through pollution associated with the construction or operational phases of the proposed development. They could also be impacted indirectly if pollution and/or changes to the sediment deposition affect their food source (small fish). As terns often rest (and roost) on the harbour walls, they may also be impacted through an increase in noise and visual disturbance during both the construction and operational phases with the increase in human, vehicular and vessel movements. These impacts could result in injury or death of individuals and reduced prey availability.	**Screened in**
	Gannet (*Morus bassanus*)	Pathway for LSE identified Gannets may utilise the open water surrounding the habitat to forage in. They could be impacted directly in the short term through pollution associated with the construction or operational phase of the project. They could also be impacted indirectly if pollution and/or changes to the sediment deposition affect their food source (fish and squid). These impacts could result in injury or death of individuals and reduced prey availability.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Lesser Black-backed Gull (*Larus fuscus graellsii*)	Pathway for LSE identified Lesser Black-backed Gull may roost and forage in the urban habitat within, and surrounding Granton Harbour. They may also use the intertidal mud habitat within, and adjacent to the harbour and sheltered open water surrounding the harbour to forage and roost in. It is possible that they could be impacted directly in the short term through disturbance from increased traffic, noise and lighting and/or pollution released during the construction or operational phase. They could also be impacted in the longer term through increased marine and human traffic and loss of roosting and foraging habitat once the proposed development is operational. They could be impacted indirectly if pollution and/or changes to the sediment deposition affect their food source (fish, invertebrates, carrion and human waste). These impacts could result in disturbance, injury or death of individuals and loss of foraging and roosting habitat.	**Screened in**
	Puffin (*Fratercula arctica*)	Pathway for LSE identified Puffin may utilise the open water surrounding the harbour to forage in. They could be impacted directly in the short term through pollution associated with the construction and operation phases of the project. They could also be impacted indirectly if pollution and/or changes to the sediment deposition affect their food source (mainly small fish). These impacts could result in injury or death of individuals and reduced availability of prey.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Shag (*Phalacrocorax aristotelis*)	Pathway for LSE identified Shags may forage in the open water adjacent to the harbour and can roost on man-made structures such as harbour walls. It is possible for them to be impacted in the short term through disturbance from increased traffic, noise and lighting associated with the construction phrase of the proposed development and pollution occurring once it is operational. They could also be impacted in the longer term through increased marine traffic once the new marina is operational. Shags could be impacted indirectly in the short term if pollution and/or changes to the sediment deposition affect their food source (small fish, mainly sand eels). These impacts could result in disturbance, injury or death to individuals and loss of a roosting resource.	**Screened in**
	Seabird assemblage Additional qualifying species include: Cormorant, Fulmar (*Fulmarus glacialis*), Guillemot (*Uria aalge*), Herring Gull (*Larus argentatus*), Kittiwake (*Rissa tridactyla*), Razorbill (*Alca torda*)	Pathway for LSE identified The birds within the assemblage could utilise the open water surrounding the harbour to forage in. Some of the species may also use the rocky shore, intertidal mud and urban habitat within and surrounding the harbour to forage and roost in. The bird assemblage could be impacted directly in the short term through disturbance from increased traffic, noise and lighting and/or pollution released during the construction or operational phase. They could also be impacted in the longer term through increased marine and human traffic and loss of roosting and foraging habitat once the proposed development is operational. They could be impacted indirectly if pollutions affect their food source (largely small fish, with the exception of Herring Gull which have a much more varied diet. These impacts could result in disturbance, injury or death of individuals and loss of foraging and roosting habitat.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
Imperial Dock Lock, Leith SPA	Common Tern	Pathway for LSE identified There is potential for Common Terns to utilise the open water surrounding the harbour to forage in from April - September. They could be impacted directly in the short term through pollution associated with the construction or operational phases of the proposed development. They could also be impacted indirectly if pollution and/or changes to the sediment deposition affect their food source (small fish). As terns often rest (and roost) on the harbour walls, they may also be impacted through an increase in noise and visual disturbance during both the construction and operational phases with the increase in human, vehicular and vessel movements. These impacts could result in injury or death of individuals and reduced prey availability.	**Screened in**
Isle of May SAC	Grey seal	Pathway for LSE identified Grey seals are mobile species which can travel up to 100km between haul-out sites and in order to find prey (SNH, 2016). Seals from the Isle of May SAC could be present within the water near Granton Harbour and the proposed dredging disposal sites (c. 46km and c. 40km from the designated site respectively). Grey seals could be impacted directly in the short term due to increased marine traffic and noise associated with the proposed development (including piling) and by any release of pollutants in the water during the construction or operational phase. They could also be impacted in the longer term through increased marine traffic using the harbour once it is operational. They could be impacted indirectly if pollutants affect their food source (mainly small fish). These impacts could result in disturbance, injury or death to individuals and reduced prey availability.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
	Reefs	Pathway for LSE identified It is possible that pollutants or sediment released during the construction and/or operational phase of the proposed development could reach the habitats within the designated site through dispersion. Due to the distance (c.46km) between the proposed development and the Isle of May SAC any materials reaching the designated site would be dilute and the effects on the reef habitat would be negligible.	**Screened out**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
Outer Firth of Forth and St Andrews Bay Complex pSPA	Seabird assemblage breeding Qualifying species include: Arctic Tern, Common Tern, Gannet, Guillemot, Herring Gull, Kittiwake, Manx Shearwater, Puffin, Shag. Seabird assemblage non-breeding Qualifying species include: Black-headed Gull, Common Gull, Common Scoter, Eider, Goldeneye, Guillemot, Herring Gull, Kittiwake, Little Gull (*Hydrocoloeus minutus*), Long-tailed Duck, Razorbill, Red-breasted Merganser, Red-throated Diver, Shag	Pathway for LSE identified The birds within the assemblage could utilise the open water surrounding the harbour to forage in. Some of the species may also use the rocky shore, intertidal mud and urban habitat within and surrounding the harbour to forage and roost in. The bird assemblage could be impacted directly in the short term through disturbance from increased traffic, noise and lighting and/or pollution released during the construction or operational phase. They could also be impacted in the longer term through increased marine traffic and loss of roosting and foraging habitat once the proposed development is operational. They could be impacted indirectly if pollution and/or alterations to sediment deposition affect their food sources. These impacts could result in disturbance, injury or death of individuals and loss of foraging and roosting habitat.	**Screened in**

Site	Qualifying Features	Likely Significant Effect (LSE)	Screening Assessment
River Teith SAC	Migratory fish including: • Atlantic salmon (*Salmo salar*) • River lamprey (*Lampetra fluviatilis*) • Sea lamprey (*Petromyzon marinus*)	Pathway for LSE identified All of the migratory fish qualifying features returning to the River Teith from the sea will have to pass through the Firth of Forth. The migratory fish could be impacted directly in the short term by noise generated during construction, sediment released during dredging and dredging disposal, as well as pollution during construction and/or operational phases of the proposed development. These impacts could result in disturbance, injury or death to individuals as well as obstruction of the migratory route.	**Screened in**
	Brook lamprey (*Lampetra planeri*)	Pathway for LSE identified Brook lamprey are non-migratory fish and complete their entire lifecycle within the riverine habitat. It is possible that sediment released during the dredging and disposal of material from Granton harbour or pollutants from construction activities could disperse in the water and reach the River Teith SAC. Due to the distance between the designated site and the proposed development (c. 58km to the harbour and 42km to the closest dredging disposal site) the volume of any sediment or pollutants reaching the habitat would be dilute and any effects on the species within in it would be negligible.	**Screened out**

5.2 Screening Conclusion

The outcome of screening for appropriate assessment is to reach one of the following determinations:

a) A Stage Two AA of the proposed development is required if it cannot be excluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site.
b) A Stage Two AA of the proposed development is not required if it can be excluded, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will have a significant effect on a European site.

Following an examination, analysis and evaluation of the relevant information including, in particular, the nature of the proposed development and the likelihood of significant effects on any European site, and applying the precautionary principle, it is the professional opinion of the authors that, on the basis of objective information, that the proposed development, individually or in combination with other plans or projects, will not have a significant effect on the following European sites due to distance from the harbour:

- Firth of Tay and Eden Estuary SAC

At present there is not sufficient information to rule out likely (or possible) significant impacts to one or more of the qualifying features of the following designated sites:

- Firth of Forth SPA
- Outer Firth of Forth and St Andrews Bay Complex pSPA
- Firth Islands SPA
- Imperial Dock Lock, Leith SPA
- Isle of May SAC
- Berwickshire and North Northumberland Coast SAC
- River Teith SAC

A Stage 2 Appropriate Assessment for the proposed project will therefore be required for this site to ascertain whether or not the proposed harbour development will adversely affect the integrity of the above site's qualifying features.

6 APPROPRIATE ASSESSMENT FOR FIRTH OF FORTH SPECIAL PROTECTION AREA (SPA)

6.1 Site Description

The Firth of Forth SPA was designated in 2001 and extends for over 100 km from Alloa to the coasts of Fife and East Lothian leading to a to a wide estuary mouth. The SPA boundary includes much, but not all, of the coastline (see Figure 6-1). The site has been designated as of major importance for its assemblage of waterbirds during migration and over winter.

The site has been designated for populations of wintering and migratory bird species. It qualifies as an SPA under Article 4.1 of the Birds Directive by regularly supporting wintering populations of European importance of four Annex 1 species (red-throated diver (*Gavia stellata)*, Slavonian grebe (*Podiceps auritus)*, golden plover (*Pluvialis apricaria)* and bar-tailed godwit (*Limosa lapponica*) and regularly supporting a post-breeding population of European importance of sandwich tern (*Thallaseus sandvicensis)*.)

It also qualifies under Article 4.2 by regularly supporting wintering populations of both European and international importance of five migratory species (pink-footed goose (*Anser brachyrhynchus*), shelduck (*Tadorna tadorna)*, knot (*Calidris canutus)*, redshank (*Tringa totanus)* and turnstone (*Arenaria interpres*), and for regularly supporting a wintering waterfowl assemblage of European importance.

Some of the qualifying features also contribute to the selection of the Firth of Forth as a Ramsar site (wintering waterfowl assemblage, wintering populations of goldeneye, knot, pin-footed goose, redshank, shelduck, Slavonian grebe, turnstone, bar-tailed godwit and passage Sandwich tern). For the purpose of this HRA, the winter period of assessment is considered to be between September and March.

6.2 Conservation Objectives

The conservation objectives for the Firth of Forth SPA are

- 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

6.3 Site Condition

Table 6-1 summarises the condition of the qualifying bird interest features. Fifteen species are considered to be in Favourable Maintained condition; six features are considered to be in Favourable Declining condition; and seven species are considered to be in Unfavourable Declining condition. There does not appear to be an obvious pattern to explain the observed changes in bird numbers, as species that inhabit similar habitats have shown different trends.

Figure 6-1 Location of Firth of Forth SPA

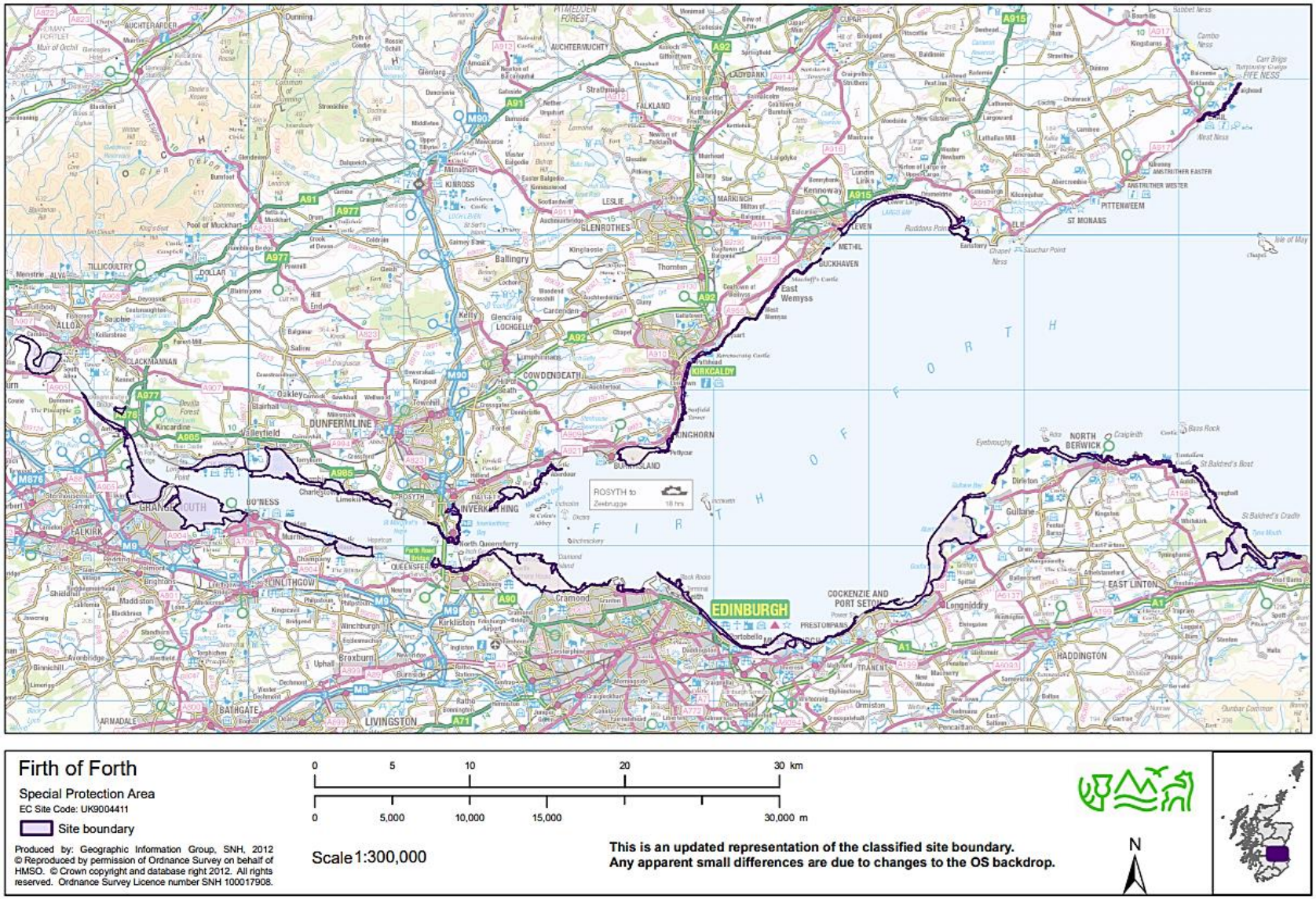


Table 6-1 Condition of qualifying interest features of the Firth of Forth SPA based on data published by SNH[17]

Qualifying Species:	Latest Assessed Condition	Summary Condition	Last Visit Date
Bar-tailed godwit (*Limosa lapponica*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Common scoter (*Melanitta nigra*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Cormorant (*Phalacrocorax carbo*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Curlew (*Numenius arquata*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Dunlin (*Calidris alpina alpina*), non-breeding	Favourable Declining	Favourable	01/03/2015
Eider (*Somateria mollissima*), non-breeding	Favourable Declining	Favourable	01/03/2015
Golden plover (*Pluvialis apricaria*), non-breeding	Favourable Maintained	Favourable	26/10/2010
Goldeneye (*Bucephala clangula*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Great crested grebe (*Podiceps cristatus*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Grey plover (*Pluvialis squatarola*), non-breeding	Favourable Declining	Favourable	01/03/2015
Knot (*Calidris canutus*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Lapwing (*Vanellus vanellus*), non-breeding	Favourable Declining	Favourable	01/03/2015
Long-tailed duck (*Clangula hyemalis*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Mallard (*Anas platyrhynchos*), non-breeding	Favourable Declining	Favourable	01/03/2015
Oystercatcher (*Haematopus ostralegus*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Pink-footed goose (*Anser brachyrhynchus*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Red-breasted merganser (*Mergus serrator*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Redshank (*Tringa totanus*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Red-throated diver (*Gavia stellata*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Ringed plover (*Charadrius hiaticula*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Sandwich tern (*Thallaseus sandvicensis*), passage	Favourable Maintained	Favourable	01/03/2015
Scaup (*Aythya marila*), non-breeding	Unfavourable Declining	Unfavourable	01/03/2015
Shelduck (*Tadorna tadorna*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Slavonian grebe (*Podiceps auritus*), non-breeding	Favourable Declining	Favourable	01/11/2010
Turnstone (*Arenaria interpres*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Velvet scoter (*Melanitta fusca*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Wigeon (*Anas penelope*), non-breeding	Favourable Maintained	Favourable	01/03/2015
Waterfowl assemblage, non-breeding	Favourable Maintained	Favourable	01/03/2015

Non-breeding waterbirds are monitored as part of the Wetland Birds Survey (WeBS). WeBS data within this report were supplied by WeBS, a partnership between the British Trust for Ornithology (BTO), the Royal Society for the Protection of Birds (RSPB) and the Joint Nature Conservation Committee (JNCC).

WeBS data are the principal information used by the statutory conservation agencies to determine the status of bird populations associated with wetland habitats and are used by them in determining whether designated sites are meeting their Conservation Objectives.

Alerts have been triggered for 17 out of the 26 species assessed for Firth of Forth SPA. For six of these species, comparison of site trends with broadscale trends suggests that the declines underpinning Alerts status may be driven by site-specific pressures (Table 6-2).

[17] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8499#features

Three species have not been evaluated: Pink-footed Goose; Red-throated Diver; Slavonian Grebe

Table 6-2 WeBS Alerts: Firth of Forth SPA[18]

Species	First Winter	Ref Winter	Short-term % Δ	Med-term % Δ	Long-term % Δ	% Δ since classification
Common Scoter	84/85	09-Oct	-32	-42	-21	-39
Cormorant	88/89	09-Oct	-40	-50	-47	-49
Curlew	84/85	09-Oct	-11	-8	175	-23
Dunlin	84/85	09-Oct	-31	-52	45	-56
Eider (except Shetland)	84/85	09-Oct	-17	-32	22	-31
Golden Plover	84/85	09-Oct	-81	-76	-19	-83
Goldeneye	84/85	09-Oct	15	-69	-58	-50
Great Crested Grebe	85/86	09-Oct	-64	-74	-88	-72
Grey Plover	84/85	09-Oct	-45	-69	483	-60
Knot	84/85	09-Oct	-31	-56	-43	-57
Lapwing	84/85	09-Oct	-43	-62	27	-56
Long-tailed Duck	84/85	09-Oct	-45	-75	-68	-67
Mallard	84/85	09-Oct	-18	-30	-37	-30
Oystercatcher	84/85	09-Oct	-7	-20	239	-22
Pink-footed Goose	–	–	–	–	–	–
Red-breasted Merganser	84/85	09-Oct	-44	-54	-57	-53
Redshank	84/85	09-Oct	-20	-11	86	-10
Red-throated Diver	–	–	–	–	–	–
Ringed Plover	84/85	09-Oct	19	-23	78	-9
Scaup	84/85	09-Oct	31	-71	-94	-42
Shelduck	84/85	09-Oct	40	20	56	30
Slavonian Grebe	–	–	–	–	–	–
Turnstone	84/85	09-Oct	0	-13	109	-7
Velvet Scoter	84/85	09-Oct	-45	-21	288	-47
Wigeon	84/85	09-Oct	-29	-24	49	-32

Source: Cook et.al (2013)

[18] https://app.bto.org/webs-reporting/?tab=alerts

6.4 Effects on Site Integrity as Defined by the Conservation Objectives

Conservation Objective 1. To ensure for the qualifying species that the following is maintained in the long term; population of the species as a viable component of the site.

No potential impacts to breeding sites within the SPA have been identified. The potential impacts identified in Table 5-1 relate to birds potentially foraging in East Granton Harbour and the surrounding waters. Redshank and Turnstone may also use the mud habitats and surrounding rocky shores for foraging and roosting.

It is possible for Golden Plover to utilise the intertidal mud habitat within the east harbour and adjacent to the harbour on the east and west for roosting through the winter months (Sept – Dec).

Shelduck could utilise the intertidal mud area within the west harbour and to the east and west of the harbour for foraging. They may also be present within the open water surrounding the harbour.

There is potential for the birds included in the waterfowl assemblage to utilise the intertidal mud habitat within east Granton harbour and to the east and west of Granton Harbour for foraging and roosting. There is also potential for them to use the open water habitat surrounding the harbour for foraging.

The majority of the potential impacts are of a temporary nature and would not affect population numbers in the long term. The only long-term potential impact identified is displacement from foraging habitat adjacent to the proposed development area (east harbour) and the surrounding waters due to potential noise disturbance.

It is possible that any qualifying species utilising this habitat would become habituated to the increased vessel movements associated with the marina at Edinburgh Marina in time. If this is not the case it is considered that there is sufficient alternative foraging habitat for breeding birds such that there would be no loss in individual condition, breeding success or long term population viability as a result of displacement.

Conservation Objective 2. To ensure for the qualifying species that the following is maintained in the long term; distribution of the species within the site.

Dredging and disposal operations and construction noise will be short term impacts and will not cause any effects to the distribution of species associated with the Firth of Forth SPA once construction the works are completed.

Conservation Objective 3. To ensure for the qualifying species that the following is maintained in the long term; distribution and extent of habitats supporting the species.

No changes to the distribution or extent of habitats supporting qualifying species within or outwith the SPA are predicted as a result of the proposed development.

Conservation Objective 4. To ensure for the qualifying species that the following is maintained in the long term; structure, function and supporting processes of habitats supporting the species.

No impacts to the structure, function and processes of habitats supporting qualifying species are predicted within the designated site.

During construction and operation of the proposed development there is the potential for chemical pollutants to be released into the water. This could have temporary impacts on the function and supporting processes of qualifying species within east harbour and adjacent to the harbour within the Forth of Forth, which could lead to reduced prey availability in the short term. It is predicted that the risk of such an event occurring is minimal if the mitigation and relevant Guidance for Pollution Prevention (GPP), detailed in section 13 of this report, are adhered to.

No significant long term alterations to the structure, function or supporting processes for qualifying species habitat outside of the designated site are predicted.

Conservation Objective 5. To ensure for the qualifying species that the following is maintained in the long term; no significant disturbance of the species.

Activities such as piling, more specifically impact piling, movement of rock armour and increased vessel movements may result in short term disturbance during the construction phase of the project. Due to the temporary nature these activities are not predicted to result in significant disturbance in the long term.

Longer term disturbance may occur due to increased vessel movements once the proposed development is in operation. The increased capacity for visiting boats, may increase the magnitude of impact qualifying species. However, there is already a variety of marine traffic associated with the existing harbour and the eastern harbour. It is also considered that there is ample alternative foraging habitat available around the coastline to support qualifying species. No significant long term disturbance is therefore anticipated as a result of increased vessel movements in the area.

7 APPROPRIATE ASSESSMENT FOR FORTH ISLANDS SPA

7.1 Site Description

Forth Islands SPA consists of a series of islands supporting the main seabird colonies in the Firth of Forth (Figure 7-1). The islands of Inchmickery (together with the nearby Cow and Calves), Isle of May, Fidra, The Lamb, Craigleith and Bass Rock were classified on 25 April 1990. The extension to the site, classified on the 13 February 2004 consists of the island of Long Craig (under the Forth Road Bridge just off North Queensferry harbour), which supports the largest colony of roseate tern in Scotland. It is the most northerly of only six regular British colonies. The seaward extension extends approximately 2km into the marine environment to include the seabed, water column and surface.

The inner islands are low lying whilst those in the outer Firth are steeper, higher and rockier. This applies particularly to the Bass Rock, a volcanic plug rising to over 100m, and to the Isle of May, which is surrounded by cliffs up to 50m. The islands support important numbers of a range of breeding seabirds, in particular terns, auks and gulls. The colony of Gannets (*Morus bassanus*) is the largest on the east coast of the UK. The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

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.

The Firth of Forth Islands are located in or near to the Firth of Forth on the east coast of central Scotland. The SPA comprises a number of separate islands or island groups, principally Inchmickery (together with the nearby Cow and Calves) off Edinburgh, Fidra, Lamb and Craigleith together with the Bass Rock off North Berwick, and the much larger Isle of May in the outer part of the Firth.

The site also includes additional other small islands. The inner islands are very low lying whilst those in the outer Firth are higher, steeper and rockier. This applies especially to the Bass Rock which is a volcanic plug rising to over 100 m, and to the Isle of May, which is surrounded by cliffs up to 50 m. The islands support important numbers of a range of breeding seabirds, in particular terns, auks and gulls. The Gannet colony is the largest on the east coast of the UK. The seabirds feed outside the SPA in nearby waters, as well as more distantly in the North Sea.

Qualifying species
This site qualifies under **Article 4.1** of the Directive (79/409/EEC) by supporting populations of European importance of the following species listed on Annex I of the Directive:

During the breeding season;

Arctic Tern *Sterna paradisaea*, 540 pairs representing at least 1.2% of the breeding population in Great Britain (Mean 1992 to 1996)

Common Tern *Sterna hirundo*, 800 pairs representing at least 6.5% of the breeding population in Great Britain (Seabird Census Register)

Roseate Tern *Sterna dougallii*, 9 pairs representing at least 15.0% of the breeding population in Great Britain (5 year mean 1994-1998)

Sandwich Tern *Thallaseus sandvicensis*, 22 pairs representing at least 0.2% of the breeding population in Great Britain (5 year mean, 1993-1997)

This site also qualifies under **Article 4.2** of the Directive (79/409/EEC) by supporting populations of European importance of the following migratory species:

During the breeding season;

Gannet *Morus bassanus*, 34,400 pairs representing at least 13.1% of the breeding North Atlantic population (Count, as at 1994)

Lesser Black-backed Gull *Larus fuscus*, 2,920 pairs representing at least 2.4% of the breeding Western Europe/Mediterranean/Western Africa population (Count, as at 1994)

Puffin *Fratercula arctica*, 21,000 pairs representing at least 2.3% of the breeding population (Count, as at 1992)

Shag *Phalacrocorax aristotelis*, 2,887 pairs representing at least 2.3% of the breeding Northern Europe population (Count as at 1987)

Assemblage qualification: A seabird assemblage of international importance

The area qualifies under **Article 4.2** of the Directive (79/409/EEC) by regularly supporting at least 20,000 seabirds

During the breeding season, the area regularly supports 90,000 individual seabirds (Three year mean, 1986-1988) including: Razorbill *Alca torda*, Guillemot *Uria aalge*, Kittiwake *Rissa tridactyla*, Herring Gull *Larus argentatus*, Cormorant *Phalacrocorax carbo*, Fulmar *Fulmarus glacialis*, Puffin *Fratercula arctica*, Lesser Black-backed Gull *Larus fuscus graellsii*, Shag *Phalacrocorax aristotelis*, Gannet *Morus bassanus*, Arctic Tern *Sterna paradisaea*, Common Tern *Sterna hirundo*, Roseate Tern *Sterna dougallii*, Sandwich Tern *Thallaseus sandvicensis*.

7.2 Conservation Objectives

The conservation objectives for the Forth Islands SPA are

- 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

7.3 Site Condition

Table 7-1 summarises the condition of the qualifying bird interest features. Seven species are considered to be in Favourable Maintained condition; two features are considered to be in Favourable Declining condition; four species are considered to be in Unfavourable Declining condition; and one species is considered to be Unfavourable Recovering condition.

Figure 7-1 Location of Forth Islands SPA

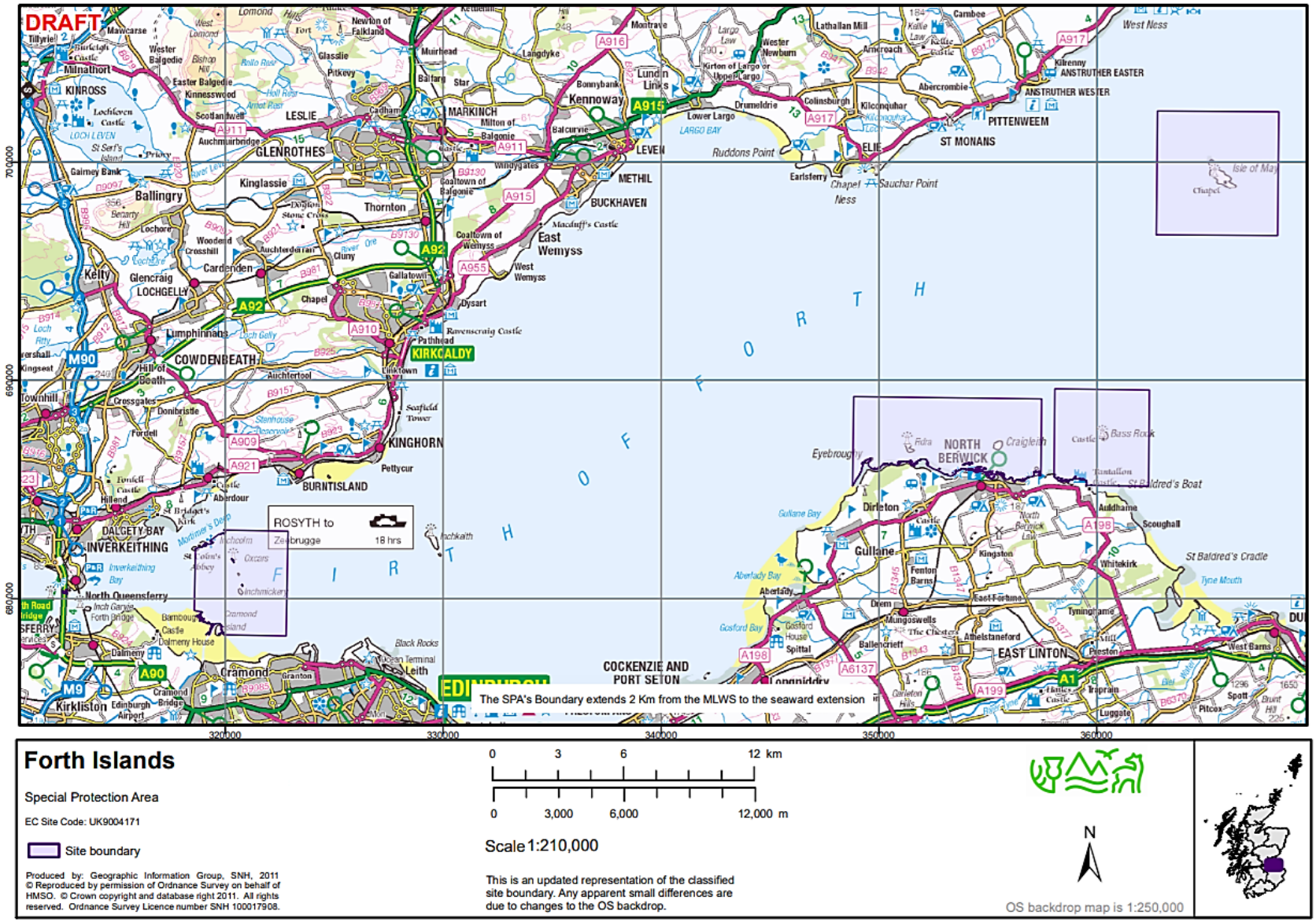


Table 7-1 Condition of qualifying interest features of the Forth Islands SPA based on data published by SNH[19]

Qualifying Species:	Latest Assessed Condition	Summary Condition	Last Visit Date
Arctic tern (*Sterna paradisaea*), breeding	Favourable Declining	Favourable	15/06/2009
Common tern (*Sterna hirundo*), breeding	Favourable Maintained	Favourable	30/06/2003
Cormorant (*Phalacrocorax carbo*), breeding	Favourable Declining	Favourable	16/03/2010
Gannet (*Morus bassanus*), breeding	Favourable Maintained	Favourable	17/07/2004
Guillemot (*Uria aalge*), breeding	Favourable Maintained	Favourable	30/06/2007
Herring gull (*Larus argentatus*), breeding	Favourable Maintained	Favourable	30/06/2001
Kittiwake (*Rissa tridactyla*), breeding	Unfavourable Declining	Unfavourable	30/06/2007
Lesser black-backed gull (*Larus fuscus graellsii*), breeding	Favourable Maintained	Favourable	15/06/2008
Puffin (*Fratercula arctica*), breeding	Favourable Maintained	Favourable	27/04/2003
Razorbill (*Alca torda*), breeding	Favourable Maintained	Favourable	30/06/2007
Roseate tern (*Sterna dougallii*), breeding	Unfavourable Declining	Unfavourable	01/07/2009
Sandwich tern (*Thallaseus sandvicensis*), breeding	Unfavourable Declining	Unfavourable	30/06/2003
Seabird assemblage, breeding	Unfavourable Declining	Recovering	17/07/2004
Shag (*Phalacrocorax aristotelis*), breeding	Unfavourable Recovering	Favourable	30/06/2001

[19] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8500

7.4 Effects on Site Integrity as Defined by the Conservation Objectives

Conservation Objective 1. To ensure for the qualifying species that the following is maintained in the long term; population of the species as a viable component of the site.

No potential impacts to qualifying species breeding sites within the SPA have been identified. The potential impacts identified in Table 5-1 are primarily related to breeding birds foraging in the Firth of Forth and mud habitats. Gannets, Puffin, Tern species (April – September) may utilise the open water surrounding the harbour to forage in from

Lesser Black-backed Gulls may roost and forage in the urban habitat within, and surrounding Granton Harbour. They may also use the intertidal mud habitat within, and adjacent to the harbour and sheltered open water surrounding the harbour to forage and roost in.

Shags may forage in the open water adjacent to the harbour and can roost on man-made structures such as harbour walls.

The birds within the assemblage could utilise the open water surrounding the harbour to forage in. Some of the species may also use the rocky shore, intertidal mud and urban habitat within and surrounding the harbour to forage and roost in.

The majority of the potential impacts are of a temporary nature and would not affect population numbers in the long term.

The only long-term potential impact identified is displacement from the foraging habitat within the proposed development area and the surrounding waters due to noise disturbance. It is possible that any qualifying species utilising this habitat would become habituated to the increased vessel movements in time. If this is not the case it is considered that there is sufficient alternative foraging habitat for breeding birds such that there would be no loss in individual condition, breeding success or long term population viability as a result of displacement.

Conservation Objective 2. To ensure for the qualifying species that the following is maintained in the long term; distribution of the species within the site.

The Forth Islands SPA is located within the Firth of Forth, and is currently subject to noise disturbance caused by human activities and vessel movements. It is predicted that the feature of interest will not be affected by noise disturbance associated with dredging and disposal or piling. There will be no likely significant effects.

Conservation Objective 3. To ensure for the qualifying species that the following is maintained in the long term; distribution and extent of habitats supporting the species.

No changes to the distribution or extent of habitats supporting qualifying species within or outwith the SPA are predicted as a result of the proposed development.

Conservation Objective 4. To ensure for the qualifying species that the following is maintained in the long term; structure, function and supporting processes of habitats supporting the species.

No impacts to the structure, function and processes of habitats supporting qualifying species are predicted within the designated site.

During construction and operation of the proposed development there is the potential for chemical pollutants to be released into the water. This could have temporary impacts on the function and supporting processes of qualifying species foraging habitat withing the SPA, which could lead to reduced prey availability in the short

term. It is predicted that the risk of such an event occurring is minimal if the mitigation and relevant Guidance for Pollution Prevention (GPP), detailed in section 13 of this report, are adhered to.

No significant long term alterations to the structure, function or supporting processes for qualifying species outside of the designated site are therefore predicted.

Conservation Objective 5. To ensure for the qualifying species that the following is maintained in the long term; no significant disturbance of the species.

Activities such as impact piling, movement of rock armour and increased vessel movements may result in short term disturbance during the construction phase of the project. Due to the temporary nature these activities are not predicted to result in significant disturbance in the long term.

7.5 Appropriate Assessment Conclusion

Due to the availability of alternative foraging habitats, mitigation measures outlined in section 13 and the likelihood that species utilising the habitat will be somewhat accustomed to vessel movements, no significant long term effects on the integrity of the Forth Islands SPA are predicted with regard to the conservation objectives for the qualifying species.

8 APPROPRIATE ASSESSMENT FOR IMPERIAL DOCK LOCK, LEITH SPA

8.1 Site Description

Imperial Dock Lock SPA is the smallest SPA in Scotland and is located in the heart of the Port of Leith, in Edinburgh (Figure 8-1). The site only covers around 1,000 square metres, yet it is home to one of the UK's biggest common tern colonies. The boundary of the SPA is coincidental with that of the Imperial Dock Lock.

8.2 Site Condition

Table 8-1 summarises the condition of the qualifying bird interest features. One species (common tern) is considered to be in Favourable Maintained condition.

8.3 Conservation Objectives

- 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

Figure 8-1 Location of Imperial Dock Lock, Leith SPA

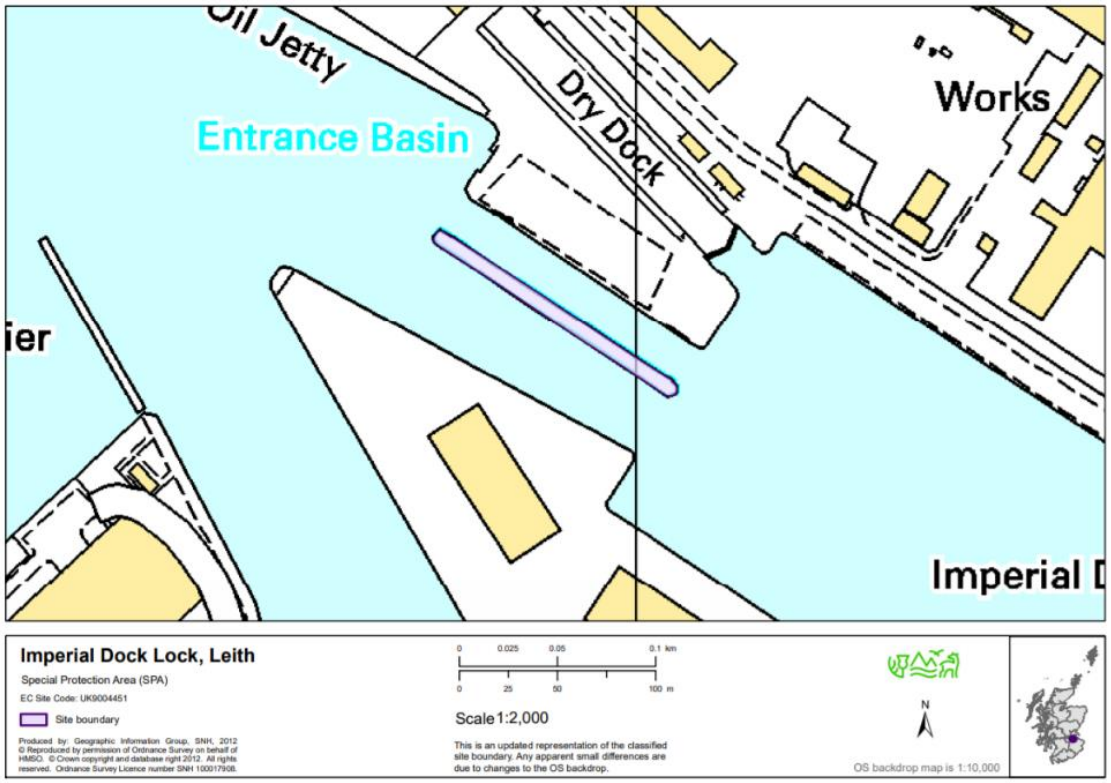


Table 8-1 Condition of qualifying interest features of The Imperial Dock Lock, Leith SPA based on data published by SNH[20]

Qualifying Species:	Latest Assessed Condition	Summary Condition	Last Visit Date
Common tern (*Sterna hirundo*), breeding	Favourable Maintained	Favourable	12/06/2009

8.4 Effects on Site Integrity as Defined by the Conservation Objectives

Conservation Objective 1: To ensure for the qualifying species that the following is maintained in the long term; population of the species as a viable component of the site.

There is potential for Common Terns to utilise the open water surrounding the harbour to forage in from April - September.

Possible localised temporary effects on food sources. However, no significant effect is predicted due to localised nature of impacts, mobility of birds and availability of potential food around the Port of Leith and wider Firth of Forth.

Conservation Objective 2: To ensure for the qualifying species that the following is maintained in the long term; distribution of the species within the site.

The qualifying species within Imperial Dock SPA are approximately 3km (straight line) from Edinburgh Marina. The SPA is located within the Port of Leith, subject to disturbance caused by human activities and vessel movements. It is predicted that the feature of interest will not be affected by noise disturbance associated with dredging, disposal and piling. There will be no likely significant effects

Conservation Objective 3: To ensure for the qualifying species that the following is maintained in the long term; distribution and extent of habitats supporting the species.

The proposed development at Edinburgh Marina will not result in any direct loss of habitat within the Port of Leith, therefore, no likely significant effects on Imperial Dock SPA sites are predicted.

Conservation Objective 4: To ensure for the qualifying species that the following is maintained in the long term; structure, function and supporting processes of habitats supporting the species.

Wave modelling provides data which demonstrate that any changes to coastal processes and sediment suspension caused by the dredging or construction of the structure would not be significant.

Conservation Objective 5: To ensure for the qualifying species that the following is maintained in the long term; no significant disturbance of the species.

No significant decrease in population against national trends.

8.5 Appropriate Assessment Conclusion

Due to the availability of alternative foraging habitats, pollution prevention mitigation outlined in section 13 and the likelihood that any individuals utilising the habitat will be somewhat accustomed to vessel movements, no

[20] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8668#features

significant long term effects on the integrity of the Imperial Dock SPA are predicted with regard to the conservation objectives for Common Tern.

9 APPROPRIATE ASSESSMENT FOR ISLE OF MAY SAC

9.1 Site Description

The Isle of May SAC at the entrance to the Firth of Forth comprising sea inlets, saltmarshes, shingle and seacliffs, lies approximately 47 km (in a direct line) to the east of the proposed Edinburgh Marina site at Granton. The site covers an area of 3.56 km^2 and is an island site comprising mainly of marine habitat.

The SAC supports reefs and a breeding colony of grey seals (*Halichoerus grypus*), with circa 3,000 pups born annually between September and December. In total, there are approximately 4,000 seals living on the island.

About 39% of the world population of grey seals is found in Britain, with over 90% of British grey seals breeding in Scotland, mostly in the Hebrides and Orkney (Special Committee on Seals (SCOS), 2005). Elsewhere, they occur in Shetland and along the north and east coasts of the UK and in the southwest. Major grey seal colonies on the east coast of Scotland and England include the Isle of May, Fast Castle and the Farne Islands, which between them hold 12% of the UK grey seal population. The population of grey seals (based on the number of pups produced) is increasing at all three sites (refer to Table 9-1) (Sparling *et al.,* 2012).

Table 9-1 Grey seal pup production estimates for breeding colonies on the northeast coast of England and southeast coast of Scotland for the last decade

Colony	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Isle of May	1,766	2,133	1,932	1,977	1,882	1,953	1,954	1,827	1,751	1,875	2,065
Fast Castle	268	381	321	532	717	659	764	804	1,005	1,265	1,715
Firth of Forth Islands	-	-	-	-	86	72	110	171	206	247	267
Farne Islands	843	1,171	1,247	1,200	1,266	1,133	1,138	1,254	1,164	1,318	1,346
Total	2,877	3,685	3,500	3,709	3,951	3,817	3,966	4,056	4,126	4,705	5,393

(Source: Sparling et al., 2012)

The site is the largest east coast breeding colony of grey seals in Scotland and the fourth-largest breeding colony in the UK, contributing approximately 4.5% of the annual UK pup production (Thompson and Duck, undated).

Grey seals forage in the open sea and return regularly to haul out on land where they rest, moult and breed. They may range widely to forage and frequently travel over 100km between haul-out sites. Foraging trips can last anywhere between 1 and 30 days. Compared with other times of the year, grey seals spend longer hauled out during their annual moult (between December and April) and during their breeding season (between August and December). The Isle of May is a major breeding colony on the Firth of Forth.

Tracking of individual seals has shown that they can feed up to several hundred kilometres offshore although most foraging probably occurs within 100 km of a haul-out site. Individual grey seals based at a specific haul-out site often make repeated trips to the same region offshore, but will occasionally move to a new haul-out site, often several hundred kilometres away and begin foraging in a new region.

The Isle of May colony is thought to be closely related to the Farne Islands and Fast Castle breeding colonies because of their proximity and the relationships between their growth patterns

Seals use haul-out sites for a range of purposes including breeding, resting and moulting (SCOS, 2009). There are five designated haul-out sites for Grey and Common/Harbour Seals (Protection of Seals Orders) - May 2017 (OSCP)[21]:

[21] https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=446

- Inchmickery and Cow & Calves (~4km NW in a direct line);
- Inchkeith (~7km NE in a direct line);
- Kinghorn Rocks (~11km NE in a direct line);
- Craigleith (~33km NE in a direct line); and
- Fast Castle (~56km E in a direct line).

9.2 Conservation Objectives

- 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 ¾ Distribution of the habitat within site
  - Structure and function of the habitat ¾ 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

9.3 Site Condition

Table 9-2 summarises the condition of the qualifying marine mammal interest features. One species (grey seal) is considered to be in Favourable Maintained condition.

Figure 9-1 Location of Outer Firth of Forth and St Andrews Bay Complex Proposed SPA

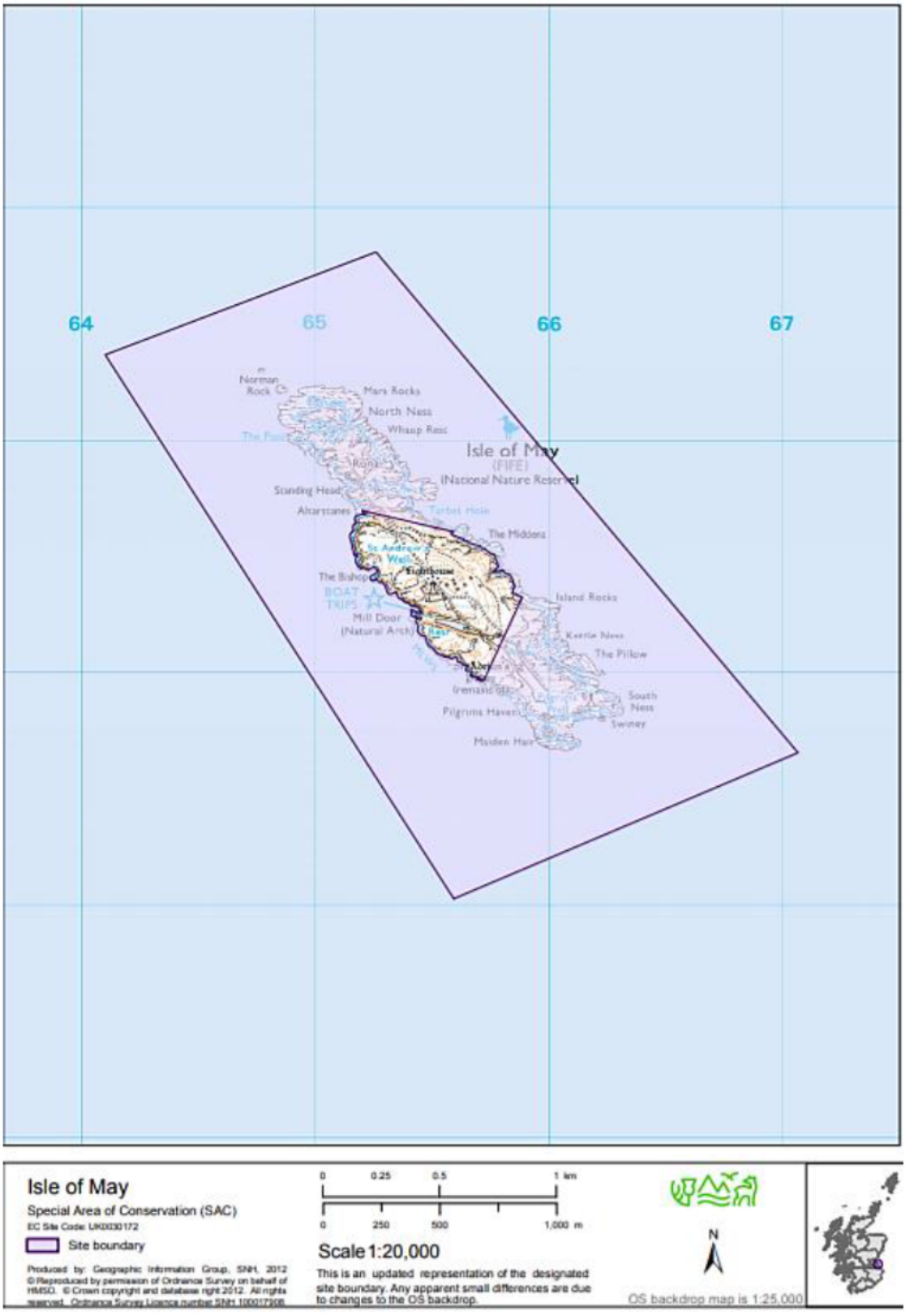


Table 9-2 Condition of qualifying interest features of Isle of May SAC on data published by SNH[22]

Feature	Latest Assessed Condition	Summary Condition	Last Visit Date
Grey seal (*Halichoerus grypus*)	Favourable Maintained	Favourable	24/11/2014

[22] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8278

9.4 Effects on Site Integrity as Defined by the Conservation Objectives (Grey Seal

Potential impact – Short term disturbance during dredging and disposal.

Conservation Objective 1. Population of the species as a viable component of the site

Dredging involves a variety of activities that produce underwater sounds. Most of these are relatively low in intensity and frequency, although recent investigations indicated that occasionally higher frequencies are emitted.

Compared to other activities that generate underwater sound, dredging is within the lower range of emitted sound pressure levels. While it is clear that dredging sound has the potential to affect the behaviour of aquatic life in some cases, injury in most scenarios should not be a concern, or should be preventable. It is very unlikely that dredging-induced sounds will lead to any population level consequences, although harm to individuals should not be overlooked.

With reference to the CEDA *Position Paper 7: Underwater Sound In Relation To Dredging*, it is considered likely that only the lowest potential impact will occur from the dredging and disposal works (including vessel movements). Grey seals will be able to detect the noise but it will likely be too weak to induce an observable reaction.

Noise impacts will not therefore, compromise the viability of harbour porpoise within the Isle of May SAC and the species will remain a viable component of the site.

Conservation Objective 2. Distribution of the species within site

The JNCC provides guidance on disturbance of European protected marine mammals estimates the grey seal population for the UK and adjacent waters to be circa 124,000[23]. For significant effects to take place the report suggests that 2% of the estimated population would need to be impacted. Therefore, 2,480 individuals per year would need to be disturbed in order for the effects to be considered significant on the population. Given the small to mediums scale dredging and disposal, and the distance from the Isle of May, it is unlikely that a significant number of individuals would be affected by dredging and disposal operations, and noise associated with vessel movements. For an activity to disturb a significant number of grey seals it would have to continue for a considerably long period of time. The supporting habitats and processes relevant to grey seal distribution and their prey will be maintained.

Conservation Objective 3. Distribution and extent of habitats supporting the species

With reference to CEDA Position Paper 7[24] (*Underwater Sound in Relation to Dredging*) the short term noise levels from dredging and disposal works will be similar to current background noise levels in the Firth of Forth and will not disturb prey such as sand eel, whiting, squid and octopus. The supporting habitats and processes relevant to grey seal and their prey will be maintained.

Conservation Objective 4. Structure, function and supporting processes of habitats supporting the species

Given that the Isle of May and the features of interest are located within the Firth of Forth where there is significant shipping movements and industrial operations within close proximity to the Forth (i.e. the INEOS Grangemouth facility, which is their largest manufacturing site by volume of products, and is home to Petroineos, Scotland's only crude oil refinery, and Babcock Rosyth, home to one of the largest waterside manufacturing and

[23] http://jncc.defra.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=s1364

[24] https://dredging.org/media/ceda/org/documents/resources/cedaonline/2011-11_ceda_positionpaper_underwatersound_v2.pdf (Accessed 06/08/2018)

repair facilities in the UK which included work on the Queen Elizabeth Class (QEC) aircraft carrier), it is unlikely that dredging and disposal operations at Edinburgh Marina will affect the structure, function and supporting processes of habitats supporting grey seals.

Conservation Objective 5. No significant disturbance of the species

Given the small to medium scale of the dredge (~219,726 m^3) and disposal to sea operation (~83,485m^3), the temporary nature of the works and the large number of individuals which are required to be affected for disturbance to be considered significant, no significant adverse effects are anticipated with regards to this conservation objective.

Potential impact – Short term disturbance during piling.

Conservation Objective 1. Population of the species as a viable component of the site

The effects of underwater noise associated with vibro and impact piling are anticipated to be temporary, negative (i.e. potentially cause avoidance behaviour in pinnipeds), of low to moderate magnitude, of high probability and of no significance. The confidence in the prediction is near certain. Population of grey seal as a viable component of the site will not be significantly affected given the location of the closest haul out site which is approximately 4 km north west(in a direct line) of Edinburgh Marina at Inchmickery and Cow & Calves.

The most significant effects will be for animals that are within 500 m of the site. In addition the area where the most severe noise effects will occur is not recognised to be of particular importance for seals. In addition, mitigation will be put in place to minimise the impacts associated with piling noise.

Conservation Objective 2. Distribution of the species within site

Noise associated with piling will be short term. It is unlikely that a significant number of individuals would be affected by Piling within the harbour. For an activity to disturb a significant number of grey seals it would have to continue for a considerably long period of time. The supporting habitats and processes relevant to grey seal distribution and their prey may therefore be effected in the short term, but grey seal distribution will be maintained.

Conservation Objective 3. Distribution and extent of habitats supporting the species

Short term noise levels associated with piling works are unlikely to disturb prey species at a distance greater than 500m from the piling activity. There may be a degree of behaviour modification i.e. species may move away from the harbour in the short term. The supporting habitats and processes relevant to grey seal and their prey will therefore be maintained.

Conservation Objective 4. Structure, function and supporting processes of habitats supporting the species

The Isle of May and the features of interest (grey seals) are located within the Firth of Forth where shipping movements are significant and there are significant industrial operations within close proximity to the harbour, it is unlikely that piling operations at Edinburgh Marina will negatively affect the structure, function and supporting processes of habitats supporting grey seals at a distance greater than 500m from the piling activity.

Conservation Objective 5. No significant disturbance of the species

There will be short terms impacts associated with piling operations which may cause grey seals to avoidance the area, however the scale of piling works is unlikely to be significant within the wider context of underwater noise within the Firth of Forth from many sources including the Port of Leith which provides full stevedoring and cargo handling services for a range of vessels and cargoes, including dry bulk, grain and animal feeds. The port is well equipped with a number of cranes and equipment. The Port of Leith Cruise Terminal also handles 40 vessels and

20,000 passengers per annum. The noise generated by piling within Granton harbour would be similar to that already experienced within the Firth of Forth.

The potential impacts on individual grey seals from piling noise within Edinburgh Marina will vary depending on individuals' sensitivities and habituation to noise. Studies suggest that the response to noise by seals may depend on whether the sound is sudden and causes a startle response or more gradual and allows habituation to occur and not cause a startle response. Where sound levels are increased more gradually there is a reduced level of displacement (Gotz & Janik, 2011). It is therefore unlikely that piling operations at Edinburgh Marina will cause negatively disturb grey seals at a distance greater than 500m from the piling activity.

In addition, mitigation will be put in place to minimise the impacts associated with piling noise.

9.5 Appropriate Assessment Conclusion

Due to the availability of alternative foraging habitats, pollution prevention mitigation outlined in section 13 and the likelihood that any individuals utilising the habitat will be somewhat accustomed to vessel movements, no significant long term effects on the integrity of the Isle of May SPA are predicted with regard to the conservation objectives for Grey Seal.

10 APPROPRIATE ASSESSMENT FOR BERWICKSHIRE AND NORTH NORTHUMBERLAND COAST SAC (GREY SEAL)

10.1 Site Description

The Berwickshire and North Northumberland Coast is one of the most varied stretches of coastline in the UK. It contains a complex of marine habitat types and associated species and communities which is unusually diverse for the North Sea, in both a UK and European context. The site contributes to the important range and variation of intertidal mudflats and sandflats in the UK as the best example of east coast clean sand and seagrass beds, and of moderately exposed reefs. Intertidal and submerged sea caves also contribute significantly to the site's overall habitat diversity and international importance. The Berwickshire and North Northumberland Coast also provides important habitats for the grey seal (*Halichoerus grypus)* in that it supports some 3% of the British annual pup production

During the screening process Reefs, Submerged or partially submerged sea caves, Mudflats and sandflats not covered by water at low tide were screened out and no further assessment has been undertaken.

The Berwickshire and North Northumberland Coast also qualifies as a SAC for Grey seals, an Annex II species as listed in the EU Habitats Directive.

The site overlaps with St Abb's Head to Fast Castle SPA in Scotland, and Lindisfarne and Farne Islands SPAs in England (Figure 10-1). This represents 115km of coastline and nearly 625 square kilometres of coastal waters.

St Abb's Head to Fast Castle lies on the coast of Berwickshire in south-east Scotland. It is a 10 km stretch of cliffs comprised of Old Red Sandstone and Silurian rocks, in places reaching over 150 m in height. The cliffs are backed by areas of grassland, open water, flushes and splash zone communities. The site is important for large numbers of breeding seabirds, especially auks and gulls, which feed outside the SPA in surrounding marine areas, as well as further away in the North Sea.

10.2 Conservation Objectives (Grey Seal)

The conservation objectives for the Berwickshire and North Northumberland Coast SAC are

- 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

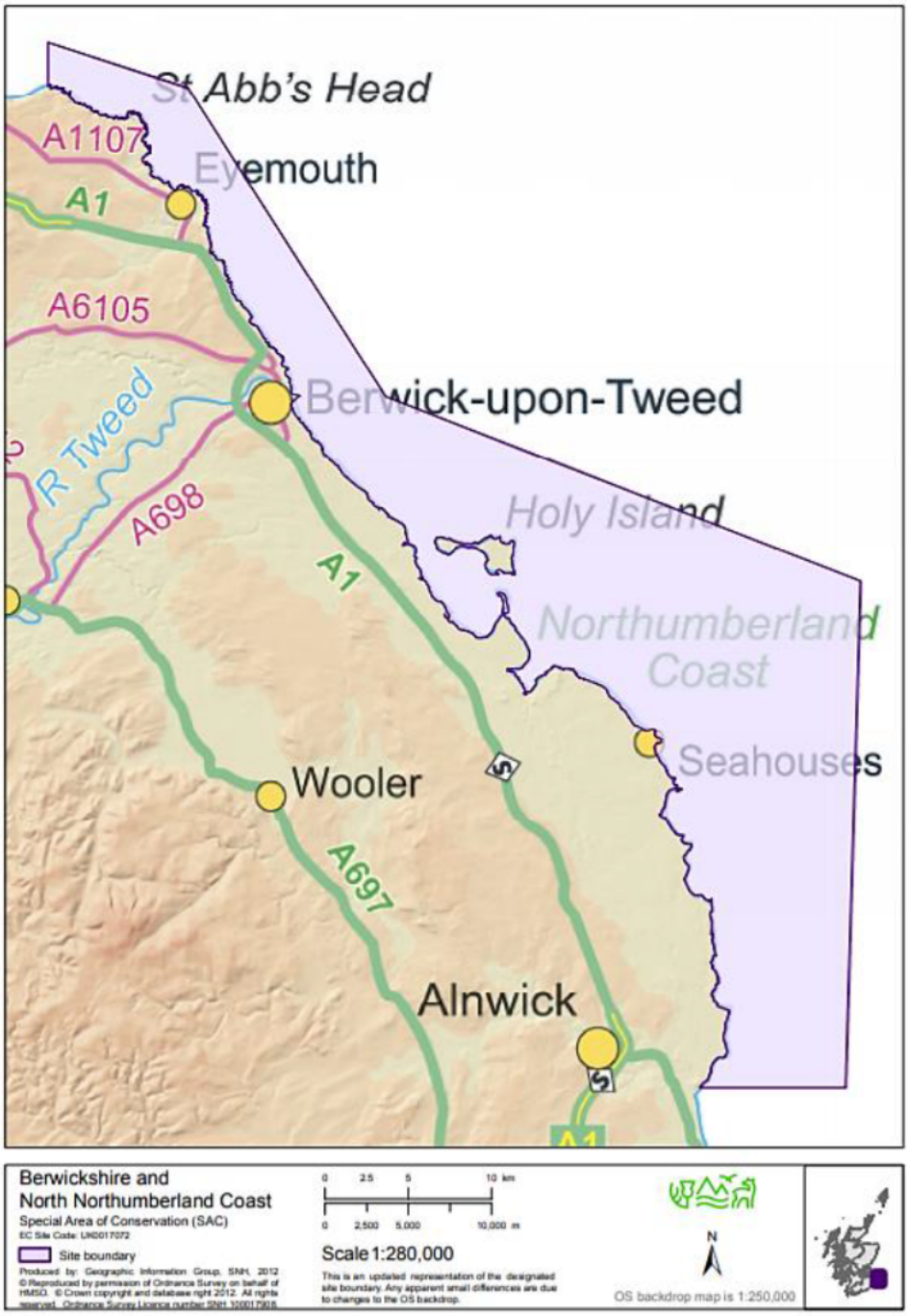
10.3 Site Condition

Table 10-1 summarises the condition of the qualifying marine mammal interest features. One species (grey seal) is considered to be in Favourable Maintained condition.

Table 10-1 Condition of qualifying interest features of the Berwickshire and North Northumberland Coast SAC based on data published by SNH[25]

Feature	Latest Assessed Condition	Summary Condition	Last Visit Date
Grey seal (*Halichoerus grypus*)	Favourable Maintained	Favourable	19/11/2014

Figure 10-1 Location of the Berwickshire and North Northumberland Coast SAC



[25] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8207#features

10.4 Impacts on Grey Seal

The potential impacts on grey seals from Berwickshire and North Northumberland Coast SAC are similar to those from the Isle of May SAC (refer to Section 9.1). They are not repeated here.

The site lies further from the proposed development area and it is predicted that there will be a lower risk of grey seals from the SAC being within the area of potential impacts than those from the Isle of May. Although they can occur in the area, it is not possible to quantify what proportion of the grey seal population may occur during any particular part of the year and therefore it is not possible to determine what proportion of the population may be impacted.

10.5 Appropriate Appraisal Conclusions

The conclusions are based on the Isle of May assessment and that the population is increasing and in a favourable condition.

It is concluded that there may be an impact on grey seals from the Berwickshire and North Northumberland Coast SAC from the proposed development of Edinburgh Marina at Graton Harbour on its own and in-combination with other plans or projects. Low numbers of grey seal are predicted to receive sound levels that will cause physical injury or mortality; seals using localised haul-out sites are unlikely to be displaced due to the distance from Edinburgh Marina, the closest being circa 4km.

Grey seals from the SAC occur widely and those that may be displaced will be able to relocate to other suitable foraging locations. The population of grey seals at the SAC are in a favourable condition and the predicted level of impact will not cause an adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC from noise related impacts on grey seals.

11 APPROPRIATE ASSESSMENT FOR OUTER FIRTH OF FORTH AND ST ANDREWS BAY COMPLEX PROPOSED SPA

11.1 Site Description

The Outer Firth of Forth and St Andrews Bay Complex pSPA comprises an area of 2,720.68 km^2 (Figure 11-1). The pSPA stretches from Arbroath to St. Abb's Head and encompasses the Firth of Forth, the outer Firth of Tay and St. Andrews Bay. The site extends beyond the 12nm boundary of territorial and offshore waters to encompass the feeding areas of some seabirds Assessment of Potential Impacts on Conservation Objectives

The Outer Firth of Forth and St Andrews Bay Complex pSPA, lying adjacent to the existing SPAs of the Firth of Forth and the Firth of Tay and Eden Estuary, supports populations of European importance of the following Annex 1 species:

- Red-throated diver (*Gavia stellata*)
- Little gull (*Larus minutus*)
- Common tern (*Sterna hirundo*)
- Arctic tern (*Sterna paradisaea*)
- Slavonian grebe (*Podiceps auritus*)

It also supports migratory populations of European importance of the following species:

- Common eider (*Somateria mollissima*)
- Long-tailed duck (*Clangula hyemalis*)
- Common scoter (*Melanitta nigra*)
- Velvet scoter (*Melanitta fusca*)
- Common goldeneye (*Bucephala c*langula)
- Red-breasted merganser (*Mergus serrator*)
- Northern gannet (*Morus bassanus*)
- Manx shearwater (*Puffinus puffinus*)
- European shag (*Phalacrocorax aristotelis*)
- Black-legged kittiwake (*Rissa tridactyla*)
- Common guillemot (*Uria aalge*)
- Razorbill (*Alca torda*)
- Atlantic puffin (*Fratercula arctica*)
- Black-headed gull (*Chroicocephalus ridibundus*)
- Common gull (*Larus canus*)
- Herring gull (*Larus argentatus*)

In winter, it provides important wintering grounds used for feeding, moulting and roosting by eight species of non-breeding inshore waterfowl. This wintering waterfowl assemblage includes the largest red-throated diver and common eider populations in Scotland. The Firth of Forth is also notable for its concentrations of four species of wintering gulls, including little gull. Black-headed gull, common gull and herring gull use the inshore waters predominantly to roost, although some foraging activity will also occur. In the non-breeding season these together with black-legged kittiwake, common guillemot, European shag and razorbill contribute to an assemblage of over 40,000 seabirds using the site.

The site also encompasses feeding grounds for breeding common tern, Arctic tern and European shag nesting at SPA colonies within the site. During the breeding season black-legged kittiwake, gannet, herring gull, common guillemot, puffin, and Manx shearwater also contribute to a major assemblage of over 100,000 seabirds[26].

[26] https://www.nature.scot/sites/default/files/2017-11/Marine%20Protected%20Area%20%28Proposed%29%20-%20Advice%20to%20support%20management%20-%20Outer%20Firth%20of%20Forth%20and%20St%20Andrews%20Bay%20Complex.pdf (Accessed 21/08/2018)

Figure 11-1 Location of Outer Firth of Forth and St Andrews Bay Complex Proposed SPA

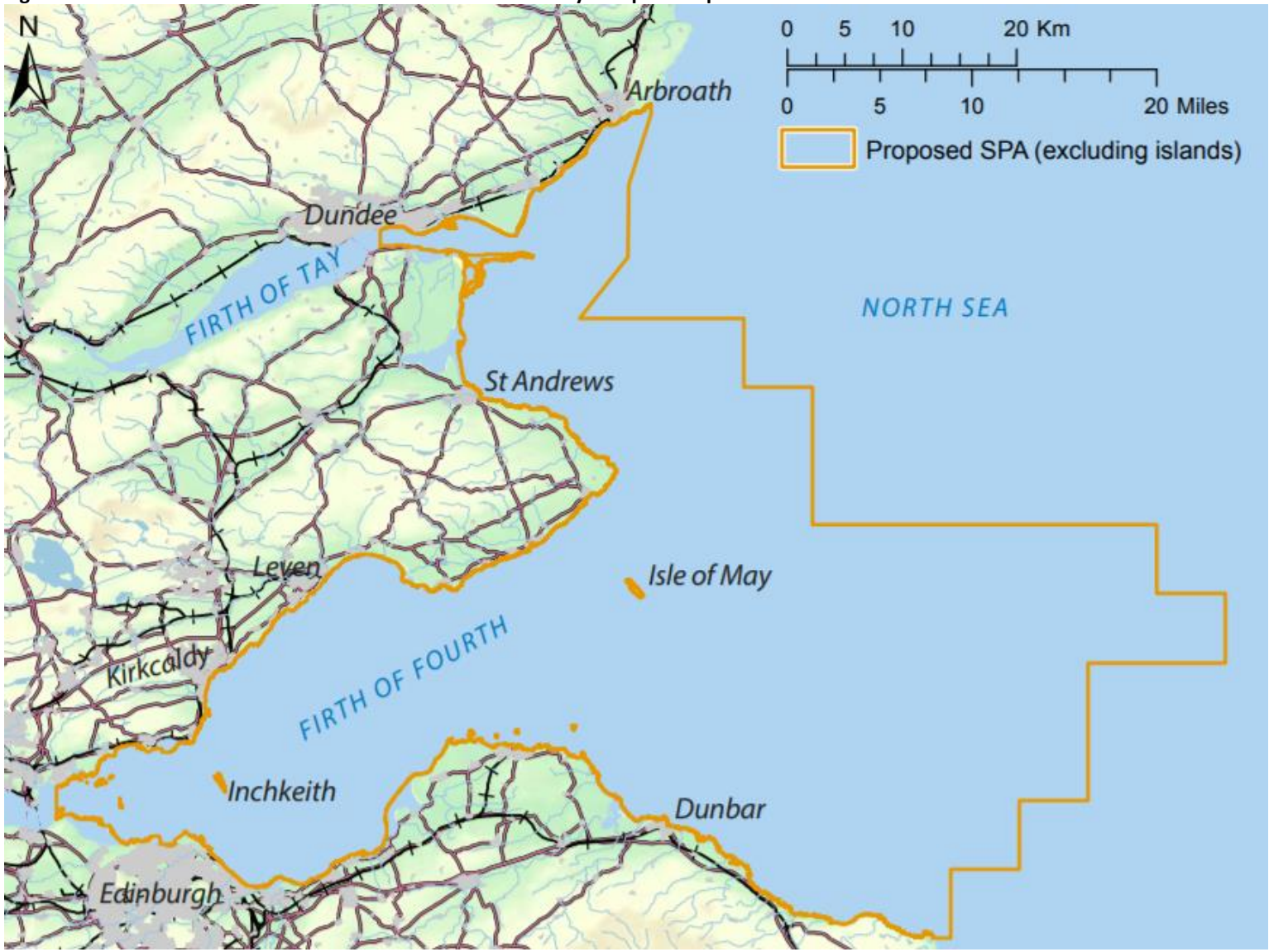


Table 11-1 Condition of qualifying interest features of Outer Firth of Forth and St Andrews Bay Complex Proposed SPA on data published by SNH[27]

Feature Category	Feature
Aggregations of breeding birds	Arctic tern (*Sterna paradisaea*), breeding
Aggregations of breeding birds	Common tern (*Sterna hirundo*), breeding
Aggregations of breeding birds	Gannet (*Morus bassanus*), breeding
Aggregations of breeding birds	Guillemot (*Uria aalge*), breeding
Aggregations of breeding birds	Herring gull (*Larus argentatus*), breeding
Aggregations of breeding birds	Kittiwake (*Rissa tridactyla*), breeding
Aggregations of breeding birds	Manx shearwater (*Puffinus puffinus*), breeding
Aggregations of breeding birds	Puffin (*Fratercula arctica*), breeding
Aggregations of breeding birds	Seabird assemblage, breeding
Aggregations of breeding birds	Shag (*Phalacrocorax aristotelis*), breeding
Aggregations of non-breeding birds	Black-headed gull (*Chroicocephalus ridibundus*), non-breeding
Aggregations of non-breeding birds	Common gull (*Larus canus*), non-breeding
Aggregations of non-breeding birds	Common scoter (*Melanitta nigra*), non-breeding
Aggregations of non-breeding birds	Eider (*Somateria mollissima*), non-breeding
Aggregations of non-breeding birds	Goldeneye (*Bucephala clangula*), non-breeding
Aggregations of non-breeding birds	Guillemot (*Uria aalge*), non-breeding
Aggregations of non-breeding birds	Herring gull (*Larus argentatus*), non-breeding
Aggregations of non-breeding birds	Kittiwake (*Rissa tridactyla*), non-breeding
Aggregations of non-breeding birds	Little gull (*Hydrocoloeus minutus*), non-breeding
Aggregations of non-breeding birds	Long-tailed duck (*Clangula hyemalis*), non-breeding
Aggregations of non-breeding birds	Razorbill (*Alca torda*), non-breeding
Aggregations of non-breeding birds	Red-breasted merganser (*Mergus serrator*), non-breeding
Aggregations of non-breeding birds	Red-throated diver (*Gavia stellata*), non-breeding
Aggregations of non-breeding birds	Seabird assemblage, non-breeding
Aggregations of non-breeding birds	Shag (*Phalacrocorax aristotelis*), non-breeding
Aggregations of non-breeding birds	Slavonian grebe (*Podiceps auritus*), non-breeding
Aggregations of non-breeding birds	Velvet scoter (*Melanitta fusca*), non-breeding
Aggregations of non-breeding birds	Waterfowl assemblage, non-breeding

11.2 Assessment of Potential Impacts on Conservation Objectives

Conservation Objective 1: To ensure for the qualifying species that the following is maintained in the long term; population of the species as a viable component of the site.

Possible localised temporary short term effects on food sources. However, no significant effect is anticipated due to the localised nature of impacts, mobility of birds and availability of potential food sources around the wider Firth of Forth.

Conservation Objective 2: To ensure for the qualifying species that the following is maintained in the long term; distribution of the species within the site.

The pSPA is located within the Firth of Forth, is currently subject to noise disturbance caused by human activities and vessel movements. It is predicted that the feature of interest will not be affected by noise disturbance associated with dredging and disposal or piling. There will be no likely significant effects.

[27] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=10478#features (Accessed 21/08/2018)

Conservation Objective 3: To ensure for the qualifying species that the following is maintained in the long term; distribution and extent of habitats supporting the species.

The proposed development at Edinburgh Marina will not result in any direct loss of habitat, therefore, no likely significant effects on the Outer Firth of Forth and St Andrews Bay Complex pSPA are predicted.

Conservation Objective 4: To ensure for the qualifying species that the following is maintained in the long term; structure, function and supporting processes of habitats supporting the species.

Wave modelling provides data which demonstrate that any changes to coastal processes and sediment suspension caused by the dredging or construction within the harbour area would not be significant.

Conservation Objective 5: To ensure for the qualifying species that the following is maintained in the long term; no significant disturbance of the species.

No significant decrease in population against national trends.

11.3 Appropriate Assessment Conclusion

Due to the availability of alternative foraging habitats, pollution prevention mitigation outlined in section 13 and the likelihood that any individuals utilising the habitat will be somewhat accustomed to vessel movements, no significant long term effects on the integrity of the Outer Firth of Forth and St Andrews Bay Complex pSPA are predicted with regard to the conservation objectives for the qualifying species.

12 APPROPRIATE ASSESSMENT FOR RIVER TEITH SAC

12.1 Site Description

The River Teith is the most significant tributary of the River Forth, covering the lower reaches of the River Teith to its mouth with the River Forth at Stirling and major tributaries. The River Teith SAC extends to 143.76km and covers an area of 1289.33 ha.

The River Teith SAC was designated in 2005. The site covers the lower reaches of the River Teith to its mouth with the River Forth at Stirling and major tributaries. A map showing the boundary of the site can be found on SNH's SiteLink website (http://gateway.snh.gov.uk/sitelink/). It has been notified for the presence of four fish species:

- River lamprey (*Lampetra fluviatilis);*
- Brook lamprey (*Lampetra planeri);*
- Sea lamprey (*Petromyzon marinus); and*
- Atlantic salmon (*Salmo salar).*

The three species of lamprey are Annex II species and are a primary reason for selection of the site as a SAC, whilst Atlantic salmon is an Annex II species that is present as a qualifying feature, but is not a primary reason for site selection.

These species are vulnerable to sedimentation and reductions in water quality, and are dependent on a range of in-stream habitat features for varying stages of their life cycles. Salmon also depend on riparian plants for shade and invertebrates as food. Leaf litter is an important nutrient supply for in-stream invertebrates that are eaten in turn by juvenile salmon.

During the screening process, brook lamprey was screened out and no further assessment has been undertaken for this qualifying feature.

Lamprey

The River Teith is known to support all three native species of lamprey: Sea Lamprey (*Petromyzon marinus*), River Lamprey (*Lampetra fluviatilis*) and the Brook Lamprey (*Lampetra planeri*).

The river provides excellent habitat to support the spawning and juvenile stages of the lamprey life-cycle (extensive gravel beds and marginal silt beds) with usually pristine water quality, well-vegetated banks and a substantially unaltered river channel without any significant artificial barriers to migration. The conservation importance of the River Teith is increased by the fact that, unlike many British rivers, it supports populations of all three lamprey species.

Lampreys are an ancient type of eel-like fish, quite unlike any other fish in the British Isles. They are amongst the most primitive of all living vertebrate animals. Young larval lampreys (ammocoetes), live buried in silt beds along the river margin. They are blind and feed on minute particles in the water. After several years of larval growth, they transform into adult lampreys and migrate away from the nursery areas.

Sea Lamprey

As in many other Scottish rivers Sea Lampreys appear to be relatively rare in the Teith system. Even where they occurred in samples collected during the present study, the numbers were very small compared to those of River/Brook Lampreys (Maitland and Lyle, 2003).

Adult sea lamprey, the largest of the three lamprey species, spend some time in the estuary but live mainly in coastal waters as adults where they parasitize a number of marine fish species, including herring (*Clupea harengus*), Atlantic salmon, sea trout (*Salmo trutta*), cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*).

The River Teith represents part of the east coast range of the sea lamprey in the UK. Sea lamprey have previously been recorded in the River Teith by Gardiner et.al (1995), who recorded ammocoetes at four, of a possible six, sites demonstrating optimum habitat types.

The most recently available data for lamprey suggests that no sea lamprey were recorded in the 2004 study, supporting Maitland & Lyle (2003) in identifying that this species is less common in comparison to the river and brook species, as is the case in many other Scottish rivers (Bull, 2004).

River Lamprey

The river lamprey is a primitive, jawless fish resembling an eel. River lamprey adults live primarily within estuaries feeding on a number of estuarine fish, but, in the Firth of Forth principally herring, sprat (*Sprattus sprattus*) and flounder (*Platichthys flesus*) (Maitland et.al 1984).

Both feeding and migrating stages of river lamprey are entrained regularly at Longannet Power Station. While no specific data are available for the Firth of Forth as a whole, it is suggested that river lamprey, along with the fish species on which they feed, occupy most parts of the estuary.

Migration of adult river lamprey from the sea to the river occurs mainly from October to December.

Available data for all species of lamprey in the Firth of Forth catchment indicates that river lamprey ammocoetes were observed at 16 of 25 freshwater sites where suitable habitat for lamprey was previously identified (Bull 2004).

Atlantic salmon

The River Forth is known to carry a substantial population of salmon that run throughout the year and spawn in the upper reaches and tributaries including the River Teith. Salmon exhibit an early run up the Firth of Forth from early February to March followed by runs through the summer until early autumn, although the end of season run is not as pronounced as on some other east coast river systems (e.g. River Tweed). Salmon smolts run to sea in a relatively narrow window between mid- April and mid-June.

12.2 Conservation Objectives

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

12.3 Site Condition

Table 12-1 summarises the condition of the migratory fish interest features. One species is considered to be in Favourable Maintained condition; one features is considered to be in Favourable Declining condition; and one species is considered to be Unfavourable Recovering condition.

Figure 12-1 Location of the River Teith SAC

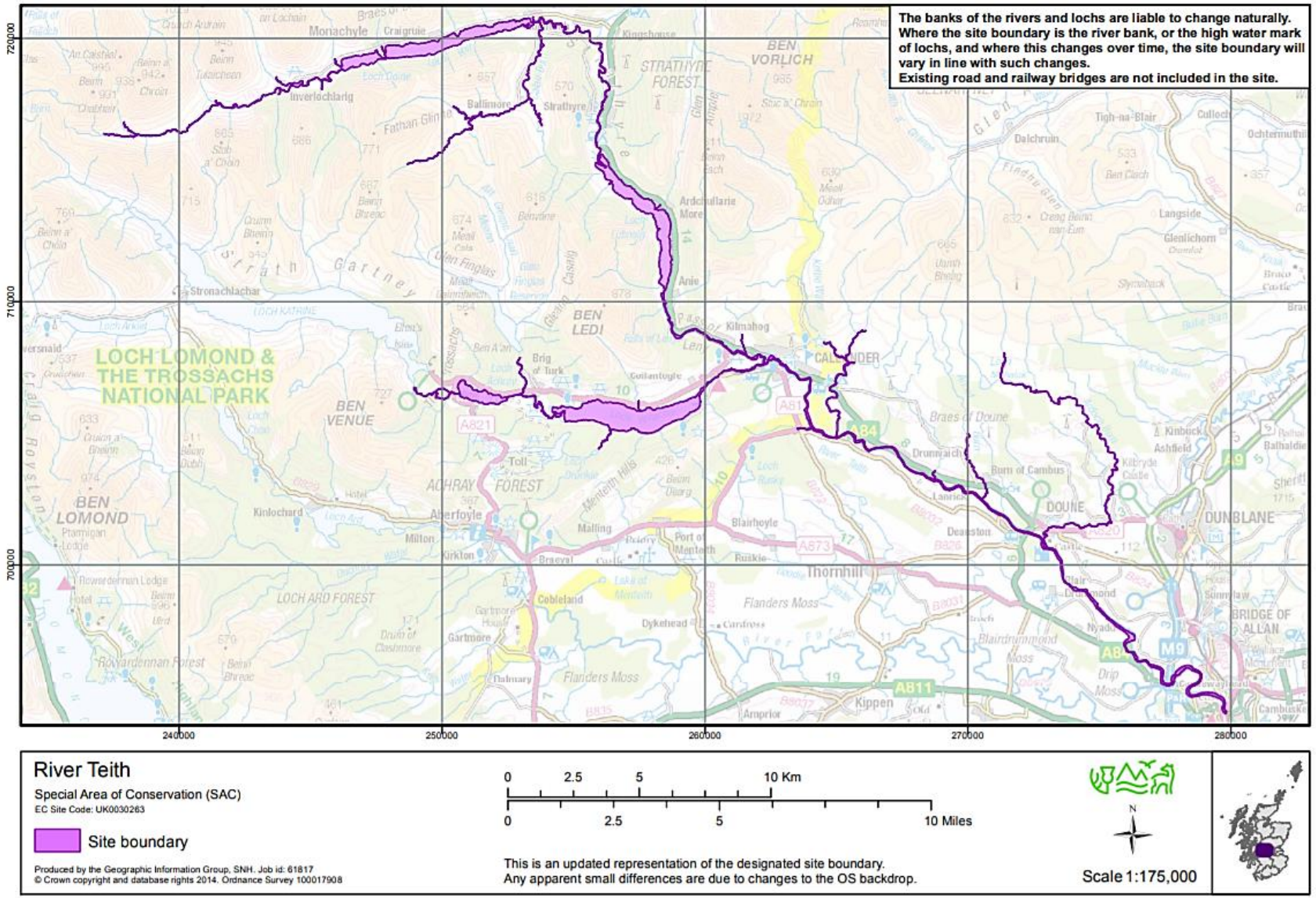


Table 122-1 Condition of qualifying interest features of the River Teith SAC on data published by SNH[28]

Feature	Latest Assessed Condition	Summary Condition	Last Visit Date
Atlantic salmon (*Salmo salar*)	Unfavourable Recovering	Favourable	19/08/2011
River lamprey (*Lampetra fluviatilis*)	Favourable Maintained	Favourable	09/11/2011
Sea lamprey (*Petromyzon marinus*)	Unfavourable Declining	Unfavourable	09/11/2011

12.4 Effects on Site Integrity as Defined by the Conservation Objectives

Conservation Objective 1: To ensure for the qualifying species that the following is maintained in the long term; population of the species as a viable component of the site.

Rivers within the vicinity of Edinburgh Marina are not designated at any level for river lamprey populations, the nearest SAC population is at least 58km north west (straight line) away, and river lamprey reside close to their natal rivers, it is concluded that there will be no likely significant effect on the river lamprey feature of the River Teith SAC.

River lamprey distribution is primarily restricted to the immediate vicinity of their natal rivers, and associated estuarine and coastal waters approximately 58km from Edinburgh Marina.

Sea lamprey do not show homing behaviour to their natal river to spawn and the rarity of their capture in coastal and estuarine waters suggests that they are widely dispersed in the marine environment. They migrate from freshwater to coastal waters as a juvenile and remain resident for a period of years before returning to spawn. The rarity of their capture in coastal and estuarine waters suggests that they are not shoaling fish and are widely dispersed at sea (Henderson, 2003).

However, the risk of sea lamprey impacted by noise associated with construction works at Edinburgh Marina are considered to be extremely small and the risk to sea lamprey that eventually end up in the River Teith SACs is even smaller due to the size, scale and location River Teith relative to the Project at Edinburgh Marina. In the case of returning salmonid adults, they typically stay in deeper waters following olfactory trails when they are relatively close to their natal rivers (Quinn, 2005).

There will be no likely significant effect on the river lamprey feature of River Teith SAC as a result of the construction works at Edinburgh Marina.

It is considered that there is no likely significant effect on the sea lamprey feature of the River Teith SAC as a result of the construction works at Edinburgh Marina.

The potential impacts on salmon populations are not considered to extend beyond 500m of construction works at Edinburgh Marina. In addition, the risk of salmon destined for, or originating from, the River Teith SAC at least 58km upstream is considered to be extremely low. It is therefore considered that there will be no likely significant effect on the Atlantic salmon feature of the River Teith SAC.

Conservation Objective 2: To ensure for the qualifying species that the following is maintained in the long term; distribution of the species within the site.

The River Teith SAC is located approximately 58km from Edinburgh Marina, and it is predicted that the features of interest will not be affected by noise disturbance associated with dredging, disposal or piling. There will be no likely significant effects.

[28] http://gateway.snh.gov.uk/sitelink/siteinfo.jsp?pa_code=8367

Conservation Objective 3: To ensure for the qualifying species that the following is maintained in the long term; distribution and extent of habitats supporting the species.

The habitats and species for which the site is designated are dependent on the maintenance of good water quality and suitable flow conditions. Fish species require suitable in-stream habitat and an unobstructed migration route. It is unlikely that construction works at Edinburgh Marina will have a negative in the long impact on the distribution and extent of habitats supporting the species give the distance from the River Teith SAC

Conservation Objective 4: To ensure for the qualifying species that the following is maintained in the long term; structure, function and supporting processes of habitats supporting the species.

Wave modelling provides data which demonstrate that any changes to coastal processes and sediment suspension caused by the dredging or construction within the harbour area would not impact the River Teith SAC.

Conservation Objective 5: To ensure for the qualifying species that the following is maintained in the long term; no significant disturbance of the species.

No significant decrease in the populations of river lamprey, sea lamprey or salmon against national trends are predicted.

13 MITIGATION

The following mitigation will be employed to avoid and minimise the risk of a pollution event occurring both during the construction and operational phases of the proposed development:

- *Timing and duration* – Avoid conducting piling activities during times when marine mammals and fish are likely to be breeding, calving, feeding, or resting in biologically important habitats located within the potential noise impact footprint.
- *Piling method* – Use low noise piling methods where practicable, such as vibropiling, instead of impact piling methods where possible. Vibropiling methods produce lower noise levels and are not impulsive in character. This reduces the likelihood of hearing injury to occur within marine mammals. The piling method should be optimised taking into account time on-site and likely noise levels.
- *Soft start* - The use of a 'soft start' or 'ramping up' process, in which pile driving energy is gradually increased to normal operating levels, gives nearby animals an opportunity to vacate the area before sound levels increase to an extent that may cause injury. There is some concern that this technique may actually attract animals, and so should be used with this is mind and always with trained marine mammal observers present (Jefferson et al. 2009). Also, it is likely that behavioural changes and possibly masking will still occur for nearby animals (Madsen et al. 2006).
- *Contract documentation* – Include the standard management and mitigation procedures, and any additional measures to be put in place, in the contract documentation.
- *Trained team* – Ensure that a suitably qualified person is available during piling activities to conduct the standard operational procedures outlined below. A suitably qualified person should have qualifications in ecology or environmental sciences and demonstrated experience with the identification and management of marine mammals. A briefing on environmental matters, including information on guidelines, marine mammal identification and legal obligations should be provided to all staff involved in the piling activities. Likely marine mammal concentration areas, key feeding sites, and other aggregation areas should be identified during the planning stage and this information should be provided to trained team members and the marine mammal observer to improve the identification and observation of marine mammals.
- *Bubble curtains* - Demonstrated to significantly lower both pile driving sound pressure levels and peak frequencies (Würsig et al. 2000; Jefferson et al. 2009). Typically a bubble curtain consists of a perforated hose that is anchored to the sea floor around the area where piling is taking place. Compressed air is pumped through the hose and a 'curtain' of bubbles produced. Bubble screens can reduce the sound pressure levels up to a biologically significant 25dB in the frequency range of concern for marine mammals (Jefferson et al. 2009). Other variations of bubble curtains such as screens and jackets are commonly used to reduce pile driving noise at offshore wind-farms (Evans 2008) and are worth considering.
- *Construction Environment Management Plan (CEMP)* - detailing pollution prevention measures will be agreed with the regulatory authority prior to works commencing;
- The following good practice guidelines will be adhered to and incorporated into the CMS:
    - GGP5: Works and maintenance in or near water;
    - PPG 6: Working at construction and demolition sites;
    - PPG 7: Safe Storage – The safe operation of refuelling facilities;
    - GPP21: Pollution and incident response planning; and
    - PPG22: Incident response – dealing with spills.
- An Ecological Clerk of Works (ECoW) will be employed throughout the construction phase to audit adherence to the mitigation outlined in the CMS.

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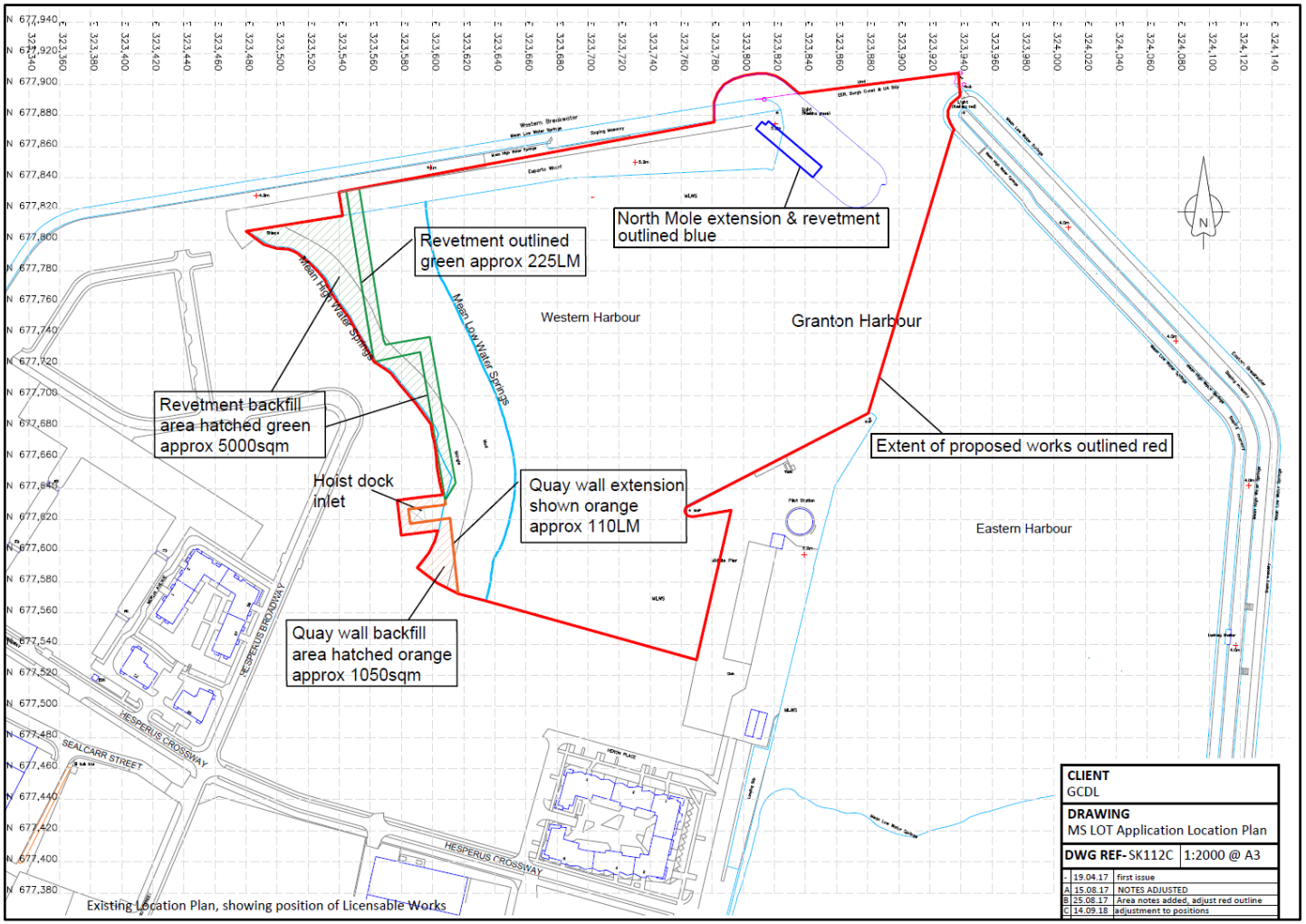
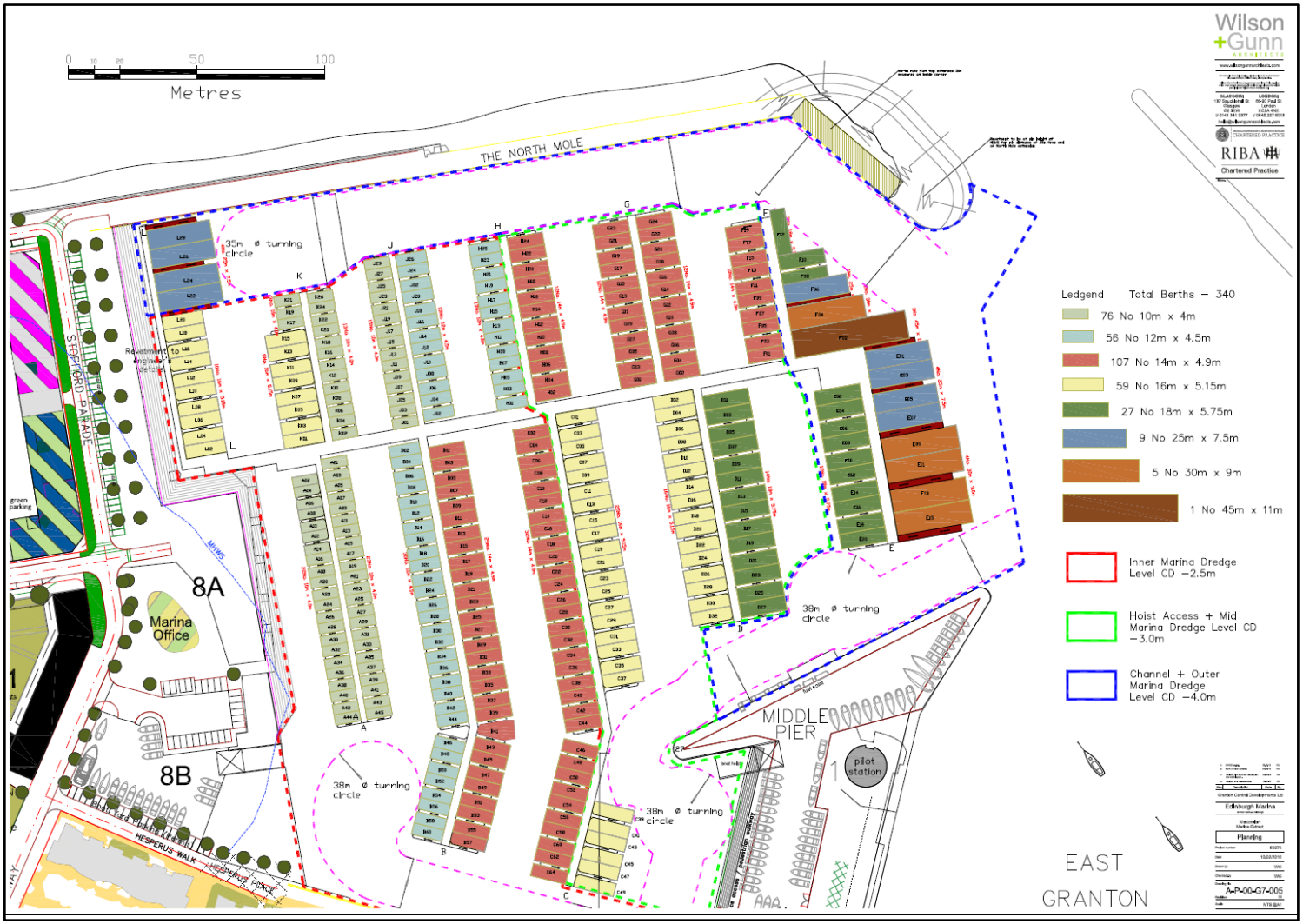
APPENDICES

A PROPOSED DEVELOPMENT

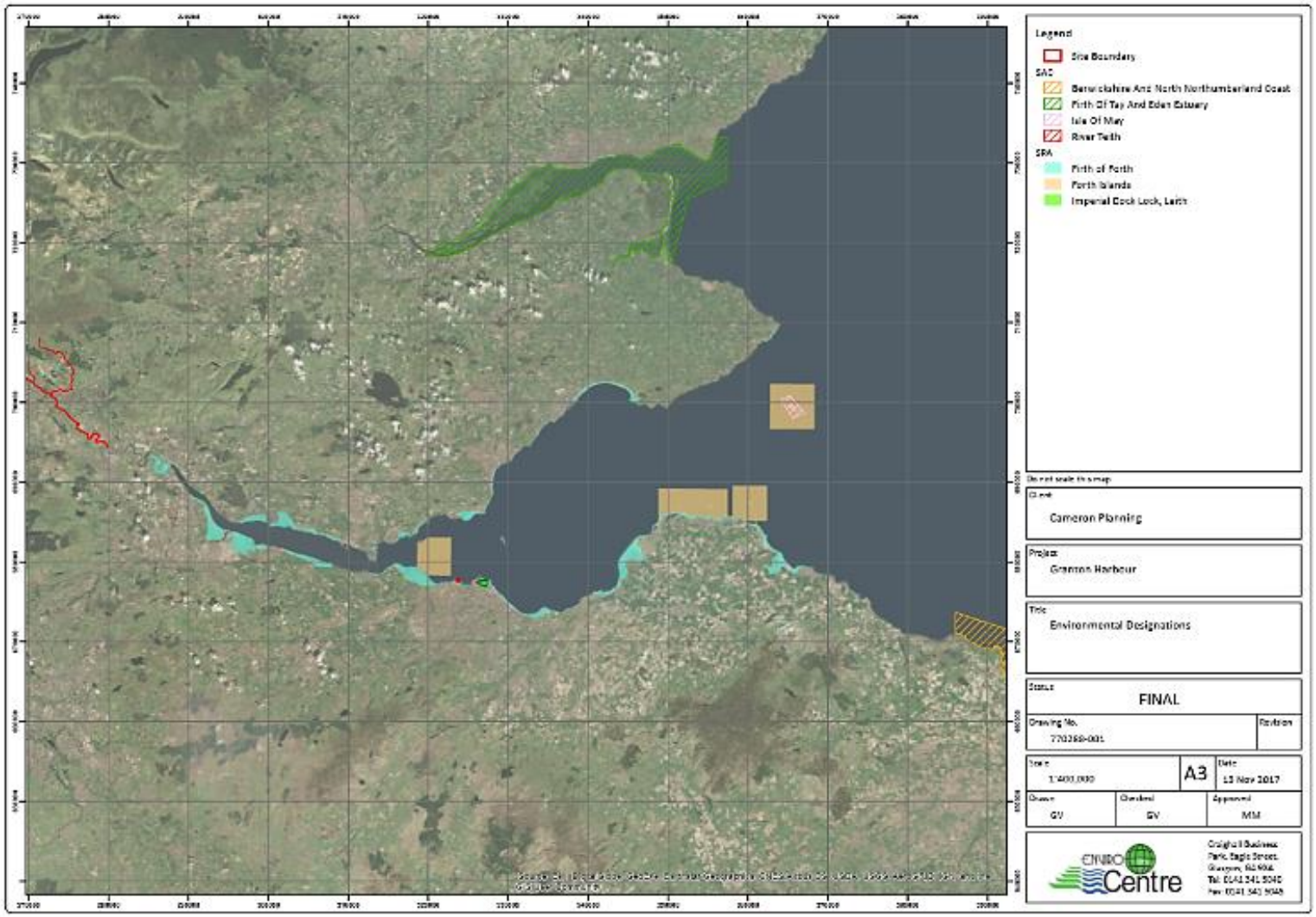


Existing Location Plan, showing position of Licensable Works

B PROPOSED MARINA LAYOUT



C LOCATION OF NATURA 2000 SITES



Technical Appendix 5-5: Underwater Noise

Edinburgh Marina Granton Harbour Ltd

Edinburgh Marina
Technical Appendix 5-5: Underwater Noise, Qualitative Assessment

September 2018

Edinburgh Marina
Technical Appendix 5-5: Underwater Noise, Qualitative Assessment

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1 INTRODUCTION

1.1 Terms of Reference

EnviroCentre Limited was commissioned by Edinburgh Marina Granton Harbour Ltd, to undertake a review of literature and guidance relating to underwater noise and marine mammals. The review of literature and guidance was required to inform an Ecological Impact Assessment (EcIA) for the proposed Edinburgh Marina Development

1.2 Scope of Report

The aim of the review was to establish the potential impacts to marine mammals as a result of underwater noise from dredging and piling. The main objectives of the survey were as follows:

- Search for pertinent information relating to marine mammals and underwater noise; and
- Identify potential impacts as a result of noise and outline appropriate mitigation methods;

1.3 Report Usage

The information and recommendations contained within this report have been prepared in the specific context stated above and should not be utilised in any other context without prior written permission from EnviroCentre.

If this report is to be submitted for regulatory approval more than 12 months following the report date, it is recommended that it is referred to EnviroCentre for review to ensure that any relevant changes in data, best practice, guidance or legislation in the intervening period are integrated into an updated version of the report.

2 PROJECT DESCRIPTION: CONSTRUCTION METHODS

2.1 Introduction

Fairhurst were commissioned by Granton Central Developments Ltd to prepare a high level civil engineering statement[1] setting out the likely method of construction various aspects of civil engineering works to support the development and provide protection for Edinburgh Marina and Granton Harbour. These comprise an extension to the North Mole breakwater, an internal quay wall and an internal harbour revetment. General layout arrangements are demonstrated on Drawing No's. A-P-00-G7-005-G and 115875-0001-A within Volume 2 of the EIAR.

This report undertakes a qualitative assessment of underground noise based on current research knowledge.

2.2 Assumptions

Typical geology of Granton Harbour consists of soft alluvial silts overlying stiff glacial till which overlies bedrock comprising inter-bedded strata of sandstone and mudstone. Detailed Geotechnical Investigation is required to inform the detailed design. This will be provided to the Contractor to inform the Temporary Works design as required.

A Bathymetric Survey of the current bed levels has been carried out to inform the design, identify the current extent of dredging and inform the construction methodology. The methodology may vary depending on the preferred approach of the Contractor, the availability of marine plant and the comparative cost of temporary works. However, this statement is considered to be a reasonable and practical approach to the Works that highlights the likely interface with the Firth of Forth.

2.3 Construction Activities

2.3.1 Local Dredging

The area of the Western Harbour will be dredged to a finished dredge level sufficient for the planned operation of the marina. The depth varies across the marina with shallower waters for smaller craft closed to the shore.

Dredging in advance of the north mole is likely to be by backhoe dredger. Sediment testing has been undertaken across the marina site with some material identified as suitable for disposal at sea site at an approved site and the remainder brought ashore for disposed or treatment and reuse.

The typical geology of Granton Harbour consists of soft alluvial silts overlying stiff glacial till which overlies bedrock comprising inter-bedded strata of sandstone and mudstone (Arup, 2015).

It is anticipated that dredging works will be undertaken during the early stages of construction. However, conditions and circumstances may dictate that some will occur in later in the construction programme and so options for phasing of these works will be clarified once a contractor has been appointed.

[1] Fairhurst, Edinburgh Marina Civil Engineering Method Statement North Mole Extension, Inner Revetment and Quay Wall 14th September 2018

Sediment sampling was undertaken in November 2017 and discussions have been ongoing with Marine Scotland since this time regarding the various options available due to the presence of some contaminants of concern in exceedance of Revised Action Level 2. Sediments sampled within the proposed dredge area are reported as primarily silt.

With reference to the Granton Harbour Dredging 2018; Best Practicable Environmental Option Report (EnviroCentre Document Number 8192 (June 2018)), dredging will be undertaken within the western harbour to facilitate the development of the proposed marina.

Based on the dredging plan for the harbour volume split is as follows based on chemical quality (Table 2-1).

Table 2-1: Dredge Volumes

Dredge	Volume (m^3)	Comment
Total Dredge Nett Volume	241,365	Total proposed dredge volume
Dredge Volume for Areas for surface to 1.2m Dredge	86,980	Proposed for Sea Disposal
Dredge Volume from below 1.2mto base of dredge plus Area around VC8 & VC9 with Shallow Contamination	154,385	Land Based Disposal Options
Total Infill (Nett) Volume	19,322	

Multiple contaminants of concern were recorded above Revised Action Level1 including

- Metals
- PAHs
- PCBs
- Petroleum Hydrocarbons

Mercury was recorded in exceedance of Revised Action Level 2 in multiple locations.

Further review of the information and discussion with a view to segregating the material with exceedances above REV AL2 was undertaken and communicated with Marine Scotland. The key points being that if all material with mercury concentrations >RAL2 are excluded for sea disposal i.e. the material is dredged to a fixed depth of 1.6m the average concentration is 1.06 mg/kg which is also <RAL 2.

On this basis, it was proposed that the upper 1.2m of material would be dredged, excluding a large buffer around VC 8 and VC9 where shallow mercury contamination was also encountered with a view to disposing this material at sea on the basis that sufficient supporting evidence could be provided to justify this in the presence of REV AL1 exceedances. All remaining material would be taken to land for a land based disposal solution.

2.3.2 Backhoe Dredger

At the moment of writing it is advised, by Fairhurst Consulting Engineers, that Backhoe dredging will be utilised to effectively remove 'stiffer' consolidated material, as well as boulders and weathered/weaker rock outcrop and looser material will be dredged directly from the seafloor by the BHD. The dredged material would be deposited on a separate barge which would transport the dredged material to the reclamation and disposal area.

Figure 2-1 shows the typical backhoe dredger arrangement with a long reach excavator positioned on a barge; it also shows the self-propelled disposal barge that is used to take the dredged material to the disposal ground.

The dredging barge is stabilised on spud legs, so it does not require anchors and can be easily and rapidly moved.

Where it is not possible to reuse dredged materials elsewhere in the works, material will be disposed of at an approved disposal at sea site.

Figure 2-1: Typical Backhoe Dredger

2.4 Quay Wall Construction

2.4.1 Description

On the west side of the marina basin, a quay wall is to be formed. This will be a continuation of the existing quay wall along the south boundary. The proposed form of construction is a tied sheet pile wall with insitu reinforced concrete capping beam with metal parapet. The form of construction will be similar to the existing.

2.4.2 Construction Method

The wall is formed from driven sheet piles. The existing sheet pile wall was installed from a barge and it is likely that the same methodology would be used for the additional length of wall. A barge would be positioned at high water and stabilised on jack up legs. From this platform, the sheet pile wall can be installed tying into the existing wall. Individual sheet pile sections are lowered vertically into the sea bed, interlocked with the adjacent pile sections. Piles are usually driven to staged depths to maintain the continuity and allow adjustments. After being driven to full depth, the top of the piles are cut off to the design level. At this stage, the piles will be free standing but not capable of being backfilled. Ties will be installed between the piles and a secure anchorage point on shore. These will be buried reinforced concrete blocks that will resist the thrust from the wall when it is backfilled.

The wall will be backfilled with suitable material available from elsewhere on the site. The top of the wall is completed by a reinforced concrete capping beam that is cast in-situ to tie the top of the piles together. It will also support to the metal pedestrian parapet that will provide edge protection.

2.5 North Mole Extension

2.5.1 Form of Construction

The North Mole extension requires a vertical internal face for a length of 50m to maximise space available for the marina. An inclined seaward face of rock armour will provide protection from wave action. Several forms of construction are possible for this structural layout but it is anticipated that a reinforced concrete wall would be formed, resting on the seabed with a natural rock faced revetment to the seaward side. The Reinforced concrete

wall would be assembled from hollow pre-cast concrete boxes that can be filled on site with concrete and or ballast rock. The concrete wall will extend for 50m, beyond which a 25m rock revetment will provide additional protection.

2.5.2 Construction method

For the purposes of this method statement, it is assumed that all works will be carried out using marine based plant. However, subject to an assessment of the existing Esparto Wharf and North Mole it may be possible to create an access to allow some of the work to be undertaken by land, reducing marine based activity.

The overall steps in the construction process are

i. Locally reduce the level of the seabed to design dredge level
ii. Excavate further to the design formation level for the concrete wall
iii. Place a regulating layer of stone to land the concrete units on
iv. Place precast concrete foundation blocks
v. Build up the precast concrete wall units, sealing the joints as they are placed to control subsequent wet concrete placement
vi. Place any binding reinforcement and drop in pre-formed reinforcement cages
vii. Fill concrete units with underwater mix concrete
viii. Backfill around concrete wall externally to revetment founding level, internally to bed level.
ix. Construct revetment on outer face of concrete wall, and for an additional 25m along the line of the wall.

2.5.3 Base Formation

The wall of the breakwater is expected to be founded approximately 4.5m below final dredge level subject to geotechnical investigation and design. A trench will be excavated from the dredge level to the base formation level with sloped sides of a gradient dependent on the geotechnical properties of the bed material. Figure 2-2 below represents this construction phase.

A 250mm thick layer of Type 1 material will be placed on the base of the excavation and then levelled to allow placement of the reinforced concrete foundation units. These solid units provide a solid and stable foundation from which the wall can be supported. Divers will be employed to direct the placement and levelling of the units.

Once placed, a local bathymetric survey will be undertaken to confirm the base is at the correct level to receive the precast units making up the wall.

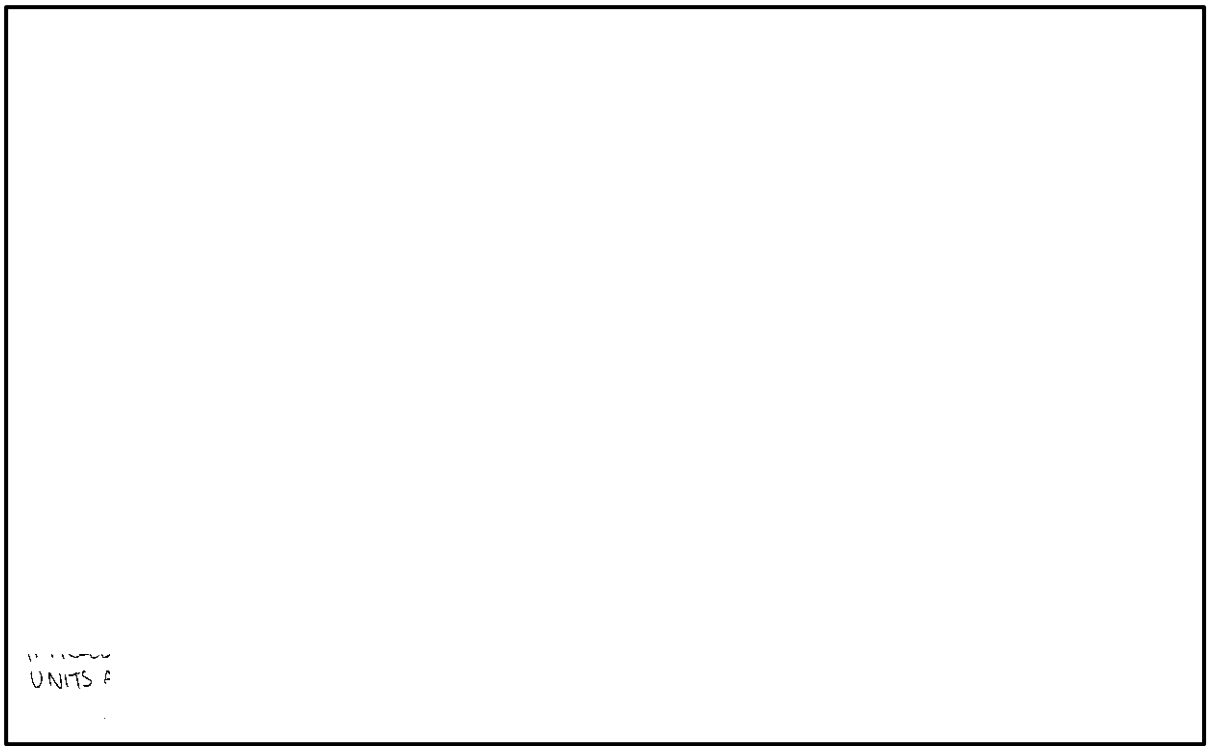

Figure 2-2: Potential construction within a trench to sound formation

2.5.4 Precast Unit Construction and Placement

In order to minimise the time of construction on site and the associated cost of marine based plant, the wall will be constructed from precast units, which can be fabricated off site. The units will be transported to site by road or sea, depending on the location of the fabrication site.

The wall consists a reinforced concrete foundation approximately 7.5m wide and totalling a length of 50m. This will be made up of individual precast units sized to suit placement by crane from a barge and will be keyed together. Hollow units to form the bulk of the wall will be lifted and placed by crane from a barge with divers directing placement of the units, which lock together. This will form a sealed cofferdam into which concrete will be pumped in lifts.

2.5.5 Breakwater Construction

Following the construction of the breakwater wall, the rock infill forming the core of the revetment to the east of the wall will be placed using a long reach excavator from a barge. Some reinstatement of bed material may be possible if material properties permit prior to build up of the core of the breakwater.

Prior to placement of the secondary rock layer, consisting typically 300kg sized rock, divers will place a layer of geotextile to prevent material washout. The larger primary rock armour will then be placed on top to provide the full level of wave protection. The rock will be placed using a barge mounted long reach excavator. It is assumed that all rock will be delivered to site by sea and will be placed directly from the delivery barge to the revetment.

2.5.6 Wave Wall

In order to provide additional protection along the top of the structure, a precast reinforced concrete wave wall will be placed. The wave wall units will be lifted into place by barge mounted crane or telehandler and secure in place.

2.5.7 Finished Walkway

Behind the wave wall, a paved surface will be installed to form the walkway. Fixtures such as lighting can be installed, with service ducts having been cast into the final lift of precast concrete boxes.

2.6 Marina revetment

2.6.1 Description

The west boundary of the marina basin is formed with a natural stone faced revetment that will enclose and protect an area of reclaimed land. The core of the revetment is expected to be a combination of material recovered from elsewhere on the site and imported structural fill. The facing rocks will be imported to site by road. Along the top of the revetment, a concrete capping detail with integral channel for planting and parapet along the top provides the transition

2.6.2 Construction Method

The revetment can be constructed using land based plant and machinery working progressively along the line of the revetment until completed. The fill behind the revetment can be placed behind once the revetment is structurally sufficient to protect the infill.

The revetment needs to be founded on a sound strata and so the first operation will be excavation of the bed sediments down to a suitable formation level. The core can then be built up in layers before being sealed behind within a geotextile. This will protect the integrity of the core and prevent future washout of material. The rock armour facing will then be placed on the outer face of the revetment and if the bed was excavated below dredge level, some bed material can be reinstated up to this level. Infill behind the revetment will comprise material from elsewhere on the site that has been tested for suitability. The reclaimed area will be suitable for car parking and landscaping.

3 UNDERWATER NOISE ASSOCIATED WITH CONSTRUCTION

3.1 Underwater Sound Descriptors

Sound is a physical phenomenon consisting of minute vibrations or acoustic waves that travels through a medium, in this case water, and occurs as a backward and forward motion of the medium's particles driven by a vibrating source.

The magnitude of the water particle motion determines the intensity of the sound. The rate at which the water particles oscillate backward and forward determines its frequency given in Hertz (Hz) or cycles per second.

Sound travels about four-and-a-half times faster in water than in air. Absorption of sound energy is much smaller in water at lower frequencies, where man-made noise generally has most energy. As a result, man-made noise generally travels much further underwater than in air.

A tone is a sound of a constant frequency. Most underwater noise sources are not tonal but include a broad range of frequencies. Screeching or whistling noises are composed mainly of high frequency sound while rumbles or booms are composed mainly of low frequency sound (Leventhall et.al, 2003).

Underwater sounds are classified according to whether they are continuous or impulsive in character.

- Continuous sounds occur without pauses and are typically produced by the ambient environment, ships, or rotating machinery such as pumps.
- Impulsive sounds are of short duration and occur singly, irregularly, or as part of a repeating pattern. An explosion represents a single impulsive event whereas the periodic impacts from a piling rig or a geophysical survey result in a patterned impulsive sequence. Pulses typically sound like clicks or bangs and may include a broad range of frequencies.

3.1.1 Measured or received levels

A number of metrics that measure sound wave pressure and energy are used to assess the potential impact of piling on marine mammals.

Noise descriptors that are commonly used in underwater acoustics to present measured or received levels include the following (Blackwell et al. 2004).

- **Sound pressure level (SPL)** – Average noise level over the measurement period expressed in dB re 1 µPa. For impulsive sources, such as impact piling and blasts, the measurement period is the time period that contains 90% of the sound energy (Southall et al. 2007). Continuous sources, such as vibro-piling and shipping, are commonly described in terms of an SPL.
- As an example, small sea going vessels typically produce broadband noise at source SPLs from 170 to 180 dB re. 1µPa @ 1 m (Richardson et al, 1995), whereas a supertanker generates source SPLs of typically 198 dB re. 1µPa @ 1 m (Hildebrand, 2004).
- **Sound exposure level (SEL)** – Total noise energy over the measurement period expressed in dB re 1 $\mu Pa^2 \times s$. The SEL is commonly used for impulsive sources because it allows a comparison of the energy contained in impulsive signals of different duration and peak levels (Blackwell et al 2004). Sound pressure levels themselves are dependent upon several, additional factors. As would be expected, blow energy significantly influences the level of sound pressure produced by a piling event (Brandt et al. 2011). Brandt et al (2011) calculated a maximum SEL at high blow energy (850KJ), whilst at low energy

(<200KJ). SEL was significantly lower. Sound pressure is also influenced by the type of pile used (wood, steel etc), the pile's diameter and the characteristics of the seafloor sediment (Richardson et al. 1995).

- When piling, the initial strike generates a shock wave, which, over distance, becomes a pressure/sound wave. Sound is radiated into the water column from the pile itself, and from the sediment, which liquefies as the pile is driven. Hence sound radiation from a pile-strike event is complex, and cannot be modelled accurately without extensive measurement data.
- **Peak level –** Maximum noise level recorded during the measurement period expressed in dB re 1 µPa. The peak level is commonly used as a descriptor for impulsive sources.
- **Peak-to-peak level –** Difference between the maximum and minimum noise level recorded during the measurement period, expressed in dB re 1 µPa. The peak-to-peak level is used as a descriptor for impulsive sources.

The duration of the impulsive sound is a very important characteristic when considering, for example, piling effects. Increases in duration could lead to impacts that are not initially observed with activity that is similar in frequency and sound pressure (Bailey et al. 2010). Experimental evidence indicates that there is a linear relationship between temporary hearing threshold shifts and exposure duration. This indicates that the longer animals are exposed to high sound levels, the lower the sound pressure required to induce a negative response. Frequency dependent representations include spectral density levels, one-third octave band levels, or octave band levels. Spectral density levels give a greater frequency resolution, which is sometimes desirable for identifying narrowband sources such as rotating machinery, and are expressed in unit of dB re 1 μPa^2/Hz. One-third octave and octave band levels are expressed in units of dB re 1 µPa.

3.1.2 Sound pressure and decibels (dB)

In water, the sound pressure is typically measured with a hydrophone – the underwater equivalent of a microphone. The international standard unit of sound pressure is the Pascal (Pa).

Typical sound pressures encountered in underwater acoustics range from levels just detectable by the marine animal ear (hundreds of µPa) to much greater levels causing hearing damage (billions of µPa). Because this range is so enormous, it would be impractical to express sound pressures in units of Pascal. Sound pressure is therefore described in terms of a sound pressure level (SPL) in units of decibel (dB), with reference to a standard pressure of 1 µPa for underwater sound. In decibel notation, the range of sound pressures typically encountered ranges from 50 to 250 dB re 1 µPa.

3.2 Underwater Dredging Noise Characteristics

Dredging involves a variety of activities that produce underwater sounds. Most of these are relatively low in intensity and frequency, although recent investigations indicated that occasionally higher frequencies are emitted.

Compared to other activities that generate underwater sound, dredging is within the lower range of emitted sound pressure levels. While it is clear that dredging sound has the potential to affect the behaviour of aquatic life in some cases, injury in most scenarios should not be a concern, or should be preventable. It is very unlikely that dredging-induced sounds will lead to any population level consequences, although harm to individuals should not be overlooked.

With reference to the CEDA Position Paper 7: *Underwater Sound In Relation To Dredging*, it is considered likely that only the lowest potential impact will occur from the dredging and disposal works. Harbour porpoise, for example, will be able to detect the noise but it will be too weak to induce an observable reaction.

One investigation carried out on grab dredgers indicates that this activity is relatively quiet and that recorded sound levels were just above the background sound at approximately 1km from the source (Clarke et al. 2002).

Noise emitted during dredging operations is broadband, with most energy below 1 kHz and is unlikely to cause damage to marine mammal auditory systems, but masking and behavioural changes are possible (Newell and Woodcock (2013). Given the evidence available and the scale of such operations, this activity is not generally considered to present a significant issue (JNCC, 2015).

3.3 Underwater Piling Noise Characteristics

Piling is one of the most intense sources of anthropogenic noise in the marine environment (Richardson et al. 1995). Research relating to noise from pile-driving activities has been established as a threat to the health of (both individuals and populations) of marine mammals (Thompson et al. 2013). The extent of risk to marine mammals is dependent on several factors including: the characteristics of the sound produced by pile-driving, environmental characteristics of the area, and the acoustic sensitivity, behavioural responses and habitat use characteristics of the species concerned (Richardson et al. 1995). The number of factors involved in determining the influence of pile-driving noise upon marine mammals, and thus complicates the comparison of results among locations and species.

The responses of marine mammals to anthropogenic noise can be described by four zones that identify the likely spatial extent of four 'types' of reaction to noise (Richardson et al. 1995). The first of these zones is the 'zone of audibility' which is simply the range over which a particular species can detect the emitted noise. This range depends on the characteristics of the noise, the animal's hearing sensitivity at the relevant frequencies, sound propagation parameters and ambient noise levels.

Piling noise varies with the size of the pile being installed and the pile driving method used. The most common pile driving methods include impact pile driving, where a pile is hammered into the ground by a hydraulic ram, and vibro-piling, where rotating eccentric weights create an alternating force on the pile, vibrating it into the ground.

Table 3-1 presents a summary of several noise levels that were measured when driving different foundations. The levels differ as the bottom type and water parameters affect the outcome, but it can still be noted that there is a trend of increased noise level as a function of pile diameter (Anderson et al., 2017).

Table 3-1: A comparison of noise emitted during construction of various windpower structures without mitigation measures, sorted by pile diameter. SPL(peak) refers to either the measured level at 750 m or normalised to 750 m as well as expected SEL(ss) where possible[2].

Site	Year	Pile diameter (m)	$SEL_{(ss)}$ (dB re 1 µPa²s)	$SPL_{(peak)}$ (dB re 1 µPa)
Port construction	2005	0.9	157	183
Port construction	2005	1	159	185
Fino 1	2003	1.6	162	184
C-Power, phases 2&3	2011	1.8	178	189
Hong Kong–Zhuhai–Macau Bridge	2014	2	167	191
Alpha Ventus	2008	2.7	174	199
Utgrunden	2000	3	166	n/a
Sky 2000	2002	3	163	189
Fino 2	2006	3.3	169	189
Amrumbank West	2005	3.5	171	191
Horns Rev II	2008	3.9	176	195
North Hoyle	2003	4	n/a	194
Q7	2007	4	177	200
Barrow	2005	4.7	n/a	195
Fino	2008	4.7	172	196
Belwind	2010	5	166	194
Northwind	2013	5	n/a	196
Kentish Flats	2015	5	180	n/a

[2] Data from Betke 2008; de Jong and Ainslie 2008; Norro et al. 2013; Kosecka et al. 2015; OSC 2015; Yang et al. 2015.

Sound pressure levels generally peak between 100 and 1500Hz, nevertheless significant energy can be present above 25 kHz (Würsig et al. 2000). This is in part due to piles being steel, and significant high-frequency content is expected. Sound attenuation is frequency dependent; low frequencies propagate further in water (and in air) than high frequencies. This effect is dramatic. Sounds below 1 kHz suffer almost no absorption (<0.04 Db/km) while at high frequency absorption is much higher (e.g. 120 kHz = 47 dB/km (Richardson et al. 1995).

3.4 Ambient underwater noise environments

The level and frequency characteristics of the ambient noise environment are two factors that control how far away a given noise source can be detected (Richardson et al. 1995).

In general, noise is only detectable if it is of a higher level than the ambient noise environment at similar frequencies. A lower ambient noise environment results in noise propagating out to greater ranges before diminishing below the background noise level. The potential zone in which noise emissions from a piling rig are detectable thus depends on the levels and types of ambient noise in the ocean waters surrounding the site.

The main sources of ambient noise in the ocean are man-made sources including shipping and sonar activity, and environmental sources including wind-dependent noise and biological noise from a variety of sources such as snapping shrimp (Richardson et al. 1995). Other environmental sources include surf noise typically localised near the coast, precipitation noise from rain and hail, seismic noise from volcanic and tectonic activity, and thermal noise.

4 MARINE MAMMALS AND SOUND

4.1 Introduction

Since its publication, Southall et al (2007) has been the definitive source of the most widely used criteria to assess the effects of noise on marine mammals. More recently NMFS (2016) was produced and was co-authored by many of the same academics from the Southall et al (2007) paper, and effectively updates it. In the updated guidelines, the frequency weightings have changed along with the criteria. As a result, the criteria have generally become more stringent and potential impact ranges may increase substantially in some cases. The NMFS (2016) guidance groups marine mammals into functional hearing groups and applies filters to the unweighted noise to approximate the hearing response of the receptor.

4.2 Hearing thresholds and audiograms

The hearing sensitivity of marine mammals varies with frequency. Audiograms are used to represent an animal's sensitivity to sounds of different frequencies. An audiogram of a species relates the absolute threshold of hearing (in dB re 1 µPa) of that species to frequency. An animal is most sensitive to sounds at frequencies where its absolute threshold of hearing is lowest. As an example, humans are most sensitive to sounds between 2–4 kHz where the absolute threshold is lowest.

- Toothed whales – Hearing is most sensitive at frequencies ranging from 8–90 kHz. The upper limits of auditory sensitivity are believed to range from 100 kHz in the killer whale to over 150 kHz and sensitivity is typically poor below 1 kHz ((Kastelein et al (2010) and Richardson et al. 1995)). The hearing of the beluga whale and bottlenose dolphin extends at least as low as 75 Hz but their sensitivity at these low frequencies seems quite poor (Au et al 2002)..
- Baleen whales – There are no underwater audiograms available for baleen whales, and there is a little data available on their hearing sensitivity. Baleen whale vocalisations are low in frequency content for a number of species, and the frequency range of acute hearing presumably includes the frequency range of vocalisations. From behavioural observations, it is apparent that baleen whales are quite sensitive to frequencies below 1 kHz, but can hear sounds up to a considerably higher but unknown frequency (Richardson et al. 1995).
- Pinnipeds – In comparison to toothed whales, pinnipeds tend to have lower frequencies of maximum hearing sensitivity, poorer sensitivity at frequencies of maximum hearing sensitivity, and lower high-frequency hearing cut-offs. However, some species may have better sensitivity at frequencies below 1 kHz than toothed whales.

4.3 Marine mammal functional hearing groups

Species of cetaceans and pinnipeds were assigned to functional hearing groups based on their hearing characteristics by (NOAH, 2018). Table 4-1 presents the four functional hearing groups, the estimated auditory bandwidth for each group, the listed species that may occur in the Firth of Forth for each functional hearing group, and the group-specific frequency weightings.

Table 4-1 Marine mammal functional hearing groups, estimated auditory bandwidth that may occur in Firth of Forth, and group-specific frequency weightings (NOAA, 2018)

Functional hearing group	Estimated auditory bandwidth*	Listed species that are known to, likely to, or may occur in Firth of Forth
Low-frequency cetaceans (All baleen whales	7 Hz to 35 kHz	Minke whale *(Balaenoptera acutorostrata)* Humpback Whale *(Megaptera novaeangliae)*
Mid-frequency cetaceans (Majority of toothed whales)	150 Hz to 160 kHz	Bottlenose Dolphin (*Tursiops truncates*)
High-frequency cetaceans (Other toothed whales)	275 Hz to 160 kHz	Harbour Porpoise *(Phocoena phocoena)*
Pinnipeds (Seals)**	50 Hz to 86 kHz	Grey Seal (*Halichoerus grypus*) Harbour (Common) Seal (*Phoca vitulina*)
* Represents the generalised hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalised hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007) and PW pinniped (approximation).		
** A further group for Otariid Pinnipeds is also given in the guidance for sea lions and fur seals but this has not been used in this study as those species of pinnipeds are not found in this region		

A simple comparison of sound pressure levels when assessing impacts upon marine mammals, does not take into account the critical bandwidth of the species concerned. The critical bandwidth is a range of frequencies over which a particular species' hearing is highly sensitive. In dolphins this is usually assumed to be the range of frequencies over which the species produces echolocation sounds (Richardson et al. 1995). In order to make a meaningful assessment of the effects of pile driving on a particular species, it would be necessary to know both the species' critical bandwidth and the pile driving noise pressure within this bandwidth (Madsen et al. 2006). Due to the broadband spectrum of pile-driving noise, this is particularly important.

Measuring the underwater hearing sensitivity of marine mammals can be done only with trained animals in captivity. For this reason, audiograms are available for only a few species. In those species, the range of most sensitive hearing closely matches their own sounds (Au et al. 2000). Baleen whales produce sounds used for communication in the frequency range 10Hz to 10kHz, while toothed whales and dolphins produce sounds for echolocation and communication between the frequencies 1 to 150kHz (Au et al. 2000). Pinnipeds communicate with vocalisation in frequencies between 50Hz and 60kHz (Richardson et al. 1995).

The low-frequency cetaceans group includes all baleen whales. Bottlenose dolphins are represented in the mid-frequency cetaceans group. The high-frequency cetaceans group contains the Harbour Porpoise.

4.4 Behavioural and physiological impacts of noise

Underwater noise impacts on marine mammals are often divided into behavioural and physiological impacts (Southall et al. 2007).

4.4.1 Behavioural Impacts

Marine mammals produce sounds in various contexts and use sound for various biological functions including social interactions, foraging, orientation, and predator detection. Interference with producing or receiving sounds could have negative consequences including impaired foraging efficiency from masking, altered movement of prey, increased energetic expenditures, and temporary or permanent hearing threshold shifts due to chronic stress from noise.

4.4.2 Physiological impacts (TTS and PTS)

Most discussions of physiological effects of underwater noise have centred on the auditory system, as this system is likely to be most sensitive to noise.

When the auditory system is exposed to a high level of sound for a specific duration, the sensory hair cells begin to fatigue and do not immediately return to their normal shape. This causes a reduction in the animal's hearing sensitivity, or an increase in hearing threshold. If the noise exposure is below some critical sound energy level, the hair cells will eventually return to their normal shape. This effect is called a temporary threshold shift (TTS) as the hearing loss is temporary. If the noise exposure exceeds the critical sound energy level, the hair cells become permanently damaged and the effect is called permanent threshold shift (PTS).

Table 3 summarises noise exposure criteria for physiological impacts, which are based on the study presented by Southall et al. (2007).

NMFS (2018) presents single strike, unweighted peak criteria (SPL_{peak}) and cumulative (i.e. more than a single sound impulse), weighted sound exposure criteria (SEL_{cum}) for both permanent threshold shift (PTS), where unrecoverable hearing damage may occur, and temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors.

Table 3 Criteria for assessment of auditory injury and TTS in marine mammals (NOAA, 2018)

NMFS (2016)	Unweighted SPL_{peak} (dB re 1 µPa)	Weighted SEL_{cum} (dB re 1 µPa²s)	
	Auditory injury (PTS)	Auditory Injury (PTS)	TTS (Temporary Threshold Shift)
Low-frequency (LF) cetaceans	219	183	168
Mid-frequency (MF) cetaceans	230	185	170
High-frequency (HF) cetaceans	202	155	140
Phocid Pinnipeds (PW) (Underwater)	218	185	170

The group-specific frequency weightings account for the fact that marine mammals do not hear equally well at all frequencies within their functional hearing range. Noise levels are M-weighted to deemphasize frequencies that are near the lower and upper frequency end of the estimated hearing range, where noise levels have to be higher to result in the same auditory effect. The M-weighting functions are similar in intent to the C-weighting function that is commonly used when assessing the impact of high-amplitude sounds on humans

4.4.3 Zones of Sound Influence

The 'zone of sound influence model' by Richardson et al. (1995) is based, at least partly, on the distance between the source and the receiver; the rationale is that sound intensity falls with increasing distance from the source and therefore impacts are likely to lessen, or at least to change, with distance (WODA, 2013). Richardson et al. (1995) defined a nested series of zones of influence centered on the source (Figure 4-1).

The zone of detection or audibility is the most spatially extensive and is defined by the receiver's ability to detect sound. Itis dependent upon the hearing range and sensitivity of the receiver and on the background sound. Further factors are the frequency of the sound emitted, local conditions such as water temperature, viscosity, density, water depth and bottom conditions as well as the depth at which the signal is generated. Zones of audibility can thus be very variable and since they do not describe an effect per se they have not been dealt with

in more detail here. The zone of masking is the area where sound interferes with the detection of biologically relevant signals such as echolocation clicks or social signals (WODA, 2013). This zone is highly variable.

Given the source noise characteristics, a model that predicts the propagation of sound away from the source, and the noise exposure criteria, the radii within which impacts are expected to occur can be predicted. The resulting radii define zones of impact which are illustrated in Figure 4-1

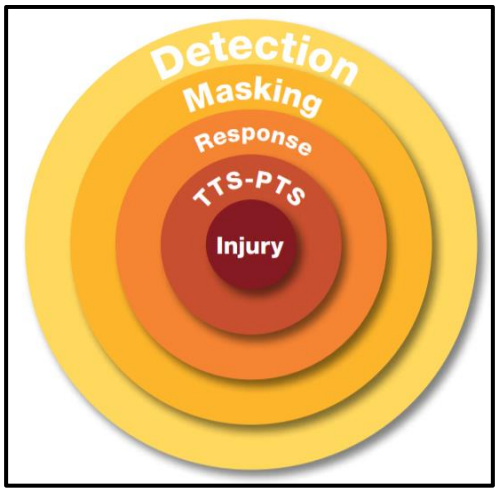

Figure 4-1: Sound impacts (Zones of sound influences after Richardson et al. 1995)

The zone of hearing injury is further divided into temporary and permanent threshold shift (TTS and PTS) zones

The following zones of impact have been defined by Richardson et al. (1995):

- *Zone of audibility* – Area within which marine mammal might hear the source noise but not show any significant behavioural response. The size of the zone of audibility is highly dependent on the ambient noise environment.
- *Zone of responsiveness* – Area within which the considered marine mammal might react behaviourally to the noise source. This zone can be smaller than the zone of audibility as marine mammals usually do not show significant behavioural responses to noises that are faint but audible.
- *Zone of hearing injury* – Area closest to the noise source where the noise levels may be high enough to cause a physiological impact such as TTS or PTS.

The zones of impact define the likely environmental footprint of a noise source and indicate how far away a noise source is expected to have an impact on a marine mammal species, either behaviourally or physiologically. This information, together with information on the biological importance of the marine site as a habitat for the considered species, e.g. breeding, calving or resting areas, or confined migratory routes or feeding areas, is used to assess the likely impact of a noise source.

The way in which sound propagates is influenced by the characteristics of the environment. Factors such as frequency dependent absorption, refraction and reflection alter the way in which sound waves are received by animals and so can influence the overall impact on species.

Sound propagates differently at different water depths due to the way sound waves interact with the acoustic channel boundaries (the sea surface and the sea floor), which results in absorption and reflection (Bailey et al. 2010). Because of these factors, shallow water depths (<20m) cause significant transmission loss, particularly in the lower frequencies where a cut-off effect can result in reduced propagation of certain low frequencies (Brandt et al. 2011). The removal of these low frequency spectra from the noise causes a decrease in energy. This cut-off effect is also influenced by the impedance of the lower boundary layer which will depend on the characteristics of the seafloor sediment (Jensen et al. 2000). The response of marine mammals to pile driving sound is likely to depend on the sound propagation characteristics of the area due to variation in received levels and frequency.

Therefore it is very important to obtain detailed local acoustic data, in addition to data from other research (e.g. Brandt et al 2011).

Variable seafloor topography may result in significant differences in received sound levels among dolphins that are in different directions from the sound source. For example, the occurrence of a sandbank, dredged channel or similar underwater feature can change propagation resulting in high levels of sound absorption, or indeed channelling, which will alter levels received by animals beyond the underwater feature (Richardson et al. 1995; Edren et al. 2004).

The potential impact on marine mammals from piling sounds depends on the level of background noise in the area. Sources such as wave exposure and shipping significantly raise background noise levels. Amoser et al. (2004) demonstrated that background noise in shallow water can be raised by up to 40dB by ships smaller than 60m. With reference to Bailey et al (2010), impulsive sound from pile driving needs to be detectable above the level of background noise in order to be considered detrimental. While this seems logical, bottlenose dolphins can detect sounds below ambient levels, as humans can (see Richardson et al. 1995). The area around Edinburgh Marina Harbour is likely to have high levels of ambient noise due to the ongoing operation of the Port of Leith, large ship visits within the wider Firth of Forth as they travel to Grangemouth etc., maintenance and recreational boating.

Based on averaging sound pressures of port noise over 30 minute windows, Dahl et al (2007) suggest peak pressures can reach 120 dB re 1 µPa at peak frequency in a typical port environment. Sounds from pile driving generally exceed this level of ambient noise. Based on sound pressures that are likely to exceed ambient noise levels and the fact that impulsive sounds a generally more detectable than constant background sound (Richardson et al. 1995) pile driving is likely to be detectable well above the background noise anywhere within Edinburgh Marina Harbour, and potentially beyond.

Edren et al. (2004) showed that during the construction and piling stage of building the Nysted offshore windfarm, there was a 20-60% reduction in the number of seals hauling out at a sandbank 4 km distant. It is likely these seals moved to an adjacent area where the noise from pile driving was less intense. However as the study did not observe the seals' in-water behaviour it was not possible to determine this conclusively. The effect was apparently short-term; seal haul-out behaviour returned to normal after the cessation of pile driving activity (Edren et al. 2004).

4.4.4 Masking

The detection of a sound is limited by the hearing threshold of the ear and the ambient noise at a particular frequency. Pure-tone hearing thresholds are usually below ambient noise levels for a given frequency, meaning increased noise could interfere with the detection of sounds (Madsen et al 2006). This interference is known as 'masking' and is discussed extensively by Richardson et al (1995) in a review of the impacts of anthropogenic sound on marine mammals. The authors describe that the 'zone of masking' is defined as "the range at which the anthropogenic noise adds significant energy to ambient noise in frequency bands that overlap with signals of interest" (Madsen et al. 2006). When loud ambient noise overlaps with signals of interest the probability of detection is decreased due to a lowering in the signal to noise ratio (Madsen et al. 2006).

Madsen et al. (2006) used information about pile driving noise characteristics (sound levels, duration, frequency spectrum and propagation likelihoods) and the acoustic characteristics of four species to assess the degree of potential masking attributable to pile driving noise. The authors suggested that significant masking problems were unlikely for the four species assessed (harbour porpoise, bottlenose dolphin, harbour seal and North Atlantic right whale). It was suggested that because of the short duration and low duty cycle of pile driving sounds there would not be significant interference with the detection of other important sounds. However, because of high received levels, it is possible that pile driving may impair the ability for animals to detect or notice sounds via other means such as neural or muscular contraction or distraction by high pressure levels (Madsen et al.

2006). Dolphins, can "turn down" the sensitivity of their hearing system to avoid damage by loud sounds (e.g. Nachtigall and Supin 2013). During these periods of reduced sensitivity they are less likely to detect the sounds of conspecifics.

Species that do not produce sounds at low frequencies are likely to have less sensitive hearing below 1 kHz. This means the detection of sounds in the low spectrum may be limited by the species hearing threshold rather than ambient noise (Madsen et al. 2006). Species such as harbour porpoise produce no sounds below 1 kHz (Table 4), thus increased ambient noise in the low spectra may not interfere significantly with their sonar. In contrast, fur seals produce sounds as low as 100Hz and so the detection of sounds may be impacted by increased low spectrum noise.

4.4.5 Injury

The high pressure of the impulsive sounds originating from pile driving activity can cause physical damage to marine organisms that are close to the origin of the sound. The zone for this type of impact is called the zone of injury, and is defined as the range over which received sound pressures may cause an animal to suffer from physical injury or loss of sensitivity in its auditory system (Madsen et al. 2006). Short duration sounds with very high peak pressure can cause blast injury in mammals and fish, which typically affects the organs and sensitive aural structures (Richardson et al. 1995). The likelihood of severe blast injury increases with decreasing body size; the peak sound levels required to cause injury are lower in small animals. Noise from pile driving has been demonstrated to result in physical trauma to fish, in particular for sound-producing fish that have sensitive hearing (Anderson 1990; Popper et al. 2006). For marine mammals, damage to aural structures is the primary concern due to their high sensitivity. The zone of injury is distinguished by the range at which hearing sensitivity is lost, ether temporarily or permanently (Richardson et al. 1995). These effects are called temporary threshold shift (TTS) and permanent threshold shift (PTS).

Using estimates of the onset of TTS for non-repeated stimuli (224 dB re 1 µPa and 212 dB re 1 µPa respectively) for cetaceans and pinnipeds, Bailey et al. (2010) found that PTS would have occurred within 5m and 20m for cetaceans and pinnipeds respectively when considering the peak source levels of the piling activity. TTS would have occurred at 10m for cetaceans and 40m for pinnipeds. The authors determined that no form of injury or hearing impairment would have been likely to have occurred beyond 100m, based on a SEL of 166dB re1 µPa2 - S recorded at this distance.

The JNCC guidance[3] defines the mitigation zone as a pre-agreed radius around the piling site prior to any piling. This is the area where a MMO keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected). The extent of this zone represents the area in which a marine mammal could be exposed to sound that could cause injury and will be determined by factors such as the pile diameter, the water depth, the nature of the activities (for example whether drilling will also take place) and the effect of the substrate on noise transmission.

The radius of the mitigation zone should be no less than 500 metres, and this is measured from the pile location. The mitigation zone is calculated following a review of underwater noise modelling; and reflects the risk zones of PTS and TTS for the species of concern, therefore cannot be defined at this time.

[3] JNCC, *Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise* August 2010 http://jncc.defra.gov.uk/pdf/jncc_guidelines_piling%20protocol_august%202010.pdf (accessed 14 September 2018)

4.4.6 Safety zones

The safety zones to be used in the standard management and mitigation procedures for piling activities include observation and shut-down zones. In the observation zone, the movement of marine mammals should be monitored to determine whether they are approaching or entering the shut-down zone. When a marine mammal is sighted within or appears to enter the shut-down zone, piling activities must be stopped as soon as reasonably practical.

The safety zones aim to minimise the likelihood of hearing injury to occur to marine mammals, and do not intend to prevent behavioural responses to audible but non-traumatic noise events. It is likely that marine mammals in the vicinity of a piling activity will show an avoidance reaction to the noise, which reduces the chance of marine mammals approaching the source close enough to enter the zone of hearing injury. The impacts of such a temporary displacement are unlikely to be significant unless it occurs during critical behaviours, such as breeding, feeding and resting, or in important areas such as migratory corridors.

The shut-down zones allow for the cumulative effect of multiple impacts, i.e. in the order of 30 minutes of exposure to pile driving noise for cetaceans and 2 minutes for pinniped. This allows some time to move away from the noise source thereby reducing the likelihood of hearing injury to occur.

Safety zones for impact piling and vibro-driving activities are presented in Table 4-2, together with the estimated zone of behavioural response. The safety zones are sized by comparing expected received noise levels with the following noise exposure thresholds.

- *Impact piling* – Noise exposure threshold is SEL 150 dB(M) re 1 µPa2s for a single impact at either 100 m or 300 m.
- *Vibro-driving* – Noise exposure threshold is SPL 180 dB re 1 µPa at 10 m for cetaceans and SPL 190 dB re 1 µPa at 10 m for pinniped.

Compliance with the noise exposure thresholds may be demonstrated through noise modelling or empirical measurements of a similar piling activity, i.e. similar piling rig and marine environment.

Table 4-2: Summary of safety zones for impact piling and vibro-driving

Species	Noise Exposure Threshold	Observation Zone	Shut Down Zone	Zone of behavioural response
Impact Piling	**SEL in dB(M) re 1 µPa²s for single impact**			
Low-frequency cetaceans	≤ 150 dB(M_{lf}) at 100 m	1 km	100m	≤ 150 m
	≤ 150 dB(M_{lf}) at 300 m	1.5km	300m	≤ 500 m
	> 150 dB(M_{lf}) at 300 m	2km	1km	≤ 3 km
Mid-frequency cetaceans	≤ 150 dB(M_{mf}) at 100 m	1km	100m	≤ 150 m
	≤ 150 dB(M_{mf}) at 300 m	1.5km	300m	≤ 500 m
	> 150 dB(M_{mf}) at 300 m	2km	1km	≤ 3 km
High-frequency cetaceans	≤ 150 dB(M_{lf}) at 100 m	1 km	100m	≤ 150 m
	≤ 150 dB(M_{lf}) at 300 m	1.5km	300m	≤ 500 m
	> 150 dB(M_{lf}) at 300 m	2km	1km	≤ 3 km
Pinnipeds	≤ 150 dB(M_{lf}) at 100 m	1 km	100m	≤ 150 m
	≤ 150 dB(M_{lf}) at 300 m	1.5km	300m	≤ 500 m
	> 150 dB(M_{lf}) at 300 m	2km	1km	≤ 3 km
Vibro-driving	**SPL in dB re 1 µPa for single impact**			
Cetaceans	≤ 180 dB at 10 m	500m	10 m when no avoidance	**≤ 5 km**
	> 180 dB at 10 m	1km	100 m when no avoidance	**≤ 10 km**
Pinnipeds	≤ 190 dB at 10 m	500m	10 m when no avoidance	**≤ 5 km**

	> 190 dB at 10 m	1km	100 m when no avoidance	**≤ 10 km**

5 UNDERWATER SOUND AND THE FIRTH OF FORTH

5.1 Introduction

Marine construction noise associated with noise generated during construction at Edinburgh Marina will likely be in the audible frequency range of sea mammals and fish. Acoustic impacts will occur due to the noise generated by vessel operations, dredging, placement of rock armour and piling. It is anticipated that construction generated noise will be intermittent.

Vessel movements are predicted to be highest during the excavation of the marina basin, construction of the quay wall, extension of North Mole, and placement of rock armour.

Intensity will vary during this period but will peak during the dredging, piling and placement of armour when the noise generated by these activities will combine with that of construction vessel e.g. tenders, survey and vessels.

Excavation of sediment will be carried out with a backhoe dredger which will work for approximately three months on site. Rock placement will most likely be undertaken from the shore using terrestrial plant.

The following discusses examples of underwater noise generated from marine plant during construction. Measurements of noise from a working trailer suction hopper dredger indicated that, whilst dredging, a sound level of 120 to 140 dB was recorded underwater (Clarke et al 2004)[4].

Measurement of sound during construction work (drilling and excavation) in Fraserburgh Harbour for example, recorded a mean sound level (SL) of 177.8 dB/µPa/m (Urquhart and Hall 2005)[5]. In the same study the peak SL recorded during rock blasting was estimated as 246.4 dB (relative to 1 µPa at 1 m) and the rms level for the whole 3.8 s period of the double blast as 238.1 dB.

Blasting ***is not anticipated*** as part of this project.

5.2 Construction Activities

The sources of noise during the construction phase will be:

1. Internally located engines, which produce relatively strong sounds that are transferred through the ship's hull to the water. These sounds will, in general, be continuous and relatively constant with respect to frequency and intensity depending on the type of engine;
2. Various configurations of winches, generators, and hydraulic equipment specific to the dredger; and
3. The action to remove the substrate from the seabed and deposit the material in the attending barge. Removal will be by backhoe dredging methods.
4. Sheet Piling associated with the construction of the quay wall

Points 1 and **2** above are typical of underwater noise produced on a daily basis within the harbour as a result of various harbour activities. The dredging programme associated with the works at Edinburgh Marina is scheduled to last three months.

[4] Clarke D, Dickerson C., Reine K. 2004 Characterisation of Sounds Produced by Dredgers US Army Corps of Engineers
[5] Urquhart D. and Hall C. 2005 A study of underwater noise generated during civil engineering works at Fraserburgh Harbour. Fisheries Research Services Collaborative Report No 07/05

With reference to **Point 3**, research has indicated that it is unlikely that underwater sound from dredging operations can cause injury to marine mammals[6]. Dredging and its associated noise are predominantly of low frequency likely between 20 Hz to 80 kHz. This may affect low and mid frequency cetaceans such as minke whales and bottlenose dolphins to a greater extent than high frequency cetaceans such as the harbour porpoise. Harbour and grey seals have relatively good underwater hearing at frequencies between 8 and 25 kHz[7], with acute hearing also at lower frequencies and will detect the continuous noise of dredging for the duration of works. Behavioural responses by cetaceans and pinnipeds can be anticipated anywhere within the zone of audibility, which varies according to the audible range of the target species. The main reaction from cetaceans and pinnipeds to dredging is likely to be avoidance during the works, although research has shown some cetaceans tolerating dredging activity.

The effects of dredging noise are anticipated to be temporary, negative (i.e. cause avoidance behaviour in cetaceans and pinnipeds), of low to moderate magnitude, of high probability and of no significance. The confidence in the prediction is near certain.

There is a greater probability that Atlantic salmon and sea trout could be affected by increased decibels in the low frequency range. Research shows that salmon are most sensitive to low frequencies around 50kHz and are unaffected by frequencies greater than 800kHz. Dredging activities are likely to operate between 20Hz to 80 kHz[54] so within the most sensitive auditory range for salmon and sea trout. Based on Wodan 2011, a full dredging cycle can emit a sound power level of up to 125dB although only a percentage of this noise will be emitting underwater, it represents a worst case scenario[8].

Atlantic salmon adults and kelts are certain to be affected if they are within 20m of the dredging activity as at 90 dBht Atlantic salmon (adults and kelts) will avoid loud noise and dredging is likely to reach up to 125db. At the predicted 125db level, if salmon or sea trout come within 8m of the dredger they may be subject to lethal or sublethal injury. However, the noise level over the width of the river would be below the 90 dBht criterion[9], therefore, while dredging may have some effect on the movement of salmon, it is unlikely to have the effect of blocking the river for migrating fish.

Temporary loss of normal hearing capabilities could happen if individuals are in the immediate vicinity of a dredger and are exposed for a long time. This is unlikely as behavioural reactions, such as startle or avoidance and likely to stimulate individuals to move away from the noise source. Given that the dredging activity will be conducted out with the peak periods of smolt runs through the Firth of Forth the potential effects are further diminished. The effects on salmon and trout will be temporary, negative (i.e. causing avoidance behaviour), the magnitude of the impact is considered to be moderate, with high probability and overall the impact is of no significance. The confidence in the prediction is near certain.

With reference to **Point 4**, the high pressure of the impulsive sounds originating from pile driving activity can cause physical damage to marine organisms that are close to the origin of the sound. The zone for this type of impact, the zone of injury, is defined as the range over which received sound pressures may cause an animal to suffer from physical injury or loss of sensitivity in its auditory system (Madsen et al. 2006). Piling is expected to last between 3-6 months.

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[6] Central Dredging Association (CEDA) (2011) Underwater Sound in Relation to Dredging, Position Paper – 7th November 2011.

[7] Frank Thomsen, Sophy McCully, Daniel Wood, Federica Pace and Paul White (2009) Marine Aggregate Levy Sustainability Fund (MALSF) A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters with particular emphasis on aggregate dredging: PHASE 1 Scoping and review of key issues MEPF Ref No. MEPF/08/P21

[8] Intersona report: concerning sound power level measurements backhoe dredger 'Wodan' on 28th October 2011.

[9] J R Nedwell, A G Brooker, D Cummins, S T Cheesman and J Lovell (2008) Subsea noise impact modeling in support of piling operations at Torry Quay, Aberdeen Harbour and assessment of effects on marine mammals and fish, Subacoustech Environmental Report No. 829R0133 - 90 dBht (species) – Strong avoidance reaction by the majority of individuals. 0–50 dBht (species) – Low likelihood of disturbance

Short duration sounds with very high peak pressure can cause injury in mammals and fish, which typically affects the organs and sensitive aural structures (Richardson et al. 1995). The likelihood of severe blast injury increases with decreasing body size; the peak sound levels required to cause injury are lower in small animals. Noise from pile driving has been demonstrated to result in physical trauma to fish, in particular for sound-producing fish that have sensitive hearing (Anderson 1990; Popper et al. 2006). For marine mammals, damage to aural structures is the primary concern due to their high sensitivity. The zone of injury is distinguished by the range at which hearing sensitivity is lost, ether temporarily or permanently (Richardson et al. 1995). These effects are temporary threshold shift (TTS) and permanent threshold shift (PTS).

Using estimates of the onset of TTS for non-repeated stimuli (224 dB re 1 µPa and 212 dB re 1 µPa respectively) for cetaceans and pinnipeds, Bailey et al. (2010) found that PTS would have occurred within 5m and 20m for cetaceans and pinnipeds respectively when considering the peak source levels of the piling activity. TTS would have occurred at 10m for cetaceans and 40m for pinnipeds. The authors determined that no form of injury or hearing impairment would have been likely to have occurred beyond 100m, based on a SEL of 166dB re1 µPa2 - S recorded at this distance.

The potential impact on marine mammals from piling sounds depends on the level of background noise in the area. Sources such as wave exposure and shipping significantly raise background noise levels. Amoser et al. (2004) demonstrated that background noise in shallow water can be raised by up to 40dB by ships smaller than 60m. With reference to Bailey et al (2010), impulsive sound from pile driving needs to be detectable above the level of background noise in order to be considered detrimental. While this seems logical, bottlenose dolphins can detect sounds below ambient levels (Richardson et al. 1995). The area around Edinburgh Marina Harbour is likely to have high levels of ambient noise due to ongoing operations at the harbour and the wider area including the Port of Leith, large ship within the wider Firth of Forth as they travel to Leith, Grangemouth, Rosyth etc., recreational boating and industrial operations.

Sounds from pile driving generally exceed this level of ambient noise. Based on sound pressures that are likely to exceed ambient noise levels and the fact that impulsive sounds a generally more detectable than constant background sound (Richardson et al. 1995) pile driving is likely to be detectable above the background noise anywhere within Edinburgh Marina Harbour, and potentially beyond.

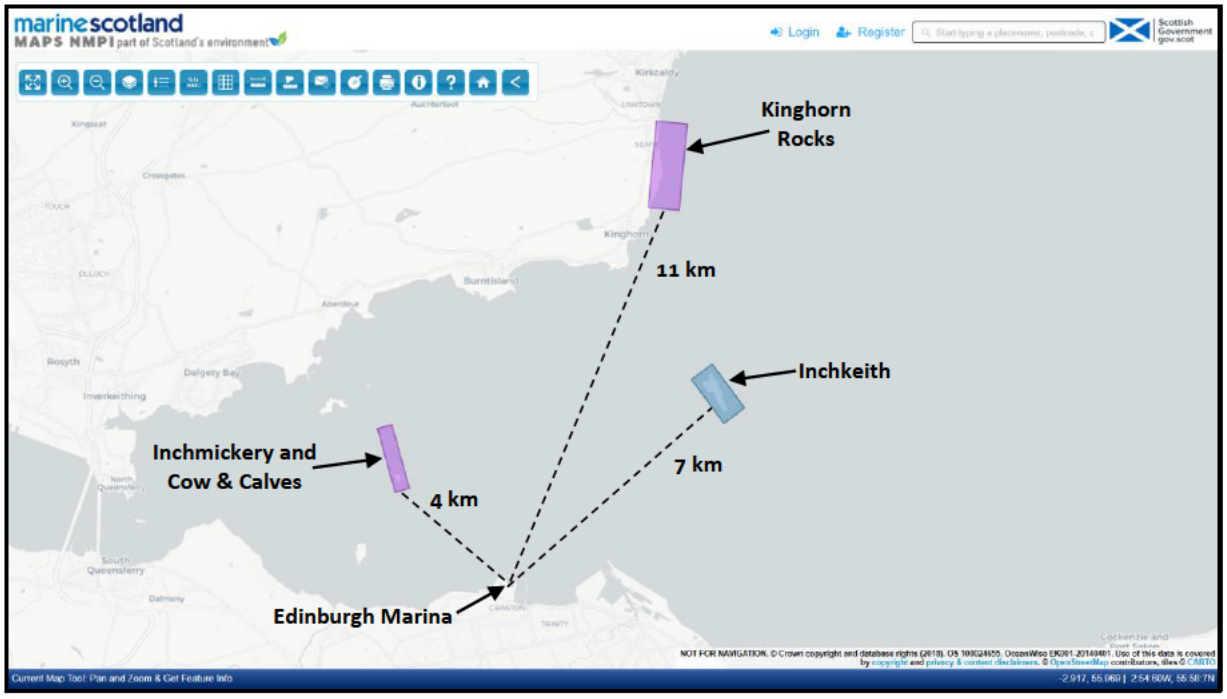
Edren et al. (2004) indicates that during the construction and piling stage of building the Nysted offshore windfarm, there was a 20-60% reduction in the number of seals hauling out at a sandbank 4 km distant. It is likely these seals moved to an adjacent area where the noise from pile driving was less intense. However as the study did not observe the seals' in-water behaviour it was not possible to determine this conclusively. The effect was apparently short-term; seal haul-out behaviour returned to normal after the cessation of pile driving activity (Edren et al. 2004). Within the Firth of Forth it is likely that seals and other marine mammals are habituated to high noise levels as substantial sources of noise have been present historically due to ongoing port and industrial operations within the area.

Seals use haul-out sites for a range of purposes including breeding, resting and moulting (SCOS, 2009). There are three designated haul-out sites for Grey and Common/Harbour Seals within 11km of Edinburgh Marina[10]:

- Inchmickery and Cow & Calves (~3.7km NW in a direct line);
- Inchkeith (~7km NE in a direct line);
- Kinghorn Rocks (~11km NE in a direct line);

[10] https://marinescotland.atkinsgeospatial.com/nmpi/default.aspx?layers=446

Figure 5-1: Seal haul out sites- Firth of Forth



Madsen et al (2006) defines the zone of injury from repetitive pile driving noise to extend to a range where the sound level has dropped to 180 dB re 1 µPa (RMS) for whales and dolphins and 190 dB re 1 µPa (RMS) for seals.

JNCC guidance[11] defines the mitigation zone as a pre-agreed radius around the piling site prior to any piling. This is the area where a MMO keeps watch for marine mammals (and delays the start of activity should any marine mammals be detected). The extent of this zone represents the area in which a marine mammal could be exposed to sound that could cause injury and will be determined by factors such as the pile diameter, the water depth, the nature of the activities (for example whether drilling will also take place) and the effect of the substrate on noise transmission.

The radius of the mitigation zone should be no less than 500 metres, and this is measured from the pile location. The mitigation zone is calculated following a review of underwater noise modelling; and reflects the risk zones of PTS and TTS for the species of concern, therefore cannot be defined at this time. The above noted seal haul-out sites are therefore out with the 500m zone.

5.3 Behavioural Effects

Pile driver noise could interfere with environmental sounds that cetaceans and seals listen to and underwater noise could startle or displace animals and prey as discussed above. Data analysed as part of an offshore wind development reported that – as a result of piling activities - harbour porpoises either avoided the construction area to a large extent or the animals used their echolocation signals much less due to noise from construction activities (Carstensen et al (2006)[12]. A review of noise effects of piling on harbour porpoise by (Thompson et al 2006) indicated that mild behavioural reactions can be expected to occur between 7 and 20 km distant from piling activity. At 9 kHz, pile driving noise is capable of masking strong vocalisations within 10–15km and weak vocalisations up to approximately 40 km (David 2006)[13].

[11] http://jncc.defra.gov.uk/pdf/jncc_guidelines_piling%20protocol_august%202010.pdf (accessed 14 September 2018)
[12] Carstensen J, Henriksen OD and Teilmann J (2006). *Impacts of offshore wind farm construction on* harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs) Marine Ecological Press Series, Vol. 321: 295–308
[13] David J.A (2006) Likely sensitivity of bottlenose dolphins to pile-driving noise. Water and Environment Journal 20 p48-54

The masking radius reduces as the frequency increases: 6 km at 50 kHz and 1.2km at 115 kHz. The impacts of masking are expected to be limited by the intermittent nature of pile driver noise which in this case will be greatly reduced due to the design and piling method, the dolphin's directional hearing, their ability to adjust vocalisation amplitude and frequency, and the structured content of their signals. Startle response due to sudden noise (e.g. from rock placement) cannot be discounted but is likely to be intermittent, occasional and of low importance.

Seals are not as sensitive to noise as cetaceans. Like cetaceans, seals use noise to communicate and to identify prey (by listening for prey generated noise) but they do not echolocate. Götz (2008)[14] identified that seals become habituated to continuous noise sources but are most affected by sudden noise which causes a startle response. Seal calls are however in the same frequency band as some construction generated noise and masking of seal calls is therefore possible.

Potentially seals may detect source level of 175 dB re 1µPa @ 1m at distances of 1.4 km to 2.9 km in low ambient noise conditions (Terhune et al. 2002)[15] although at these distances the sound it not likely to be sufficient to cause a startle response.

Based on the above behavioural effects on individual cetaceans and seals is estimated to be confined to the duration of the construction operations and be intermittent. The most significant effects will be for animals that are within 500 m of the site. In addition the area where the most severe noise effects will occur is not recognised to be of particular importance for seals or cetaceans.

5.4 Summary of Impacts

The period of most intense noise is predicted to occur during the dredging of the marina basin and construction of the quay wall and extension to the breakwater.

In line with the findings of CEDA (2011), noise associated with dredging is unlikely to be significant and will not cause injury to marine mammals or fish.

This piling program will generally be confined to the period between 0700 and 1900. During this time most of the piling will be over a comparatively short period of impact piling for every pile. The most significant underwater noise impact will therefore be intermittent and last for approximately three months.

However, there is the potential for piling noise to affect cetaceans and migratory fish. For cetaceans such effects are predicted to only affect a small number of animals due to the low significance of the area. However the high value of these species justifies some mitigation as outlined in section 6. Whilst there may be effects on seals, this area is not recognised as being of specific importance for seal species. In addition they are less sensitive to noise than cetaceans. The development area is considered to be of any particular importance for salmonids during the run however this period will be avoided.

Although there is the potential for species such as salmon and trout to be affected, the study area is not recognised as being an important fish breeding or nursery area, and it is likely that fish will adopt avoidance behaviour for the duration of noisy activities.

Once the construction is completed fish species will repopulate the area and so the impacts will be short term, intermittent and negligible. Noise during operation will be confined to intermittent vessel engine noise and maintenance dredging.

[14] Götz, T., 2008 Aversiveness of sound in marine mammals : Psycho-physiological basis, behavioural Correlates and potential applications. Phd Thesis University of St Andrews

[15] Terhune, J.M., Hoover, C.L. & Jacobs, S.R. (2002) Potential detection and deterrence ranges by harbour seals of underwater acoustic harassment devices (AHD) in the Bay of Fundy, Canada. Journal of the World Aquaculture Society, 33, 176-183.

The effects of noise are therefore predicted to be Intermittent and most severe locally although of potentially some relevance over a moderate extent (e.g. 1 km from the marina) if however sensitive species such as pinnipeds, cetaceans salmon / trout are present the effects could be of moderate magnitude. In recognition of the importance of these species mitigation will be implemented as outlined in Section 6.

6 MANAGEMENT AND MITIGATION PROCEDURES

Planning of piling activities

The planning stage of piling activities should consider the following:

- *Timing and duration* – Avoid conducting piling activities during times when marine mammals are likely to be breeding, calving, feeding, or resting in biologically important habitats located within the potential noise impact footprint.
- *Piling method* – Use low noise piling methods, such as vibro-piling, instead of impact piling methods where possible. Vibro-piling methods produce lower noise levels and are not impulsive in character. This reduces the likelihood of hearing injury to occur within marine mammals. The piling method should be optimised taking into account time on-site and likely noise levels.
- *Soft start* - The use of a 'soft start' or 'ramping up' process, in which pile driving energy is gradually increased to normal operating levels, gives nearby animals an opportunity to vacate the area before sound levels increase to an extent that may cause injury. There is some concern that this technique may actually attract animals, and so should be used with this is mind and always with trained marine mammal observers present (Jefferson et al. 2009). Also, it is likely that behavioural changes and possibly masking will still occur for nearby animals (Madsen et al. 2006).
- *Contract documentation* – Include the standard management and mitigation procedures, and any additional measures to be put in place, in the contract documentation.
- *Trained team* – Ensure that a suitably qualified person is available during piling activities to conduct the standard operational procedures outlined below. A suitably qualified person should have qualifications in ecology or environmental sciences and demonstrated experience with the identification and management of marine mammals. A briefing on environmental matters, including information on guidelines, marine mammal identification and legal obligations should be provided to all staff involved in the piling activities. Likely marine mammal concentration areas, key feeding sites, and other aggregation areas should be identified during the planning stage and this information should be provided to trained team members and the marine mammal observer to improve the identification and observation of marine mammals.
- *Bubble curtains* - Demonstrated to significantly lower both pile driving sound pressure levels and peak frequencies (Würsig et al. 2000; Jefferson et al. 2009). Typically a bubble curtain consists of a perforated hose that is anchored to the sea floor around the area where piling is taking place. Compressed air is pumped through the hose and a 'curtain' of bubbles produced. Bubble screens can reduce the sound pressure levels up to a biologically significant 25dB in the frequency range of concern for marine mammals (Jefferson et al. 2009). Other variations of bubble curtains such as screens and jackets are commonly used to reduce pile driving noise at offshore wind-farms (Evans 2008) and are worth considering.

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