REPORT

Boston Alternative Energy Facility

Chapter 17 Marine and Coastal Ecology and Appendix 17.1 Habitats Regulations Assessment Update

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1 Introduction

1.1.1 This report provides updated information to inform Chapter 17 of the Environmental Statement (ES) Marine and Coastal Ecology (document reference 6.2.17, APP-055) and Appendix 17.1 Habitats Regulations Assessment (HRA) (document reference 6.4.18, APP-111) undertaken for the Boston Alternative Energy Facility (BAEF) ('the Facility'). The information should be read alongside these documents as it builds on information already provided.

1.1.2 The topics covered by this report relate to questions that have arisen throughout the Development Consent Order (DCO) process (including during the environmental hearing on the 24th November 2021 and through questions raised by interested parties during the examination process) that require further explanation relating to ornithological information and are summarised as follows:

- Presence of breeding redshank within the area and potential for impact;
- Presence of common tern within the area and potential for impact;
- Connectivity potential for the area of The Haven between the proposed Facility and the mouth of The Haven, and the Principal Application Area;
- Assessment of potential for effect on the waterbird assemblage in its own right at the mouth of The Haven;
- Potential for lighting from the Facility to affect foraging and roosting birds; and
- Disturbance events and energy usage by birds.

1.1.3 These topics are dealt with in the sections below.

2 Presence of breeding redshank within the area and potential for impact

2.1 Questions raised relating to breeding redshank

2.1.1 A question has been raised regarding the presence of breeding redshank at the Application Site during the latter stages of the consultation process. The question raised is outlined below in **Table 2-1**.

Table 2-1 Comments raised by RSPB (REP2-051) regarding breeding redshank

Interested Party	Question or comment	AUBP Response at Deadline 1	RSPB's Comment	AUBP's Response
Comments on the Applicant's response to the RSPB's Relevant Representation (REP2-051)				
Royal Society for the Protection of Birds (RSPB) ES Chapter 17 (Marine and Coastal Ecology/HRA)	The potential impacts of the application could compromise the ability to restore the breeding redshank population of The Wash SSSI and the maintenance of the non-breeding population of The Wash SPA/Ramsar.	The Applicant does not consider the conservation objectives for redshank will be compromised. Site-specific issues are not identified as key drivers for changes to the redshank population of The Wash based on WeBS Alerts.	We disagree with the Applicant's position. We highlight how the breeding redshank population of The Wash has declined and the uncertainty over the drivers of change in our Written Representation (Section 3(i), REP1-060) and provide more detailed comments on this in our response to the Ornithology Addendum.	Breeding redshank are not likely to be significantly affected by the proposed project. The reasons for this response are provided below in **Section 2.2**.

2.2 Technical information relating to potential for vessel disturbance to breeding redshank within The Wash Site of Special Scientific Interest

2.2.1 Breeding redshank is not a qualifying interest of The Wash Special Protection Area (SPA). For this reason the potential for impact on The Wash breeding redshank qualifying interest was not considered in the HRA report (document reference 6.4.18, APP-111) or ES Chapter 17 - Marine & Coastal Ecology and Appendix 17.1 - HRA: Ornithology Addendum (document reference 9.13, REP1-026, hereafter 'the HRA addendum'). However, breeding redshank is a qualifying feature of The Wash Site of Special Scientific Interest (SSSI) and therefore assessing potential impacts on their breeding regional population is relevant to the Environmental Impact Assessment (EIA) assessment required for the proposed Facility.

2.2.2 The 'Note on Breeding Redshanks on The Wash' (RSPB, 2021, REP3-034), submitted at Deadline 3 provides a comprehensive background information on the status and breeding ecology of locally breeding redshank. This note highlights the poor conservation status of saltmarsh breeding redshank in England.

2.2.3 It is relevant to point out that the redshank that overwinter in The Wash (and are a qualifying feature of The Wash SPA) are to a large extent different individuals and far greater in number than the redshank that breed locally to The Wash. Indeed, it is estimated by Natural England that only between 6 and 10% of The Wash non-breeding redshank population (i.e. The Wash wintering population) comprise locally breeding birds (as stated in RSPB, 2021). Information on the proportion of local breeders that remain in The Wash through the winter and the proportion that move elsewhere are not known precisely. However, there is a good basic knowledge of this species movement patterns gained through bird ringing (Wernham *et al*., 2003).

2.2.4 During the breeding season (approximately mid-March to mid-July) redshank largely change habitat. The redshanks that overwinter in The Wash generally move to areas of breeding habitat up to a few 100km away. These are mostly located in eastern England, but also further afield in north west England and Scotland. Breeding habitats include saltmarsh, lowland wet grassland, and traditionally managed rushy upland pastures. Locally, saltmarsh and lowland wet grassland habitats within and around The Wash saltmarshes provide habitat for large numbers of breeding redshank with a total of 2,353 pairs estimated in the 2011 National Saltmarsh Redshank Survey (Malpas *et al*., 2011).

2.2.5 The Wash SSSI includes extensive areas of saltmarsh but does not include appreciable areas of other types of redshank breeding habitats. Lowland wet grassland is also used for breeding locally (e.g., at the RSPB Freiston Shore and Frampton Marsh reserves). The RSPB managed lowland wet grassland areas lie behind the seawall and mostly therefore outside The Wash SSSI boundary. When breeding, redshanks are loosely territorial and individual birds will largely confine their activities to their territory. The territories of local breeding birds will be approximately evenly spread across suitable breeding habitat.

Assessment

2.2.6 The proposed Facility could potentially impact on breeding redshank through loss or change to breeding habitat and through disturbance of feeding birds by vessels transiting The Haven.

Habitat loss/change

2.2.7 The proposed Facility would lead to habitat loss/ change along a short length of The Haven alongside Principal Application Site (Area A, **Figure 2-1**) due the development of the wharf facilities there. There would also be habitat management measures at the adjacent ground (Area B, **Figure 2-1**) undertaken to benefit waterbirds. Baseline breeding bird surveys of these areas (red-line boundary of the Principal Application Site plus Areas A and B) undertaken in 2020 and 2021 showed that there were no breeding redshank there (Bentley, 2020 and 2021). The absence of breeding redshank in Areas A and B was in line with expectations, given that the remnant saltmarsh habitat there is considered to be in poor condition (ES Chapter 17 Marine and Coastal Ecology (document reference 6.2.17, APP-055), is isolated from other redshank breeding habitat and covers only a small area (a few hectares). It is concluded that habitat loss and change impacts at the Principal Application Site (Area A) and adjacent habitat mitigation site (Area B) would have no adverse effect on breeding redshank due to the lack of use of these areas.

2.2.8 It is possible that habitat net gain/mitigation/compensation measures undertaken elsewhere to address the issue of vessel disturbance to roosting birds, could lead to habitat change to areas used by breeding redshank. The process of identifying and securing sites for such net gain/habitat mitigation/compensation measures takes into consideration the existing nature conservation value. The future management aims for the sites will include ensuring that their value to breeding redshank (if any) is no less than it is under baseline conditions. Although the focus of the habitat management at the net gain/mitigation/compensation sites is likely to be on providing new high-tide roost sites for waterbirds, this aim is not considered to be incompatible with the same site also delivering enhanced

potential for breeding redshank. RSPB has demonstrated this through its habitat management at its Freiston Shore and Frampton reserves.

Figure 2-1 Environmental Statement Figure 17.8, Bird survey area A (blue dashed boundary), area B (black dashed boundary), order limit of Principal Application Site (red line) including Habitat Mitigation Area (smaller red-line boundary within area B).

2.2.9 It is concluded that habitat net gain/mitigation/compensation measures that may be undertaken away from the Principal Application Site are not likely to adversely affect breeding redshank. Rather the habitat management at these sites could potentially enhance the value of a site for breeding redshank. However, any such gains are likely to be small in the context of the overall number of redshank breeding locally to The Wash. This is because the size of the net gain/mitigation/compensation sites is anticipated to be relatively small and redshank breed at relatively low density (typical breeding densities on saltmarsh are between approximately 30 and 60 pairs per km^2, Malpas *et al*., 2011), thus at best the habitat measures would be expected to benefit only a few breeding pairs.

2.2.10 It is concluded that there is only a very small potential for breeding redshanks to be adversely affected by habitat loss/change due to the proposed Facility. Therefore, for habitat loss/change it is judged to be an impact of negligible magnitude and not significant.

2.2.11 It is also concluded that habitat net gain/mitigation/compensation measures aimed primarily to address the vessel disturbance of roosting non-breeding waterbirds could also provide opportunities to benefit breeding redshank. However, the potential magnitude of any such gain to breeding redshank is likely to be relatively small because of the relatively small size (in the context of the size of breeding territories) of net gain/mitigation/compensation sites.

Vessel disturbance

2.2.12 The proposed Facility will lead to an increase in vessel transits along The Haven during the high tide period when compared to current levels. This is predicted to lead to an increase in the frequency of disturbance of birds that use areas in close vicinity to The Haven during the high tide period, in particular roosting waders.

2.2.13 Breeding redshank distribute themselves across the suitable breeding habitat at relatively low densities (compared to wintering redshank). In the case of The Wash, the habitats used by redshank for breeding are the extensive areas of saltmarsh and wet coastal grassland, where typical breeding densities are between approximately 30 and 60 pairs per km^2. It is possible that redshank breeding on the saltmarsh habitat that is within approximately 150m of The Haven shipping channel at the time a vessel passes could show a short-term disturbance response (disturbance distance based on information in Goodship & Furness 2019, and Cutts *et al*., 2013). However, this could affect only a very small proportion of breeding redshank because only a small proportion (well below 1%) of The Wash redshank breeding habitat lies close to The Haven shipping channel.

2.2.14 During the low tide period, breeding redshank may feed on exposed intertidal mud that lies within approximately 1 km of their breeding territory. Thus, redshank breeding within approximately 1 km of The Haven are likely to use the exposed intertidal mud along The Haven for feeding. However, because these birds would be feeding there only during the low tide period (when the feeding habitat is exposed) they are not likely to be subject to disturbance by vessels transiting The Haven around the high tide period (the only time that the large vessels are able to transit due to depth restrictions).

2.2.15 It is concluded that there is only very small potential for breeding redshanks to be affected by disturbance caused by vessel movements associated with the Proposed Facility. Therefore, it is judged to be an impact of negligible magnitude and not significant. Turning to the likelihood of indirect, carryover effects of winter disturbance caused by vessel movements to the wintering population, on subsequent breeding in redshanks on The Wash SSSI, it is similarly concluded that vessel disturbance during the non-breeding period will have a negligible effect on the breeding redshank feature of the Wash SSSI. As detailed in Appendix A1 of the HRA Addendum, vessel disturbance is concluded not to adversely affect the non-breeding redshank feature of The Wash SPA/Ramsar/SSSI. Local breeding birds form only a very small percentage of this non-breeding population as detailed above and are likely to be distributed evenly throughout The Wash Embayment in winter periods.

3 Presence of common tern within the area and potential for impact

3.1 Potential concern raised with regard to common tern

3.1.1 The RSPB raised a concern during the Issue Specific Hearing on November 24th 2021 regarding the presence of common tern that have been observed breeding on the RSPB reserve at Frampton Marshes and Freiston Shore. Prior to this the presence of common tern was not known from any records for The Haven area other than one record of 10 birds being disturbed by a vessel on the 25th June 2021, during the waterbird behaviour surveys undertaken specifically for the project. As a result of this, further work has been undertaken to investigate the potential for effects on this species. The technical information is provided in **Section 3.2** below.

3.1.2 The questions raised by RSPB relating to common tern are outlined below in **Table 3-1**.

Table 3-1 Comments raised by Interested Parties regarding common tern

Interested Party	Question or comment	AUBP Response
Summary of Comments on Issue Specific Hearing 2: Environmental Matters of the RSPB (REP3-035)		
RSPB (Paragraph 3.16)	In response to the Applicant's query about whether the common terns breeding within or outside The Wash SPA boundary, we confirmed that they are breeding adjacent to The Wash SPA boundary and functionally linked to The Wash SPA. We can provide more detail at Deadline 4.	The potential for impacts on common tern relating to the proposed project are discussed further below in **Section 3.2**.
Final comments on the Ornithology Addendum for the RSPB (REP4-026)		
RSPB (Paragraph 1.4)	The failure to account for at least 50% of The Wash SPA population of common terns breeding at Freiston Shore and Frampton Marsh. Thus, the closest breeding colonies are no more than c.3.5km from the mouth of The Haven, not 20-30km as stated in the addendum.	This was new information submitted at the hearing in November 2021. The potential impact has been discussed below in **Section 3.2**.
RSPB (Paragraphs 2.23 and 2.24)	<u>f) Failure to collect two full years of ornithological data</u> We note that Section 3.4 of the addendum stresses that, with respect to the mouth of The Haven, "…observation sessions have been completed over two winter seasons: November to March of winter 2019/20, and January to March of winter 2020/21." Whilst some data have been collected in both winters, this is not the same as data over two full years. No data were collected for October to December 2020. Limited survey effort of the autumn and spring passage periods have also been completed. Observations completed between May and July 2021 amounted to three surveys and did not account for late July and August when significant numbers of features such as common tern are known to occur from the WeBS data presented by the Applicant (see Section 3(m) below for more comments on how common terns have failed to be adequately assessed in the HRA). We therefore disagree that two winters worth of data has been collected, or that two full years of ornithological data have been collected. This would appear an unusual situation for a Nationally Significant Infrastructure Project and especially	Two years of overwintering and spring passage data have been collected and provided to the Stakeholders for review as they became available from the surveyor prior to and during the examination process. One year of autumn passage data has also been collected and submitted and shows lower numbers of birds during this period which was expected. The presence of common tern outside of the SPA was not known until the November 2021 issue specific hearing. This data has been requested through the formal channels with RSPB, as requested by RSPB. In light of this, an assessment has been carried out on the potential for impact on common tern outside of the SPA and is reported in **Section 3.2.**

Interested Party	Question or comment	AUBP Response
	one that could have an adverse effect on integrity to sites within the National Site Network.	
RSPB (Paragraphs 2.63 to 2.65)	p) Disagreement with species that have been scoped out of the Appropriate Assessment Paragraph 5.3.4 (pp.42-43) of the addendum states that common tern is scoped out as the Applicant considers there to be no breeding colonies close to The Haven, although the addendum appendix indicates that common tern is scoped-in to the assessment. Irrespective of this discrepancy, this statement in the addendum is incorrect as c.39% of The Wash SPA population of common terns bred at RSPB Freiston Shore and RSPB Frampton Marsh in 2021 (see section 3(m) below for more detail). Common terns were also observed to be disturbed at the mouth of The Haven by vessels during surveys, however, the surveys did not assess numbers of birds or how many were disturbed by vessel movements in late July and through August when peak numbers of birds have been recorded during WeBS counts (addendum appendix, p.152). Whilst paragraph 5.3.4 suggests that birds using the area at the end of the breeding season may be from other colonies, this has not been quantified. In addition, the UK SPA Review 2001 site account states that: *"Note that sites selected for waterbird species on the basis of their occurrence in the breeding, passage or winter periods also provide legal protection for these species when they occur at other times of the year."* Whilst features may occur outside the main season for which they are listed as a feature, they are therefore afforded protection at other times of the year. This applies to not just common terns but all other qualifying features, such as redshanks and oystercatchers that occur year-round on The Wash.	The presence of common tern outside of the SPA was not known until the November 2021 hearing. This data has been requested through the formal channels with RSPB, as requested by RSPB. In light of this, an assessment has been carried out on the potential for impact on common tern outside of the SPA and is reported in **Section 3.2** of this document.
RSPB (Paragraphs 3.54 to 3.59)	m) Disagreement with the HRA conclusion regarding common tern We disagree that there would not be an adverse effect on integrity beyond reasonable scientific doubt on common tern.	The presence of common tern outside of the SPA was not known until the November 2021 hearing. This data has been

Interested Party	Question or comment	AUBP Response
	The Addendum Appendix states that: *"The closest [sic] breeding colonies within the Wash SPA are located on the east coast of the Wash between approximately 24 and 30 km from the MOTH."* This is not the case. Common terns breed at both RSPB Freiston Shore and RSPB Frampton Marsh, having done so since annually since 2005, and are located c.3km and c.3.5km from the mouth of The Haven. We are happy to share our data with the Applicant and have presented the latest breeding figures and 5-year means for the reserves in Table 1. We know that the birds will move between sites and if birds fail they can relocate to the other reserve to relay. For analysis purposes, we therefore recommend that the combined breeding figures would be most appropriate. Whilst we have provided the latest breeding figures, there have been up to 126 pairs breeding at RSPB Freiston Shore, with the highest 5-year mean for this reserve being 105 pairs. For RSPB Frampton Marsh, the highest 5- year mean has been 43 pairs. These reserves are therefore highly important in supporting The Wash SPA population of common tern. Table 1: The tables below present the common tern data from RSPB Freiston Shore and RSPB Frampton Marsh. Data are presented according to A) the number of pairs recorded breeding on the reserves in 2021 and B) the 5-year mean number of pairs breeding on the reserves. The proportion of The Wash SPA is presented. It should be noted that The Wash Ramsar population of common tern is 152 pairs. **A) RSPB Reserve** / **Number of pairs (Adults on Nests) in 2021** / **% of The Wash SPA population (based on 220 pairs)** / **% of the latest WeBS 5-year peak mean (based on 583 pairs)** Freiston Shore / 65 / 29.5 / 11.1 Frampton Marsh / 20 / 9.1 / 3.4 Combined / 85 / 38.6 / 14.6 **B) RSPB Reserve** / **Pairs (5-year mean of Adults on Nests)** / **% of The Wash SPA population (based on 220 pairs)** / **% of the latest WeBS 5-year peak mean (based on 583 pairs)** Freiston Shore / 42 / 19.1 / 7.2 Frampton Marsh / 27 / 12.3 / 4.6 Combined / 69 / 31.4 / 11.8	requested through the formal channels with RSPB, as requested by RSPB. In light of this, an assessment has been carried out on the potential for impact on common tern outside of the SPA and is reported in **Section 3.2** of this document.

Interested Party	Question or comment	AUBP Response
	We also note that surveys at the mouth of The Haven have only been conducted on three occasions during the breeding season and that surveys will have ended before movements of juveniles and adults that had finished breeding may have used the area. This is acknowledged within the addendum appendix (p.152): *"When assessing the potential for MOTH vessel disturbance to affect The Wash SPA breeding common tern qualifying feature, it should be borne in mind that WeBS counts of common tern made in August and September (the months when peak numbers are counted at the MOTH site and the local area) will include juvenile birds. Also, August and September WeBS counts are made after common terns have departed their breeding colonies and therefore may include birds that are not from The Wash SPA breeding colonies."* Whilst we agree that there may be mixing of birds from other colonies, we disagree that impacts on juveniles and adults that have finished breeding should be ignored. Juveniles will still be developing their ability to fly and forage, anything that could increase their stress during this time preparing to migrate could be significant. Anything that could reduce juvenile survival would have consequences for the breeding population over time. Equally, adult birds will need to restore their fitness after breeding in preparation for migration and increased disturbance in foraging and roosting areas could be significant. None of this has been explored. We also note the caveat provided in the UK SPA Review 2001 site account that provides protection for features of The Wash SPA throughout the year: *"Note that sites selected for waterbird species on the basis of their occurrence in the breeding, passage or winter periods* ***also provide legal protection for these species when they occur at other times of the year****."* We request more detailed, site-specific information on the ecology of common terns, the local breeding colonies, and their distribution along The Haven and the entire navigation channel. This is essential to inform the HRA and justify its conclusions.	

Interested Party	Question or comment	AUBP Response
RSPB Appendix: The RSPB's initial comments with respect to specific sections and paragraphs in the addendum, and recommendations on how the issues identified could be addressed.	Revision of the common tern section of the HRA to include the reserve data and provide evidence of potential impact on common terns using The Haven over the entire period that they are present. Additional data will likely be required to assess abundance and distribution during late July and August.	The presence of common tern outside of the SPA was not known until the November 2021 hearing. This data has been requested through the formal channels with RSPB, as requested by RSPB. In light of this, an assessment has been carried out on the potential for impact on common tern outside of the SPA and is reported in **Section 3.2**.

3.2 Technical information relating to common tern presence at Frampton Marshes and Freiston Shore

3.2.1 An assessment of the potential for breeding common terns roosting at the Mouth of The Haven (MOTH) to be affected by additional vessel disturbance caused by the proposed Facility was presented in Appendix A1 of the HRA Addendum. This assessment erroneously stated that the closest breeding common terns to the MOTH were between approximately 24 and 30 km from the MOTH and that therefore there was uncertainty whether the terns recording roosting at MOTH were birds from the SPA breeding population.

3.2.2 Since writing Appendix A1 of the HRA Addendum new information has come to light on the recent local breeding status of common tern. In response to the creation of tern nesting habitat at the RSPB Frampton Marsh and Freiston Shore reserves (in the form of predator-safe artificial islands on man-made lagoons) common terns established a breeding colony at Freiston Shore reserve in 2005 and a colony at Frampton Marsh reserve in 2010. Between 2014 and 2019 between 46 and 158 pairs of common tern (mean 82 pairs) bred at these colonies. The nesting colony at Freiston Shore reserve is approximately 3.5 km north of the MOTH and the colony at Frampton Marsh is approximately 1.8 km south-west of the MOTH. The closest distance from the channel to Frampton Marsh Reserve is approximately 400m and for Freiston Shore the closest point to the channel is approximately 1.4km. These common tern data were extracted from the Seabird Monitoring Programme (SMP) Database[1]. The data have been provided to the SMP by the generous contributions of nature conservation and research organisations, and many volunteers throughout Britain and Ireland. The data for Frampton Marsh and Freiston Shore colonies were collected and provided to SMP by RSPB. It is considered very likely that the common terns recorded roosting at the MOTH are most likely to originate from these colonies.

[1] *JNCC 2021. Seabird Monitoring Programme Database.*

3.2.3 Distances for disturbance to common terns (and many other species) are documented in a Scottish Natural Heritage report relating to seaweed harvesting (Goodship and Furness, 2019) which details minimum approach distances (MAD), alert distances and flight initiation distances (FID) for several activities. They summarise that common tern is assessed as having a medium sensitivity to human disturbance whilst hand harvesting seaweed. The maximum FID recorded for common tern is 142m for pedestrian disturbance during the breeding season, although the majority of recorded FID values are under 21m during both the breeding and nonbreeding seasons. The values given for disturbance related to motorized watercraft at a site where the level of habituation to disturbance is unknown is a mean MAD of 100m and at a disturbed site during the breeding season is also a mean MAD of 100m.

3.2.4 Vessel movements along The Haven are outside the distance range that is considered likely to cause disturbance of common terns whilst at the breeding colonies.

3.2.5 The common terns that were seen to be disturbed at the MOTH during the survey work for vessel disturbance, were not at their colony actively attending nests or chicks. Potentially, they could have been actively breeding birds that were away from the colony at the time of disturbance. The concern would be if there was vessel disturbance of birds at the colony as this could have serious consequences as it could lead to chilling of eggs or young chicks, or increased risk of predation to eggs and chicks. The vessel disturbance of 'off-duty'/foraging birds away from the vicinity of their colony (i.e. as seen at the MOTH) is not likely to have significant consequences.

3.2.6 This updated information on the local breeding status of common tern does not materially affect the assessment conclusion in Appendix 1 of the HRA Addendum. The assessment concluded that the anticipated additional vessel disturbance that would result should the Facility go ahead would not compromise the conservation objectives for the breeding common tern qualifying interest of The Wash SPA.

4 Connectivity potential for the area of The Haven between the proposed Facility and the mouth of The Haven, and the Principal Application Area

4.1 Potential concern relating to connectivity between the SPA/Ramsar site and The Haven

4.1.1 Concerns have been raised regarding the habitat connectivity between the areas used by redshank at the proposed Application Site (and potentially the intervening section of The Haven) and the SPA populations (**Table 4-1** and **Table 4-2**). The HRA Addendum briefly discussed this and that there was not a certain link between the two sites. Further work has since been undertaken to investigate this further. This has found that it is unlikely that there is a link between the populations using the proposed Facility site and the SPA populations. However, there may be a link between any birds using the intervening section of The Haven. Given that this area had never been identified as an important area for birds, was not covered by the SPA/Ramsar site and was not covered by any WeBS data it was not investigated further. Should this area support important populations of birds, as is shown for other areas along The Haven, the birds remain in these areas with the existing level of vessel traffic. An average of one additional vessel per high tide period could be expected. Works that are planned as either net gain or compensation works would provide additional habitat for any birds that are using this section and could be displaced by any additional disturbance that occurs. **Section 4.2** provides information on the data analysis used to inform this decision.

Table 4-1 Comments raised by RSPB (REP2-051) regarding presence of common tern

Interested Party	Question or comment	AUBP Response at Deadline 1	RSPB's Comment	AUBP's Response
Comments on the Applicant's response to the RSPB's Relevant Representation (REP2-051)				
RSPB Number 9 (Marine and Coastal Ecology/HRA)	No assessment along the entire length of The Haven to assess impacts on qualifying features of The Wash SPA/Ramsar/SSSI.	The Applicant discusses why disturbance could be an issue and mentions the historic management of the intervening length of the Haven. Additional surveys of roost sites along The Haven are taking place and additional data will be presented at Deadline 2.	The response to this issue by the applicant is not clear. The key factor is that no data to date have been provided to understand the abundance and distribution of roosting and foraging waterbirds along the whole of The Haven. This should also cover the area of the navigation channel out to the Port of Boston anchorage area. We set out detailed comments on this in our comments on the Ornithology Addendum. We will review any new evidence collected by the Applicant and provide comments at future deadlines.	Detailed response to be provided at Deadline 6. Connectivity between the sites is addressed in **Section 4.2**.
RSPB Number 22 (Marine and Coastal Ecology/HRA)	Insufficient evidence to assess the impact and consequences of the construction and operation of the facility on The Wash.	The Applicant has analysed the additional WeBS data to understand the importance of The Haven.	The RSPB disagrees that there is sufficient evidence from the updated WeBS analysis. We discuss this in more detail in our response to the Ornithology Addendum.	Detailed response to be provided at Deadline 6. Connectivity between the sites is addressed in **Section 4.2**.

Table 4-2 Comments raised by Interested Parties about presence of common tern

Interested Party	Question or comment	AUBP Response
Final comments on the Ornithology Addendum for the RSPB (REP4-026)		
RSPB Paragraph 2.51	n) Failure to consider the full range of factors that could influence the importance of The Haven area for qualifying features of The Wash SPA/Ramsar/SSSI Significant proportions of The Wash SPA/Ramsar qualifying features have been recorded using the mouth of The Haven and at the application site. Given the connectivity between The Wash and along The Haven there is a high potential for significant numbers of qualifying features to occur along The Haven, for example, dark-bellied brent geese are now to utilise the lower reaches of The Haven in significant numbers from the mouth of The Haven to Hobhole yet this has not been quantified by the Applicant. The presence of over 2% of The Wash SPA population of non-breeding redshanks adjacent the Application site provides good evidence that other areas of The Haven could also support significant numbers of this species, especially given the true importance for this species was not known until the Applicant conducted surveys. Species such as shelduck, curlew and other waterbirds have been observed using The Haven, yet the importance for these species has not been fully determined.	Response to the intervening area of The Haven (between the mouth of The Haven and the Application Area) is provided in **Sections 4.1** and **4.2**. It has been recognised that a data gap exists for this area in previous responses, but it is also acknowledged that birds using this area are already experiencing some level of disturbance and remain at these roost locations. An increase on average of one additional vessel per tide is the expected change to this area. The net gain/compensation measures proposed would provide additional habitat for any bird species that required alternative habitat.
RSPB Paragraph 2.52	This is important as any birds using The Haven and its approaches will be exposed to disturbance by vessels and other activities that generate noise and visual disturbance. The ability to quantify these impacts is important to enable appropriate conclusions to be made in the HRA based on the site-specific conditions.	Response to the intervening area of The Haven (between the mouth of The Haven and the Application Area) is provided in **Sections 4.1** and **4.2**. It has been recognised that a data gap exists for this area in previous responses, but it is also acknowledged

Interested Party	Question or comment	AUBP Response
		that birds using this area are already experiencing some level of disturbance and remain at these roost locations. An increase on average of one additional vessel per tide is the expected change to this area. The net gain/compensation measures proposed would provide additional habitat for any bird species that required alternative habitat.

4.2 Technical information relating to connectivity potential

4.2.1 The Principal Application Site i.e. the wharf site at Area A, the adjacent area referred to as Area B and the central part of The Haven lie outside the boundary of The Wash SPA. Surveys of these areas have identified that they are used by generally low numbers of most wader species that are qualifying interests of The Wash SPA. However, non-breeding redshank have been recorded using these areas in relatively large numbers in the context of their wider population sizes. Indeed the number of redshank recorded in areas A and B combined can exceed 1% of The Wash SPA five-year mean peak count of non-breeding redshank (the counts for these non-designated areas are not included in the SPA total). Small numbers of other species including curlew, dunlin, oystercatcher, turnstone and black-tailed godwit have also been recorded in the same areas, but in these cases the numbers are very small in the context of the species' five-year mean peak number for The Wash SPA, in all cases being well below 1%.

4.2.2 This raises the question as to how the birds using the parts of The Haven outside the SPA boundary should be treated in the assessment process. In particular whether they should be considered to be part of the SPA population in which case they would need to be examined in the HRA, or merely part of the wider regional and national receptor populations, in which only examination in the EIA is likely to be required.

4.2.3 The decision as to how these birds should be treated in the assessment process should be determined according to the extent of connectivity between the non-designated areas under examination and The Wash SPA. With respect to the HRA process, Natural England advice is that functionally linked land should be identified and considered.

4.2.4 Functionally linked land is defined (Law Insider 2022) as land outside the boundary of a National Network site (in this case The Wash SPA/Ramsar site) that provides habitat that is critical to supporting the mobile interest feature or features for which the site is listed (in this case the non-breeding redshank qualifying interest in particular).

4.2.5 For practical purposes it is advised that functionally linked habitats for birds typically need to:

- lie within reasonable flight distances (a species-specific parameter);
- comprise suitable foraging / loafing / resting habitats; and
- be large enough to realistically support 1% of a SPA / Ramsar population.

4.2.6 The concept of functional linkage appears to be applied in a purely binary way, i.e. an area of habitat should be concluded as either functionally linked or not functionally linked. Application of the concept in this way contrasts with the practical application of what is essentially the same concept in the HRA process of breeding seabird SPA/Ramsar features using the marine environment. In the case of seabirds the HRA process involves determining the likely strength of connectivity between marine sites (e.g. offshore foraging areas) and a designated onshore breeding colony based on information on marine habitat utilisation from tagging studies, in particular foraging range metrics. The strength of connectivity is categorised according to the anticipated value of the site to the SPA population under consideration (for example the strength might be categorised as negligible, low, moderate or high). The strength of potential connectivity is then taken into consideration in the HRA assessment process.

4.2.7 In the case of the Principal Application Site (Area A) and adjacent (Area B) there is no doubt that these areas largely comprise suitable habitat for feeding and resting redshank. There is also no doubt that the numbers of redshank using these areas sometimes exceed 1% of The Wash SPA 5-year mean peak count (approximately 52 birds). However, there is doubt as to whether the redshanks using these areas have connectivity with the SPA and if so to what extent.

4.2.8 There is no guidance as to the 'reasonable flight distance' value for wintering redshank that should be used for the purpose of determining functional linkage. Nor is there any specific information available from tagging studies (e.g. colour-ringing or radio tagging) on the local movements of the wintering redshanks that use The Haven. However, a search of relevant literature found two studies that provide reasonable quantified information on wintering redshank ranging behaviour.

4.2.9 The scale of local movements by wintering redshanks was studied in Cardiff Bay (Burton, 2000). In this study wintering redshank that had been fitted with unique combinations of colour-rings were regularly searched for both at the marking site (Cardiff Bay) and at other sites with suitable habitat up to 16 km away. In this way information was collected on how far wintering redshanks typically range between feeding and roosting sites, and on winter site fidelity. The study was based on observations of 59 birds for the two study winters combined. The study found that within a winter period 86% of individuals were only seen within Cardiff Bay, never more than approximately 1 km from where they were originally caught (Cardiff Bay covers an area on 175 ha only). The other 14% of individuals were seen both at Cardiff Bay and at the closest alternative area of suitable habitat approximately 4 km away. None of the sample of colour-ringed birds was seen at the other more distant sites that were searched. On the basis of this evidence, in south Wales at

least, it appears that only a small proportion (approximately 14%) of wintering redshank range as far as 4 km and that the ranging behaviour of the vast majority of individuals is confined to distances of up to approximately 1 km.

4.2.10 Additional evidence on ranging behaviour of wintering redshank comes from conventional bird ringing data. In ringing studies birds are marked with a numbered metal ring and rely on birds being either recaptured or found dead to provide data on movement patterns. A large- scale analysis of ringing data for waders caught at various sites across The Wash examined the distances between sites where birds had been caught and recaptured (Rehfisch *et al*., 1996). Based on ringing data for 9,604 adult and 2,125 juvenile redshanks, the analysis showed that the mean distance moved by adult redshank with-in the same winter was less than 0.75 km. The corresponding figure for juvenile redshank is stated as being <1.0 km. The results for redshank strongly contrasted with the results for the four other wader species examined (oystercatcher, knot, grey plover and dunlin). For these species the corresponding mean distances for adults ranged between 2.0 and 8.7 km depending on species. The same study also showed that individual redshank were only rarely recaptured in a different section of The Wash (the study divided The Wash into five sections) to which they were originally caught. The analysis showed that redshank were very section-faithful; over 93% of adults and over 86% of juveniles were recaptured in the same section (both within-year and between-years) to that where they were originally caught. Rehfisch *et al*. concluded that redshank wintering in The Wash are site faithful, remaining localised in their wintering areas.

4.2.11 On the basis of the evidence from the two published studies summarised above, it appears likely that the great majority (probably between 80 and 90%) of wintering redshanks confine their day to day activities to within a small, localised area of probably no more than approximately 2 km across. The evidence also suggests that a minority of individuals (probably between 10 and 20%) make use of a somewhat larger wintering area but even for these birds the area used is unlikely to be more than approximately 5 km across. In the absence of site-specific data these figures are considered to provide a reasonable basis to inform the decision as whether the non-designated parts of The Haven should be regarded as functionally linked land for the purposes of HRA.

Consideration of non-breeding redshank functional linkage for Area A

4.2.12 Counts of Area A (the Principal Application Site) undertaken on nine dates spread through the non-breeding season between October 2019 and March 20121 recorded a peak and mean high tide counts of 162 and 40 redshanks respectively. The peak count of 162 birds was nearly four times higher than the next highest

high tide count and coincided with a near absence of birds in the corresponding high tide count at adjacent Area B. Area A was also counted on the same nine dates in the low tide period; peak and mean counts of 27 and 21 redshanks respectively were recorded.

4.2.13 It is relevant to note that with the exception of the unusually high count of 162 redshanks in January 2020, there is generally a close correlation between the high tide and low tide counts for Area A, and that that the mean low tide count and mean high tide count are similar, at 25 and 24.5 respectively (January 2020 counts excluded). This is evidence that the birds that feed in Area A in the low tide period are likely to be largely the same as the birds that roost there in the high tide period.

4.2.14 The unusually high Area A high tide count in January 2020 (162 redshanks) is likely to have been largely caused by birds that usually roost in Area B choosing to roost in Area A on that date. As would be expected for two small areas that lie in such close proximity, there is likely to be a high degree of redshank connectivity between Area A and Area B.

4.2.15 Area A lies between 3.0 and 3.6 km from the closest part of The Wash SPA. On this basis of the published information on non-breeding redshank ranging behaviour and the proximity of Area A to the SPA it is concluded that it is likely that the great majority of redshanks that regularly use this area do not make use of the SPA during the course of the winter. Although it is likely that a minority of individuals using Area A do make use of the SPA, it is not likely that the number of these individuals corresponds to 1% or more of 5-year mean peak SPA non-breeding redshank population. It is concluded that Area A does not meet the criteria to qualify as functionally linked land.

Consideration of non-breeding redshank functional linkage for Area B

4.2.16 Counts of Area B undertaken on nine dates spread through the non-breeding season between October 2019 and March 2021 recorded a peak and mean high tide counts of 93 and 50.6 redshanks respectively. The mean high tide count rises to 56.5 birds if the January 2020 count is excluded, the date when very few birds were present because they were apparently roosting nearby in Area A. Area B was also counted on the same nine dates in the low tide period, when peak and mean counts of 61 and 30.8 redshanks respectively were recorded.

4.2.17 With the exception of the unusually low high tide count of three redshank in January 2020 (the occasion when an unusually high number roosted in Area A), the numbers of redshanks recorded in the high tide period in Area B was typically somewhat greater than the number counted in the low tide period on the same date; the mean low tide count was 30.8 birds compared to the mean high tide count 56 birds. This suggests that typically there is a small net movement (in the order of 25 birds) into Area B over the high tide period, presumably to roost. These birds are likely to mainly comprise redshanks that have been feeding during the low tide period in the adjacent central part of The Haven (i.e. feeding areas within approximately 1 km to the south-east of Area B).

4.2.18 Area B lies between 2.3 and 3.0 km from the closest part of The Wash SPA. On this basis of the published information on non-breeding redshank ranging behaviour and the proximity of Area B to the SPA it is concluded that it is likely that the great majority of birds that regularly use this area do not make use of the SPA during the course of the winter. Although it is likely that a minority of individuals using Area B do make use of the SPA, it is not likely that the number of these individuals corresponds to 1% or more of non-breeding redshank 5-year mean peak SPA population. It is concluded that Area B does not meet the criteria to qualify as functionally linked land.

Consideration of non-breeding redshank functional linkage for central part of The Haven

4.2.19 For the purposes here, the central part of The Haven is defined as the stretch between Area B upstream and The Wash SPA boundary downstream. Thus, this part of The Haven lies between 0 and 2.3 km from the closest part of the SPA.

4.2.20 There have been no regular counts of non-breeding redshank (or other birds) using the central part of The Haven in recent years. Counts are being undertaken this winter (2021/22) to address this information gap. The small amount of count data collected to date and limited historical data available suggest that this area

regularly provides feeding and roosting habitat for up to a few tens of redshanks, and potentially on some occasions numbers may approach or exceed 1% of The Wash 5-year mean peak population (approximately 52 birds).

4.2.21 On this basis of the published information on non-breeding redshank ranging behaviour and the close proximity of the central part of The Haven to the SPA it is concluded that it is likely that the majority of redshanks that regularly use this area are also likely to make use of the SPA during the course of the winter. There is circumstantial evidence that some of the redshank that feed in the central part of The Haven, particularly those in the north-west half, are likely to roost in Area B (discussed above). Other redshank that feed in the central part of The Haven, particularly those that favour the south-east half, are likely to roost either within this section (there is a regular wader roost site in the vicinity of the Hobhole Drain confluence with The Haven, approximately halfway along this section of The Haven) or within the nearest part of the SPA. It is considered likely that there is moderate to strong connectivity by wintering redshank between the central part of The Haven (as defined) and the nearest part of the SPA.

4.2.22 There is currently uncertainty as to the number of redshanks that use the central part of The Haven. As a result, it is not known whether the number of individuals that use the central part of The Haven and use the SPA during the course of a winter correspond to 1% or more of 5-year mean peak SPA non-breeding redshank population. In light of this uncertainty and in consideration of the precautionary principle, it is provisionally concluded that the central part of The Haven (as defined) meets the criteria to qualify as functionally linked land.

5 Assessment of potential for effect on the waterbird assemblage in its own right at the mouth of The Haven

5.1 Concern relating to potential for impact on the waterbird assemblage

5.1.1 Concern has been raised that although the impacts have been assessed on the individual species that feature within the SPA/Ramsar site, there is no assessment of the overall waterbird assemblage. These concerns are outlined in **Table 5-1**.

Table 5-1 Comments raised by Interested Parties on the potential impact on the waterbird assemblage

Interested Party	Question or comment	AUBP Response
Natural England's Comments on Habitats Regulations Assessment – Ornithology Addendum [REP1-026] (REP2-045)		
Natural England Paragraph 2.2	With reference to The Wash SPA Annex 1 non-breeding waterfowl assemblage some 29,395 birds of at least 22 species are at risk of exposure to disturbance with 20,208 birds of 22 species in the most sensitive area (Appendix A1 Table 2). This includes a number of 'key component' species i.e. those for which The Wash SPA is particularly important.	The individual species have been assessed in detail in the HRA addendum against the objectives for the SPA features. The SPA assemblage as a feature in its own right is discussed below in **Section 5.2**.
Natural England Paragraph 2.5	In the current documentation [REP1-026] the risk of AEoI is considered without reference to the objectives (maintain vs restore) of individual species, or their individual energy balances and the loss of the Mouth of the Haven roost area permanently is not considered. **Natural England considers that an AEoI cannot be ruled out beyond all reason scientific doubt for these impacts**. Natural England also notes that while consideration has been given to impacts on a number of individual species which form features of the site, no assessment is made of the Annex I non-breeding waterfowl assemblage as a feature in its own right of the Wash SPA.	
Natural England Table 1	The Annex II non-breeding waterbird assemblage needs to be added to the scope of the assessment. The assemblage has both numeric and species diversity attributes.	
Natural England Risk and Issues Log (REP3-029)		
Natural England Chapter 17 – Marine and Coastal Ecology - No.2	The Applicant submitted an Ornithology Addendum at Deadline 1 [REP1-026]. NE note that consideration has been given to impacts on a number of individual species which form features of the site, but there has been no assessment of the impacts to	The individual species have been assessed in detail in the HRA addendum. The SPA assemblage as a feature in its own right is discussed below in **Section 5.2**.

Interested Party	Question or comment	AUBP Response
	Annex I non-breeding waterfowl assemblage as a feature in its own right. This matter remains outstanding.	
Natural England's Response to ISH 2 (Environmental Matters) Questions (REP3-030)		
Natural England [3.1.10]. Please can NE confirm whether it is satisfied that the Applicant has identified all of the relevant European sites and features in the HRA?	As set out in Natural England's Deadline 2 advice on the Ornithological Addendum [REP2-045] Natural England highlights that the Annex I non-breeding waterfowl assemblage is a feature in its' own right, which hasn't been consider in the application documents.	The SPA assemblage as a feature in its own right is discussed below in **Section 5.2**.
A Summary of Natural England's Position on the Potential Impacts to The Wash SPA Annex I passage and Overwintering Birds (AS-002)		
Natural England Mouth of The Haven the Wash SPA - compensation	Whilst the focus of the compensation discussion has been on Annex I redshank, potentially 24 Annex I species/Assemblage features of The Wash SPA are exposed to the same risk at the mouth of the Haven and are likely to require similar compensation.	The proposed update to the HRA compensation document (to be provided for Deadline 6) will provide more detailed discussion of the specific requirements of individual bird species.
Final comments on the Ornithology Addendum for the Royal Society for the Protection of Birds (REP4-026)		
RSPB Paragraphs 3.60 and 3.61	n) Disagreement with the HRA conclusion regarding waterbird assemblage We disagree that there would not be an adverse effect on integrity beyond reasonable scientific doubt on the waterbird assemblage. We do not agree with any of the conclusions drawn for qualifying features alone or where they have been assessed as a component of the waterbird assemblage. The mouth of The Haven has been shown to support significant numbers of waterbirds and these have been observed to be disturbed by current vessel movements. We also disagree that the full suite of qualifying features (notably, shelduck) has been	Further detail on assessment of potential effects on the waterbird assemblage is provided in **Section 5.2**. It is correct to state that the mouth of The Haven does support significant numbers of waterbirds and that they have been observed to be disturbed by current vessel numbers. This is acknowledged in the assessments, however, the response of the birds to

Interested Party	Question or comment	AUBP Response
	assessed and therefore the assessment on the waterbird assemblage is incomplete. We request more detailed, site-specific information on the ecology of the waterbird assemblage qualifying features, the local breeding colonies, and their distribution along The Haven and the entire navigation channel. This is essential to inform the HRA and justify its conclusions.	the baseline disturbance is to continue to use the roost sites at the mouth of The Haven and, for some species, to fly to alternative roosts in the event of disturbance around high tide periods. The assessment has considered this in detail in the HRA addendum and concludes that it is likely that this response behaviour would continue with the additional vessel traffic and that no additional significant changes are predicted.
RSPB Recommendations Table Ref 46, Para 6.1.27, Page 52	The focus of conclusions about impacts on the waterbird (not waterfowl) assemblage is lapwing and golden plover. Energy budgets have been developed for these species. These species have been affected by multiple disturbance events, as they typically returned to their original roost and did not move away. Golden plover is a qualifying feature of The Wash SPA, and both species are components of the waterbird assemblage. They are also Ramsar features. Given concerns about impacts on the individual features we cannot agree that there would not be an adverse effect on the waterbird assemblage of The Wash SPA. RSPB's Recommendation: Collect abundance and distribution data along the whole length of The Haven and navigation channel out to the anchorage area to assess potential impacts on lapwings and golden plovers.	Further detail on the assessment of potential effects on the waterbird assemblage is provided in **Section 5.2**.

5.2 Waterbird assemblage description

5.2.1 The assemblage feature concerns the aggregation of non-breeding waterbirds (wildfowl and wader species) that occurs at The Wash. It comprises birds that use The Wash for overwintering, 'over summering' without breeding, or as a migratory stop-over site. Non-breeding waterbirds may be present in any month of the year.

5.2.2 At the time of publication of The Wash SPA citation (March 1988) the assemblage numbered 214,000 birds comprising 163,000 waders and 51,000 wildfowl (ducks, geese and swans). The citation was updated in December 2015 (Standard Data Form[2]). The updated citation states the assemblage size as 400,367 birds, this being the (5-year peak mean BTO (British Trust for Ornithology) WeBS (Wetland Birds Survey) count for the period 1991/92 to 1995/96). The 2015 updated citation does not state why the 1991/92 to 1995/96 five-year period was chosen as the new reference period.

5.2.3 Natural England's SPA Supplementary Conservation Advice (Natural England 2021) states that all the non-breeding SPA qualifying species are considered to be main component species of the waterbird assemblage. It also advises that some additional waterbird species are considered to be part of the assemblage as these contribute collectively to the assemblage diversity. Although these additional species are not identified, the Supplementary Conservation Advice states that in particular they are "*proportionally abundant populations of species of conservation importance*". In this respect species that are red-listed as Birds of Conservation Concern and on Annex I of EU Birds Directive are considered to be species of conservation importance.

5.2.4 For the purposes of assessment, 23 species are considered to be components of The Wash SPA non-breeding waterbird assemblage. These comprise the 19 SPA qualifying non-breeding species, together with four additional species of conservation importance that regularly occur in reasonably large numbers in the context of their wider UK non-breeding population size. The 23 assemblage species and the rationale for inclusion are as follows:

- Bewick's swan (SPA qualifying species);
- dark-bellied brent goose (SPA qualifying species);
- pink-footed goose (SPA qualifying species);
- shelduck (SPA qualifying species);
- oystercatcher (SPA qualifying species);
- grey plover (SPA qualifying species);

[2] *JNCC, Standard Data Form for sites within the 'UK national site network of European sites'*

- knot (SPA qualifying species);
- dunlin (SPA qualifying species);
- bar-tailed godwit (SPA qualifying species);
- curlew (SPA qualifying species);
- redshank (SPA qualifying species);
- pintail (SPA qualifying species);
- sanderlings (SPA qualifying species);
- turnstone (SPA qualifying species);
- wigeon (SPA qualifying species);
- goldeneye (SPA qualifying species);
- gadwall (SPA qualifying species);
- common scoter (SPA qualifying species);
- black-tailed godwit (SPA qualifying species);
- lapwing (BOCC red-list species);
- ringed plover (BOCC red-list species);
- ruff (BOCC red-list species); and
- golden plover (Annex I species).

5.2.5 Although great northern diver and red-throated diver are listed on Annex I of the EU Birds Directive, they only occur in very low numbers in The Wash SPA and are not regularly recorded in the vicinity of the MOTH. Therefore, for the purposes of assessment, these two species are not considered to be components of the non-breeding waterbird assemblage.

5.3 Waterbird assemblage conservation objectives and targets

Conservation objectives

5.3.1 The conservation objectives for The Wash SPA are as follows:

Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring;

- *The extent and distribution of the habitats of the qualifying features*
- *The structure and function of the habitats of the qualifying features*
- *The supporting processes on which the habitats of the qualifying features rely*
- *The population of each of the qualifying features, and,*
- *The distribution of the qualifying features within the site.*

Assemblage abundance target

5.3.2 Target: Maintain the overall abundance of the waterbird assemblage at a level which is above 214,000 whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

Assemblage diversity target

5.3.3 Target: Maintain the species diversity of the waterbird assemblage

5.3.4 With respect to the assemblage diversity target, the Supplementary Conservation Advice (Natural England 2021) states:

5.3.5 "*This target is required to ensure the bird assemblage reflects the diversity of species the SPA supports. Assemblage diversity is a product of species richness (the number of different species present), abundance (population size of each assemblage component species) and relative 'importance' (an assessment of the conservation status of each assemblage component, described below).*

5.3.6 *Each component makes a different contribution to the diversity of the assemblage, and changes to some components may be considered to affect diversity more than others. Negative changes to small numbers of relatively important assemblage components may have a similar overall effect to negative changes in larger numbers of less important components. To meet the target, the populations of each of the 'main component' assemblage species to be maintained or restored are i) those present in nationally important numbers (≥1% GB population); ii) migratory species present in internationally important numbers (≥1% biogeographic population); iii) those species comprising ≥2,000 individuals (≥10% of the minimum qualifying threshold for an internationally-important assemblage); and iv) 'named components' otherwise listed on the SPA citation. In addition to the main components, other components should be considered as these contribute collectively to the assemblage diversity, in particular proportionally abundant populations of species of conservation importance"*.

Disturbance by human activity target

5.3.7 Target: Reduce the frequency, duration and/or intensity of disturbance affecting roosting and/or foraging birds so that they are not significantly disturbed during the non-breeding (winter and/or passage) season.

5.3.8 With respect to human disturbance target, the Supplementary Conservation Advice (Natural England 2021) states:

Disturbance should be judged as significant if an action (alone or in combination with other effects) impacts on waterbirds in such a way as to be likely to cause impacts on populations of a species through

I. changed local distribution on a continuing basis; and/or

II. changed local abundance on a sustained basis; and/or

III. the reduction of ability of any significant group of birds to survive, breed, or rear their young."

5.3.9 Appendix A1 of the HRA addendum examined the amount of baseline (existing) vessel disturbance at the MOTH on SPA qualifying species, and the estimated the potential for the Facility to lead to additional MOTH vessel disturbance on these species. The information presented below considers the baseline MOTH vessel disturbance on the waterbird assemblage as a whole, in terms of both the amount of baseline disturbance and the potential for additional disturbance due to the Facility.

5.4 Definitions of relevant local area and site

Definition of The Haven local area

5.4.1 The word 'local' is not defined in the NE SPA Supplementary Conservation Advice. For the purposes of assessing MOTH vessel disturbance, and following the reasoning explained in Appendix A1 of the HRA Addendum, the local area is taken to refer to those parts of the SPA that are adjacent to The Haven. For practical purpose this is defined as the area included within the following WeBS count sectors:

- Frampton North 21;
- Frampton North 22;
- Frampton North 23;
- Frampton North 24;
- Frampton North 25;
- Frampton North 26;
- Frampton North 27;
- Frampton North 31;
- Frampton North 60;
- Witham 20;
- Witham 40;
- Witham 41;
- Witham 51;

- Witham 52; and
- Witham 60.

5.4.2 The defined **'The Haven local area'** is illustrated in Figures 1 and 2 of Appendix A1 of the HRA Addendum. The defined local area covers an area of 5.2 km^2, corresponding to 0.8% of the area of The Wash SPA.

Definition of Mouth of the Haven (MOTH) site

5.4.3 For the purposes of assessment the MOTH is considered to be at site within the covers a relatively small part of the defined local area and within the local area. For practical purposes the MOTH is defined as a site within the local area comprising the following WeBS count sectors:

- Frampton North 27;
- Frampton North 31;
- Witham 20; and
- Witham 60.

5.4.4 The defined '**MOTH site**' is illustrated in Figure 2 of Appendix 1 of the HRA Addendum. The defined MOTH site covers an area of 0.65 km^2. The extent of the defined MOTH site corresponds to 12% of the defined local area and 0.1% of the area of The Wash SPA.

5.5 Importance of the local area and MOTH site to waterbird assemblage

5.5.1 The importance (i.e., a measure of value) in terms of abundance of the MOTH site and The Haven local area (as defined) to the SPA waterbird assemblage feature is evaluated by examining the percentage of the 5-year mean peak count that is present each month. For the purposes of determining importance The Wash SPA 5-year mean peak WeBS count for 2014 to 2019 period is used: the combined mean peak count over this period for the 23 assemblage species combined, is 372,065 birds.

5.5.2 Information on the proportion of the 23 assemblage species that use the MOTH site / The Haven local area (as defined) provide additional evidence to establish the value of an area under consideration to the SPA non-breeding waterbird assemblage feature.

Importance of the MOTH site to the waterbird assemblage

5.5.3 Based on WeBS data for the 5-year period 2014/15 to 2018/19, the mean percentage of the assemblage present at the MOTH site in the winter and migration passage months ranges from 0.2 to 1.5% (**Table 5-2** and **Figure 5-1**). The mean percentage present each month from October to January approaches

or slightly exceeds 1% of the total, and thus it is concluded that for these months the MOTH site has Low Importance (defined as 1-5% of the total). For the five-year period examined, the highest ever recorded abundance at the MOTH occurred in November 2016 when 3.5% of the 5-year peak assemblage count was present.

5.5.4 On average the number of assemblage birds counted in the MOTH site (as defined) accounted for approximately half of all the assemblage birds counted in 'The Haven local area' (as defined). This indicates that within the local area (as defined) the MOTH site has high importance for the waterbird assemblage feature.

5.5.5 The importance of the MOTH site (as defined) for the non-breeding waterbird assemblage feature can also be examined in terms of the number of assemblage species that use it. Between 2014 and 2019 all but one of the 23 assemblage species were recorded in WeBS counts at least once at the MOTH site (sanderling was the only species not recorded). The percentage of the 23 assemblage species recorded in monthly WeBS counts within the MOTH site (as defined) count sections is presented in **Table 5-3**. The results in **Table 5-3** indicated that as many as 65% of assemblage species (15 species) are sometimes present at the MOTH site, however the average percentage of assemblage species present was considerably lower, ranging between 35% and 46% in the main non-breeding months (September to March). It is clear that the MOTH site regularly provides suitable habitat for a moderate proportion (defined as 25-50% of assemblage species) and occasionally for a high proportion of assemblage species (defined as greater than 50% of assemblage species).

Table 5-2 The percentage of the 5-year peak waterbird assemblage count (372,065 birds) recorded during WeBS counts each month in the Mouth of The Haven site (as defined).

Month	2014/15	2015/16	2016/17	2017/18	2018/19	Average
August	0.28%	0.22%	0.26%	0.33%	0.32%	**0.28%**
September	0.02%	0.76%	0.01%	0.47%	0.54%	**0.36%**
October	0.81%	0.69%	0.02%	2.38%	0.69%	**0.92%**
November	0.54%	0.37%	3.49%	1.91%	1.01%	**1.46%**
December	0.21%	0.26%	1.18%	1.26%	1.52%	**0.89%**
January	0.41%	0.67%	0.07%	0.92%	1.80%	**0.77%**
February	0.23%	0.31%	0.46%	0.94%	0.25%	**0.44%**
March	0.71%	0.16%	0.34%	0.58%	0.21%	**0.40%**
April	0.48%	0.29%	0.36%	0.39%	0.08%	**0.32%**
May	0.09%	0.33%	0.37%	0.00%	0.04%	**0.17%**

Table 5-3 The percentage of the 23 assemblage species recorded in monthly WeBs counts each month in the MOTH site (as defined)

Month	2014/15	2015/16	2016/17	2017/18	2018/19	Average
August	43%	26%	26%	43%	30%	**34%**
September	9%	57%	17%	65%	57%	**41%**
October	39%	35%	9%	43%	48%	**35%**
November	43%	22%	61%	52%	39%	**43%**

Month	2014/15	2015/16	2016/17	2017/18	2018/19	Average
December	22%	26%	43%	65%	57%	**43%**
January	35%	52%	35%	57%	52%	**46%**
February	35%	30%	52%	61%	39%	**43%**
March	48%	39%	48%	52%	26%	**43%**
April	39%	30%	26%	35%	13%	**29%**
May	17%	35%	30%	4%	4%	**18%**

Importance of The Haven local area to the waterbird assemblage

5.5.6 Based on WeBS data for the 5-year period 2014/15 to 2018/19, the mean percentage of the assemblage total present in The Haven local area in the winter and migration passage months ranged from 0.4 to 2.1% (**Table 5-4**, **Figure 5-1**). The mean percentage of the assemblage 5-year peak present each month from October to March was between 1 and 2% and approached 1% in the months of September and April. It is concluded that for all these months The Haven local area site has Low Importance (defined as 1-5% of the total). For the five-year period examined the highest ever recorded abundance of assemblage birds in The Haven local area occurred in December 2016 when 4.4% of the 5-year peak assemblage count was present.

5.5.7 The importance of The Haven local area for the non-breeding waterbird assemblage feature can also be examined in terms of the variety of assemblage species that use it. The percentage of the 23 assemblage species recorded in monthly WeBS counts each month in The Haven local area (as defined) sections is presented in **Table 5-5**. The results in Table 4 indicated that as many as 74% of assemblage species (17 species) are sometimes present in The Haven local area, however the average percentage of assemblage species present was considerably lower, ranging between 51% and 60% in the main non-breeding months (September to March) (**Table 5-5**). It is clear that The Haven local area typically provides suitable habitat for a high proportion (defined as 50-75% of assemblage species) and exceptionally for a very high proportion of assemblage species (defined as >75% of assemblage species).

Table 5-4 The percentage of the 5-year peak waterbird assemblage count (372,065 birds) recorded during WeBS counts each month in The Haven site local area (as defined).

Month	2014/15	2015/16	2016/17	2017/18	2018/19	Average
August	1.04%	0.25%	0.48%	0.44%	0.57%	**0.56%**
September	0.62%	0.90%	0.29%	0.67%	0.99%	**0.70%**
October	1.97%	0.88%	0.56%	2.86%	0.76%	**1.41%**
November	1.71%	0.63%	3.78%	2.26%	1.22%	**1.92%**
December	2.21%	0.38%	4.39%	1.64%	2.01%	**2.13%**
January	2.87%	1.98%	0.42%	2.13%	2.86%	**2.05%**
February	1.82%	1.51%	1.26%	1.63%	0.29%	**1.30%**
March	1.47%	0.48%	0.51%	1.53%	1.09%	**1.02%**
April	1.10%	0.93%	0.77%	1.09%	0.28%	**0.83%**
May	0.25%	0.83%	0.77%	0.03%	0.12%	**0.40%**

Table 5-5 The percentage of the 23 assemblage species recorded in monthly WeBs counts each month in The Haven local area (as defined).

Month	2014/15	2015/16	2016/17	2017/18	2018/19	Average
August	57%	26%	35%	61%	52%	**46%**
September	43%	61%	35%	74%	57%	**54%**
October	57%	48%	48%	57%	48%	**51%**
November	65%	52%	61%	70%	52%	**60%**

Month	2014/15	2015/16	2016/17	2017/18	2018/19	Average
December	57%	26%	57%	70%	65%	**55%**
January	57%	65%	57%	61%	57%	**59%**
February	65%	57%	61%	65%	43%	**58%**
March	61%	48%	52%	65%	43%	**54%**
April	48%	48%	39%	48%	39%	**44%**
May	39%	48%	43%	26%	35%	**38%**

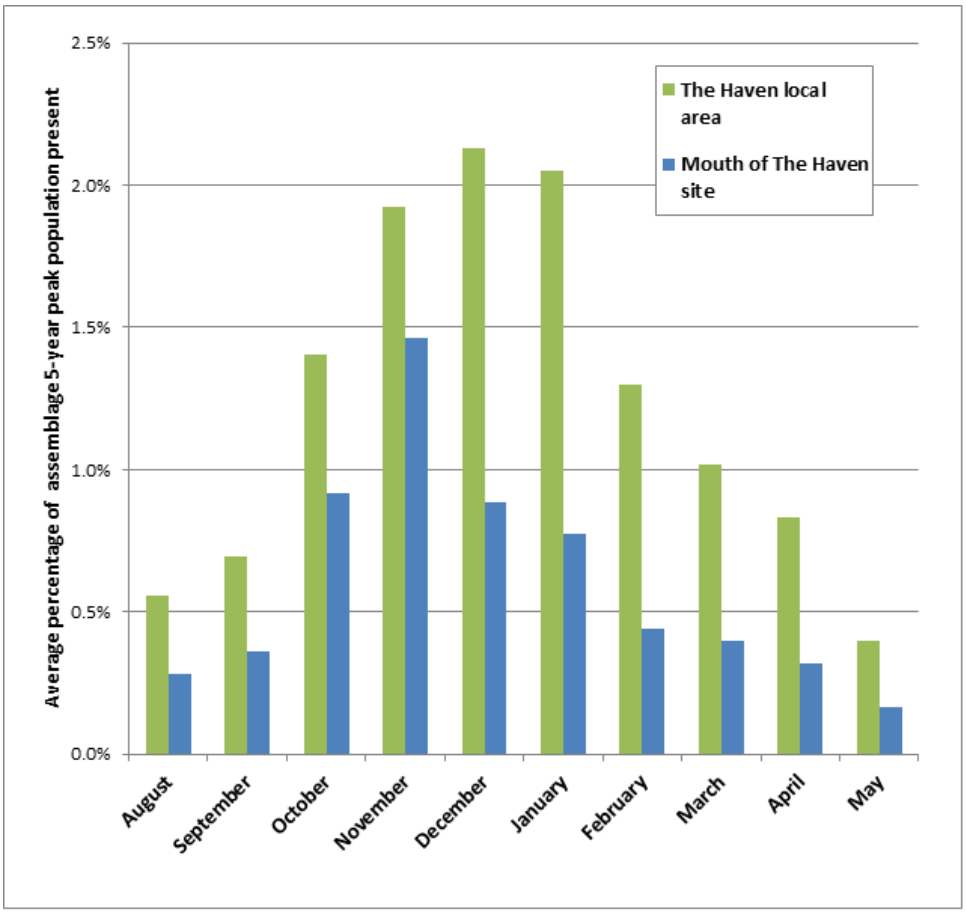

Figure 5-1 The importance of the Haven Local Area (as defined) and The Moth Site (as defined) each month to The Wash SPA waterbird assemblage in terms of abundance

Baseline vessel disturbance of waterbird assemblage

5.5.8 Under baseline conditions vessel movements along The Haven occur on approximately 75% of high tides (i.e. approximating to five days a week). Assuming the results from the eight high-tide baseline observation sessions (**Table 5-6**) are representative of the tides when vessels movement through the Haven occur during the non-breeding months, it is concluded that under baseline conditions significant numbers of assemblage individuals (considered to be <1% of 5-year mean peak assemblage count) are disturbed on approximately 12.5% (1 in 8) of high tide periods when vessel movements occur, equivalent to just under 9% of all tides.

5.5.9 The number of assemblage birds seen to be disturbed by vessels during the baseline disturbance observation sessions at MOTH varied greatly, ranging from as few as seven, to as many as 6,626 birds, corresponding to 0.002% and 1.8% of the 5-year assemblage peak total (**Table 5-6**). In terms of abundance the

proportion of the assemblage total exceeded 1% on only one occasion and on average amounted to 0.4% (**Table 5-6**).

5.5.10 The number of assemblage species seen to be disturbed by vessels during the baseline observation sessions ranged from three to twelve, corresponding to 13% and 52% of the 23 species that make up the assemblage (**Table 5-6**). The mean number of assemblage species that were disturbed by vessels in a session was seven, 29% of the species in the assemblage (**Table 5-6**).

5.5.11 The nature and consequences of the vessel disturbance observed for different species is discussed in detail in the individual species accounts in Appendix A1 of the HRA Addendum (document reference 9.13, REP1-026). Although species differed in their response, generally speaking the birds that showed a disturbance response to passing vessels were able to move to a nearby alternative location up to a few hundred metres away or quickly (within approximately two minutes) returned to the MOTH roost site after the vessel that caused the disturbance had passed by. Thus under baseline conditions (potential for vessel disturbance on approximately 75% of high tides), it is not likely that the vessel disturbance resulted in a significant reduction in the survival of the birds affected.

Table 5-6 Summary of vessel disturbance affecting the non-breeding waterbird assemblage during the eight high tide baseline observation sessions at the Mouth of the Haven undertaken between November 2019 and March 2021.

Date	22/11/19	19/12/19	17/01/20	17/02/20	12/03/20	25/01/21	22/02/21	20/03/21	Mean
No. of assemblage bird species disturbed by vessels	409	6,626	2103	156	375	1,249	888	7	**1477**
No. disturbed as % of assemblage 5-year peak total	0.1%	1.8%	0.6%	0.04%	0.1%	0.3%	0.2%	0.002%	**0.4%**
No. of assemblage species affected by disturbance	5	9	12	7	4	6	8	3	**6.8**
% of assemblage species affected by disturbance	22%	39%	52%	30%	17%	26%	35%	13%	**29%**

Predicted change due to the proposed Facility

5.5.12 If the Facility goes ahead, the proportion of high tides with vessel movements along The Haven is anticipated to rise to 100% compared to approximately 75% under baseline conditions. If the Facility goes ahead it is likely that vessel movements would disturb at least some waterbird assemblage individuals on all high tides during the non-breeding period with vessel movements.

5.5.13 If the Facility goes ahead, the numbers (e.g. peak and mean) of assemblage individuals and numbers (e.g. peak and mean) of assemblage species anticipated to be affected by vessel disturbance during a high tide period is likely to be approximately the same as during baseline conditions as this will largely reflect how many assemblage birds use the MOTH site (**Table 5-2**). However, the number of vessel disturbance incidents that would occur in a high tide period is likely to be somewhat greater, reflecting the greater number of vessel movements that on average will occur during each high tide period if the Facility goes ahead and the fact that some SPA feature or assemblage species (e.g., black-tailed godwit, golden plover and lapwing) are likely to be disturbed by vessels more than once during a high tide period because of their habit of sometimes returning to the same roost site.

5.5.14 Based on the numbers seen disturbed by vessels in the baseline observation sessions, it is anticipated that if the Facility goes ahead potentially significant numbers of assemblage birds (i.e., greater than 1% of 5-year mean peak assemblage count) are likely to be disturbed on approximately 12.5% of high tides, a rise from approximately 9% under baseline conditions. This is equivalent to a rise from approximately five high tides per month to seven per month. During the remaining high tide periods, based on existing data, the number of assemblage individuals that are anticipated to be disturbed by vessels would be below 1% of the assemblage 5-year mean peak total.

Assessment of waterbird assemblage

5.5.15 For assessing whether additional disturbance by vessels at the MOTH would compromise the SPA's conservation objectives the relevant test questions are considered to be as follows:

- **Test 1**. Would the predicted additional MOTH vessel disturbance change the local distribution of the non-breeding waterbird assemblage qualifying feature of The Wash SPA on a continuing basis?
- **Test 2**. Would the predicted additional MOTH vessel disturbance change the local abundance of the non-breeding waterbird assemblage qualifying feature of The Wash SPA on a sustained basis?

- **Test 3**. Would the predicted additional MOTH vessel disturbance reduce the ability of a significant number of individuals of the non-breeding waterbird assemblage qualifying feature of The Wash SPA to survive, breed, or rear their young.

5.5.16 For the non-breeding waterbird assemblage qualifying feature, the answer to all three of the test questions is considered to be 'no'. It is therefore considered that potential additional vessel disturbance that would result from the proposed Facility would not compromise The Wash SPA conservation objectives for this qualifying interest. The reasoning behind considering that a 'no' answer is appropriate for the three test questions is summarised below.

5.5.17 Tests 1 and 2. The analysis of WeBS count data shows that the number of waterbird assemblage birds that use the MOTH site during the high tide period and therefore potentially at risk of vessel disturbance form only a small proportion of the assemblage; monthly counts are between 0.2% to 1.5% of the 5-year peak mean total (**Table 5-2**). The baseline disturbance study showed that when disturbed by vessels, the birds affected usually relocate to a nearby alternative location within 1 km, either elsewhere within the MOTH site (as defined) or elsewhere in the wider local area (as defined), or in some cases they returned to the same location at the MOTH. It is concluded that the additional disturbance would not materially affect local distribution or abundance of the waterbird assemblage across The Wash SPA as a whole.

5.5.18 Test 3. The Wash SPA waterbird assemblage concerns non-breeding birds. Therefore the Test 3 question is limited to considering the potential for the proposed Facility to reduce the ability of a significant number of assemblage individuals to survive. The ability to survive could be reduced if a significant number of individuals were subject to a significantly higher predation risk and/or energy stress caused by additional energy demands or reduced food intake. In applying this test, the terms 'significant number' and 'ability to survive' are not easily defined. Here a judgement is made by combining information on the likely frequency and duration of additional vessel disturbance events and the anticipated number and behavioural response of the birds that would be affected. Given that the anticipated additional MOTH vessel disturbance would affect only a small proportion of assemblage individuals (during the baseline surveys vessel disturbance typically affected well below 1% of the assemblage 5-year peak total count in any one high tide period and never more than 2% of the total) and that the disturbed birds are anticipated to relocate to a nearby (within 1 km) alternative location or quickly (within approximately two minutes) return to the original site once the vessel has passed, it is considered very unlikely that additional vessel

disturbance would reduce the ability of a significant number of waterbird assemblage individuals to survive.

Management of disturbance to waterbird assemblage

5.5.19 The additional vessel disturbance that would result if the project went ahead is considered not likely to compromise the conservation objectives for The Wash SPA non-breeding waterbird assemblage qualifying interest. However, any additional disturbance of this qualifying feature is undesirable. Therefore, measures that aim to reduce vessel disturbance (baseline and project) and its consequences are considered desirable.

5.5.20 Measures to manage vessel disturbance that would benefit non-breeding waterbird assemblage include the Provision of one or more artificial roost sites in the vicinity of MOTH but far enough from the shipping channel for roosting birds not to be vulnerable to vessel disturbance. These would be achieved with the proposed net gain measures.

6 Potential for lighting from the Facility to affect foraging and roosting birds

6.1 Concern relating to lighting

6.1.1 Concerns have been raised by RSPB as shown in **Table 6-1** and **Table 6-2** regarding the potential for impacts on birds from lighting.

Table 6-1 Comments raised by RSPB (REP2-051) regarding the potential for impacts on birds from lighting

Interested Party	Relevant Representation	AUBP Response at Deadline 1	RSPB's Comment	AUBP's Response
Comments on the Applicant's response to the RSPB's Relevant Representation for the Royal Society for the Protection of Birds (REP2-051)				
RSPB Row 39 (Lighting)	Limited detail on lighting and its impacts on birds.	Lighting effects covered in the EIA and HRA	We consider more information is needed to assess ecological consequences of lighting as set out in our Written Representation (Section7(f) , REP1-060).	Further information is provided in **Section 6.2** of this document with regard to the potential for effects on birds from lighting used during construction and operation phases.
RSPB Row 89 (HRA)	Highlights the importance of the Application site for redshanks.	The Applicant accepts the peak counts of waterbirds in Survey Areas A and B. They highlight that higher numbers of birds used Area B away from the proposed wharf site. They also mention "offsets" that will benefit waterbirds.	The RSPB considers the Application site is important for redshanks and therefore robust assessments of noise, lighting, vessel movements, and how they combine with existing levels of disturbance is required. We do not agree with the use of the term "offsets" in relation to the needed compensation. We discuss this in detail in our	

Interested Party	Relevant Representation	AUBP Response at Deadline 1	RSPB's Comment	AUBP's Response
			response to the Ornithology Addendum.	
RSPB Row 123 (HRA)	Impact of additional lighting	The applicant considers lighting will have limited effects.	We consider more information is needed to assess ecological consequences of lighting as set out in our Written Representation (Section7(f), REP1-060).	

Table 6-2 Comments raised by RSPB (REP4-026) regarding the potential for impacts on birds from lighting

Final comments on the Ornithology Addendum for the Royal Society for the Protection of Birds (REP4-026)		
RSPB Ref 13, Para 4.1, Page 24	Whilst the vessel movements are set out, there is a failure to assess the worst-case noise and lighting impacts.	Further analysis of potential noise impacts on birds was provided for Deadline 4 (document reference 9.50, REP4-015). Further details for potential lighting impacts is included in **Section 6.2** below, including worst case scenarios.
RSPB Ref 17, Table 4-4, Page 27	Table 4-4 is a potentially useful summary of the impacts from the construction and operation of the Facility. However, there is no mention of the impact of increased lighting, especially from the wharf area. We also suggest that noise from the application site should be identified as a separate issue given maximum noise levels, especially impulsive noise, is not covered. RSPB's Recommendation: More detailed assessment on the effect of lighting and noise assessments are required to understand the worst-case ecological consequences arising from the Application.	

6.2 Technical information relating to assessment of potential impacts from lighting

Artificial light at night

6.2.1 Artificial light at night (commonly referred to in scientific literature as ALAN) is the anthropogenic introduction of lighting at times and locations where lighting from natural sources (sun, moon) would not be present (Gaston *et al*., 2013). Exposure of birds to ALAN is greater in urban habitats due to the greater number and concentration of individual light sources, and wider range of purposes for which light sources may be deployed (leisure, industry, security etc.). Coastal and estuarine habitats are frequently affected by ALAN due to association of urbanisation with coastal waterways (Zapata *et al*., 2019). The body of research and the challenges of studying the effects of ALAN on organisms and biology are reviewed by Gaston *et al*. (2015). Broad issues with the body of research include (i) the tendency for illumination to be considered (e.g. during mapping) from a human perspective (focus on light intensity, and the spectrum of light which is visible to humans, etc.); (ii) related to this, the paucity of information regarding how and what ALAN is experienced by birds and other organisms; (iii) lack of published examples of negative results (where no effect of ALAN on the organism is concluded), suggesting either that ALAN is ubiquitously impacting on organisms or the field of research demonstrates a 'file drawer problem' (the minority of studies, reporting a type I error, are published, while the majority of studies, reporting negative results, are unpublished); and (iv) the relatively small number of studies regarding how ALAN impacts on populations, communities and ecosystems (Gaston *et al*., 2015).

6.2.2 ALAN is an established route by which construction can impact on wildfowl and wading birds, wherein industrial development adjacent to a wildfowl and wader roosting or feeding site [has] the potential for disturbance effects caused by increased lighting of the industrial plant. In some instances the disturbance to feeding patterns can be harmful, in others it can be beneficial… The presence of artificial lights has the potential to affect birds in two ways: (i) by providing more feeding time by allowing nocturnal feeding; and (ii) by causing direct mortality or disorientation," (Hockin *et al*., 1992). An additional indirect impact on birds from lighting may be influence over daily activity patterns of their predators, and influence over predation risk. Impact of ALAN on estuary ecology has been reviewed by Zapata *et al*. (2019). For wading birds such as Scolopacidae (sandpipers including redshank) whose foraging activity closely follows tides, "the influence of ALAN will interact with the way individuals contend with night time tides" (Zapata *et al*., 2019).

Outline lighting requirements at the Principal Application Site

Construction

6.2.3 The Outline Code of Construction Practice (OCoCP) (document reference 7.1, APP-120) states that the lighting of the Principal Application Site will include "appropriate lighting and security such as control of lighting/illumination to reduce visual intrusion or any adverse effects on sensitive receptors." Visual intrusion here refers to "nuisance to footpath users, residents and users of The Haven," while cited sensitive receptors are nocturnal animal species including bats. The Updated Outline Landscape and Ecological Mitigation Strategy (OLEMS) (document reference 7.4(1), REP3-007) further cites birds, and accordance with the most recent industry guidance covering birds and bats (the latter is cited as Bat Conservation Trust Bats and Lighting in the UK Guidance (2018)). Measures to limit impact on receptors are primarily:

- use of directional lighting;
- positioning and direction of site lighting to minimise sky glow and lighting spillage;
- use of full lighting only during permitted low-natural-light work hours (sunset to 7 or 8pm Monday to Saturday), and lower-level security lighting outside of these hours (7 or 8pm to sunrise Monday to Sunday, sunset to sunrise Sunday to Monday); and
- maintenance of dark corridors (linear features where bats have either been noted as using, or could use, and where there should be an avoidance of lighting) during the construction phase.

6.2.4 Angling of lighting away from the river is cited elsewhere in the OCoCP as a measure against disruption of navigation on The Haven. ES Chapter 12 - Terrestrial Ecology (document reference 6.2.12, APP-050) cites use of "low pressure sodium lighting which will be located away from areas…used by bat/bird species (i.e. hedgerow and woodland habitats). All lights will be pointed away from these features…" The measures above therefore actively aim to prevent direct lighting of terrestrial bird habitats and The Haven, thereby including intertidal mudflats, but lighting is required to be directed onto intertidal parts of the Haven (saltmarsh and mudflat) where the wharf is proposed to be constructed.

Operation

6.2.5 Operation of the Principal Application Site will be on a 24 hours per day basis. The Outline Lighting Strategy (document reference 7.5, APP-124) lists elements of the Facility likely to require artificial lighting, which include the completed "wharf with cranes and berthing points." It is confirmed elsewhere in the document that

the wharf and berthing area will require new external artificial lighting, “for the wharf to be utilised as part of the Facility.”

6.2.6 Measures to mitigate lighting impacts on the local environment are cited in the Outline Lighting Strategy to include:

- Low-glare fully shielded fittings pointing downwards;
- Motion sensors to ensure lighting is only used when needed;
- Design to reduce brightness and spread of light during operation;
- Design to mitigate light spill onto The Haven and within the Havenside LNR and maximise dark areas for wildlife;
- Design for lighting will be as low intensity as guidelines allow; and
- Lights not being focused onto the river surface when the tide level is high (there is an indication that light spillage does not require further consideration at low tide as fish are not present below lights and vessels are immobile in this period).

6.2.7 Overall, the Outline Lighting Strategy indicates a requirement to balance “*operational requirements for both day-time and night-time lighting of buildings and external areas whilst mitigating impacts on local ecology*.” Operational requirements are cited to include safe operation of all facilities on-site and creating an attractive and safe environment for staff and visitors. Similar to during construction, the measures above actively aim to prevent direct lighting of intertidal mudflats away from the proposed wharf, and there is an indication that lighting at the wharf may be in greatest use during high water when vessels have sufficient draft to float or move. A written operational lighting scheme detailing specific designs and measures (including mitigation for effects on sensitive receptors) for the Facility will be produced post-consent and pre-commissioning in compliance with the DCO requirement 17 (document reference 2.1(2), REP3-003).

Worst-case scenario for lighting

6.2.8 Based on the above information for construction and operational phase lighting, an appropriate worst-case scenario for lighting during the construction phase would entail:

- Directional lighting within the red line boundary during construction (i.e., red line boundary with exception of that for the Habitat Mitigation Area) including the area of saltmarsh and mudflat occupying the footprint of the proposed wharf
  - required full light intensity for working between sunset and 8pm six days per week
  - lower intensity security lighting between 8pm and sunrise six nights per week, all night on the remaining night

6.2.9 An appropriate worst-case scenario for lighting during the operational phase would entail:

- Directional lighting onto all worked areas including the wharf
  - full light intensity for working applied at all hours of activity during darkness (potentially sunset to sunrise seven nights per week)

6.2.10 Under these scenarios, the area of mudflat at which construction of the wharf is planned would receive direct lighting (at 'working' or 'security' light levels) within all darkness hours during construction, with limited horizontal spillage of light to additional areas of mudflat (covered by water during high tide). The same area during site operation (i.e., following completion of the wharf) could receive direct lighting at full working intensity at all hours of darkness during operation of the Applicant site, with limited horizontal spillage of light to surrounding areas of mudflat (covered by water during high tide) and shadow cast (especially beneath the wharf) by the wharf itself and structures placed upon it.

Potential light impacts and their relevance and likelihood at the Principal Application Site

Influence on photoperiod

6.2.11 Introduction of significant artificial lighting in terms of concentration and extent (most commonly in urban areas) has been suggested to be capable of impacting on the photoperiod (hours of perceived 'day' and 'night') experienced by birds and other organisms (Gaston *et al*., 2012). However, experimental testing of the impact of artificial lighting on diurnal birds such as songbirds did not demonstrate a shift in time spent on strongly daylight-related activities such as winter feeding (da Silva *et al*., 2017a) and dawn singing (da Silva *et al*., 2017b). The experimental lighting used in these studies comprised directional halogen spotlights adjacent

to woodland feeding stations (with a significant upward element to illumination). The results suggest that diurnal birds in these conditions were nevertheless more influenced in their activity by the wider natural light cycles than the intense localised artificial lighting. Furthermore, the lighting likely to be deployed at the Principal Application Site during night-time working hours is downward-directed and of low-pressure sodium source, and therefore narrower in spectrum, less distributed and intense in the local area, and less resemblant of natural light.

6.2.12 Additionally, waterbirds foraging at the Principal Application Site are largely from taxonomic groups (sandpipers Scolopacidae, plovers Charadriidae) that are known to forage in both the diurnal and nocturnal periods under natural light cycle conditions (Thomas *et al*., 2006, reviewed McNeil & Rodríguez 1996, Zapata *et al*., 2019). Introduction of ALAN to what are likely to be existing nocturnal foraging locations will therefore generally not represent an extension to the available foraging period but will alter light levels during a period when feeding already occurs.

6.2.13 Overall, **impact of lighting at the Principal Application Site on foraging waterbirds is not predicted to specifically occur via waterbird species' perception of photoperiod**, or the daily or seasonal patterns in physiology associated with this, as light will not be directed or distributed so as to outweigh the influence of the natural light cycles of the local area (e.g., the surrounding 1 x 1 km) on diurnal birds; and most waterbirds concerned are not solely diurnal and their daily activity cycles are also (perhaps more so) influenced by tides.

Impacts on foraging conditions

6.2.14 However, localised introduction of diurnal-like light levels to nocturnal hours, has significant potential positive and negative consequences for foraging waterbirds. Species which forage visually (such as plovers), or 'mixed' visual-tactile feeders which forage more efficiently when visually feeding (such as redshank which are a predominant waterbird species of interest at the Principal Application Site), have opportunity for increased rate of intake of prey under additional introduced lighting (Santos *et al*. 2010). Shorebird species, and commonly individual populations within a species, show variation in their ability to meet their energetic requirements solely through daytime feeding (e.g. Lourenço *et al*. 2008, Cohen *et al*. 2011, Santiago-Quesada *et al*. 2014), therefore some species are reliant on nocturnal foraging to meet daily or seasonal energy requirements, and under fully natural light cycles this will be limited by moonlight or cloud cover (Dwyer *et al*. 2013). Introduced additional opportunity for visual or mixed foragers to feed in a daytime-like (visual) manner (which typically includes more successful selection of more

profitable prey items, Dwyer *et al*. 2013) within the daily cycle, can therefore have positive survival consequences dependent on species or population.

6.2.15 Santos *et al*. (2010) also observed (via video recording with night vision and infra-red illuminators at distance of up to 300 m) higher numbers of visual-forager individuals (*Charadrius* and *Pluvialis* plovers) feeding at night in artificially lit areas of habitat (relative to numbers recorded at those locations by day), than in areas not lit at night, indicating a preference or attracting effect of ALAN. This has also been reported in gull and heron species exploiting artificial light to forage nocturnally active fish (Martin & Raim 2014) but is not noted for 'mixed' foragers such as redshank and dunlin *Calidris alpina* (Santos *et al*. 2010, Dwyer *et al* 2013). Species with predominantly tactile foraging methods (such as pied avocet *Recurvirostra avosetta*) are unlikely to experience any foraging benefit from ALAN (Santos *et al*. 2010) (though it is expected that competition with any attracted visual foragers is buffered by limited overlap in prey composition between these foraging groups). It is important to note that all foragers outlined here are capable of foraging nocturnally in the immediate absence of ALAN; whether by tactile means or visually by residual light including moonlight (and existing levels of dispersed ALAN in the environment, e.g. reflected from cloud cover), though as highlighted above, successful detection of the most profitable prey is less likely under lower light levels and more tactile-oriented foraging (Dwyer *et al.* 2013).

6.2.16 Introductions of diurnal-like light levels also improve foraging conditions for diurnal or visual predators of waterbirds, therefore increased feeding opportunity for waterbirds which are visual or mixed foragers carries a trade-off against predation risk. Importantly, predominantly tactile foragers can also experience the introduction of this trade-off to their foraging habitat with negligible predicted benefit to their foraging. In cases where visual-foraging species may be actively attracted to artificially lit areas (as suggested above) which also experience higher rates of predation, ALAN could constitute an 'ecological trap'.

6.2.17 Predation risk from mammals to foraging waterbirds on artificially lit mudflat, which is an open, semi-aquatic habitat, is likely to strongly relate to the following factors:

- The willingness of predators to themselves forage in artificially lit areas (perceived risk from humans or natural predators);
- Distance from the nearest obstruction or dark area to the waterbirds;
- View by one or more waterbirds across this intervening distance; and
- Limits placed on the waterbirds' ability to detect predators by the ALAN, e.g. dazzling, or lowering their acuity for sight in low light levels.

6.2.18 Predation risk is overall likely to vary significantly on a site-by-site basis and may even be manageable via adjustment to lighting, through consideration of the

above factors or following field observational monitoring, data collection and analysis.

6.2.19 Illumination can also affect ecology and availability of waterbirds' prey, but studies concerning predator-prey interactions relevant to wading birds do not extend their investigation or data collection to prey species (or species of similar trophic level and niche). For example, Dwyer *et al*. (2013) does not detail whether prey of redshank may behave such that their detection or accessibility is higher or lower under ALAN, and Underwood *et al*. (2017) acknowledge that ALAN, "may have unforeseen effects on the settlement and anti-predator defences of prey species [mussels]," but this was beyond the scope of their largely laboratory-based study. Nevertheless, redshank, as found at the Principal Application Site, elsewhere show a close predator-prey relationship with *Corophium volutator* (Thompson *et al*. 1986, McCulloch & Clark 1991), an intertidal amphipod crustacean. ALAN is indicated to negatively affect the nocturnal activity and feeding rates of sandy beach amphipods (Lynn *et al.* 2021) and this may also apply to *C. volutator*. However, the area proposed for direct illumination is that also proposed for construction and is not likely to be a commonly used foraging area once work begins. Additionally, any downward trend in activity or energy intake of prey under ALAN is likely to be outweighed by greater detection probability of more profitable individuals under ALAN, as it facilitates visual modes of feeding (Dwyer *et al.* 2013).

6.2.20 Overall, lighting at the Principal Application Site during the construction phase is expected to only fully illuminate the mudflat area also proposed for construction, during darkness hours when work is in progress, therefore it is expected that foraging will not take place at these times due to disturbance from work in progress. The ALAN dispersed over the neighbouring areas of mudflat is planned to be limited by using low, directional lighting away from all other parts of The Haven. **Adjacent areas are therefore expected to receive little effect regarding light levels above baseline during these hours.** During non-working hours, lighting is planned to be lower intensity for security only. **During these hours when the tide is also sufficiently low,** this lighting will spill onto the area of mudflat and from the evidence above **is expected to provide higher light levels for visual foraging, during the likely short period of construction where the substrate remains unobstructed** by addition of wharf structures. During these hours of this period, an attracting effect of the lighting may occur for obligate visual feeders such as grey plover *Pluvialis squatarola* and ringed plover *Charadrius hiaticula* (from the wider mudflat area within horizontal sight of the lit area at mudflat height, around 6 ha of The Haven and its mudbanks). The light is expected to facilitate, but not attract additional individuals of, foraging sandpipers

such as redshank, dunlin, black-tailed godwit *Limosa limosa* and ruff *Philomachus pugnax*. **ALAN during construction is therefore expected to have negligible effect on the distribution of any features of The Wash SPA/Ramsar/SSSI** as no birds within the designated site itself (3 km away) will detect the lighting, and those that are present around the Principal Application Site (most likely not functionally linked to the Designated Sites) will move only over a small maximum area. The ALAN dispersed over the neighbouring areas of mudflat is planned to be limited by using low, directional lighting away from all other parts of The Haven, therefore **little effect on light levels above baseline is anticipated in adjacent mudflat areas**.

6.2.21 Once the wharf topside is added, and during the entire operational phase, the lighting previously directed onto the mudflat in the construction footprint will be directed onto the wharf top. This ALAN, and all other lighting during the remaining construction and operational phase, is planned to be limited in its dispersal onto The Haven by use of low and directional lighting. Lighting from vessels is likely to occur predominantly during navigation and (necessarily) high water levels, when many birds will not be foraging due to mudflats being largely or entirely covered. **ALAN during operation is therefore expected to have little effect on light levels above baseline in surrounding mudflat areas and, as a result, not to affect foraging or distribution of any features of The Wash SPA/Ramsar/SSSI.**

Impacts on roosting birds

6.2.22 Impacts on birds at rest, gregariously, in high tide roosts, are potentially most critical as there is possibility that few or single disturbance events can affect birds in significant numbers and proportions of their local, here designated, populations (Navedo & Herrera 2012). Rogers *et al.* (2006) noted limited (but potentially important) coverage in the literature of shorebirds' propensity to sleep in darkness, and that availability of dark night-time roost sites in which aggregations of birds can avoid detection by predators may be critically important but limited in urban areas. Rogers *et al.* (2006) also repeatedly observed that shorebirds avoid roosting in areas exposed to artificial lighting such as streetlights and vehicles. This was suggested to relate to ease with which predators could detect roosting birds, or some other factor which influences shorebirds' risk assessment of a potential roosting location. Dwyer *et al.* (2013) highlight that vigilance for predators exhibits less trade-off with roosting than with (tactile) feeding and cite an example of the converse wherein birds apparently roosted in artificially lit areas to increase detection of a predator, but this study concerned terrestrial birds (corvids) and an avian predator.

6.2.23 ALAN appears not to confer similar potential counter-balancing advantages on roosting birds as it does on foraging birds, who can benefit from improved lighting of their surrounding open habitat when it increases success of obtaining most profitable prey. There would therefore be perhaps greater potential impact of ALAN from the Principal Application Site if light from site illumination was cast over roosting waterbirds. The area of mudflat proposed for direct lighting and construction has been used for roosting by waterbirds and will be lost due to construction as outlined in the ES Chapter 17 Marine and Coastal Ecology (document reference 6.2.17, APP-055), but an alternative roost site is available in bird survey Area B downstream. The roost site in Area B (the area which also contains the Habitat Mitigation Area for wharf construction) lies at global co-ordinates 52.959376, -0.001310, well outside of the area illuminated by construction phase lighting even in the worst-case scenario. ALAN from the Principal Application Site is therefore predicted to have no impact above the baseline on birds roosting in survey Area B. These roost aggregations have also persisted through current and past periods of night-time vessel traffic and associated navigation lights, **therefore vessel and navigational light sources associated with the Applicant Project are predicted to have no impact on the suitability of roost sites available under the project scenario.**

Displacement

6.2.24 A further suggested potential impact on birds from ALAN is displacement of birds from an area altogether, due to avoidance of artificial lighting. A singular example from the literature concerns increased avoidance of an industrial site by migrating eider *Somateria spp*. (Day *et al*. 2017) and no studies have been found which report bird avoidance or displacement from preferred habitat following introduction of ALAN.

6.2.25 Overall, ALAN during the construction phase is anticipated to contribute to displacing birds from foraging or roosting in the mudflat under active construction (being fully lit during working hours of darkness). ALAN during the non-working hours of the construction phase will be directed at a lower (security lighting) intensity onto an area of progressively less suitable habitat as wharf structures are added, themselves causing displacement. Overall, it seems likely that once construction has begun, the mudflat area may be subject to reduced use or may even be avoided by waterbirds, even during overnight periods when construction is not ongoing. At this time alternate habitat will be available at the mitigation area, which will not be subject to ALAN. In the latter construction phase and operational phase, lighting is due only to be directed onto industrial areas of the facility of low general suitability for birds.

7 Disturbance events and energy usage by birds

7.1 Concerns expressed regarding disturbance and energy usage by birds

7.1.1 **Table 7-1** collates comments received relating to disturbance issues and the potential energy usage by birds that are disturbed by vessel movements along The Haven.

Table 7-1 Comments raised by Interested Parties relating to disturbance issues and the potential energy usage by birds that are disturbed by vessel movements along The Haven.

Interested Party	Question or comment	AUBP Response
A Summary of Natural England's Position on the Potential Impacts to The Wash SPA Annex I passage and Overwintering Birds (AS-002)		
Natural England (Page 2)	<u>Mouth of the Haven the Wash SPA – compensation</u> Even if the required standard best practice project specific data sets are provided, our advice that an AEoI can't be ruled out is unlikely to change due to the additional number of vessel movements adjacent to known roost sites for birds which are known to either: • Be disturbed and leave roost locations with no return thus the distribution of species is not being maintained within the SPA as required by the conservation objectives; OR • Be repeatedly disturbed and returning resulting in potential impact to energy budgets which could affect abundance within the SPA in the long term.	Additional work on energy budgets is provided below. In terms of the distribution of birds within the SPA the disturbance from vessels in the baseline situation already causes the redistribution to alternative roosting areas. With an average of one additional vessel movement per tide, it is predicted that the birds will maintain the distributions that occur during the baseline situation. Two key bird species (lapwing and golden plover) are expected to undergo increased impacts on energy budgets that would have the potential to affect abundance of these species. However, both lapwing and golden plover have daily routines considerably more de-coupled from tidal cycles, readily entering open terrestrial habitats by day and night. Their limited association with intertidal ecology is such that they have historically been excluded from analyses for an estuarine bird predator-prey dynamics study (Atkinson *et al*. 2010). Additionally, golden plover are typically present at the MOTH in 'negligible' numbers relative to their mean peak SPA populations (HRA Addendum Appendix A1 Table 2). Overall, the energetic demands of disturbance responses to project-related activities are not considered to apply at sufficient severity, or to a sufficient number of individuals, to impact survival or subsequent breeding success of The Wash SPA waterbird populations.

Interested Party	Question or comment	AUBP Response
Natural England's Relevant Representations (RR-021)		
Natural England Appendix B. 13	Natural England advises that, for species, which return to the roost it is likely to take more than 120 sec to pass by the roost from first disturbance to departure. Note this is equivalent to a fight of approx. 1.8km (based on 15m/s = 1800m per 120 secs (Hedenström, A. & Åkesson, S. (2017). (Flight speed adjustment by three wader species in relation to winds and flock size. Animal Behaviour, 134, 209-215.)	This is addressed in the subsection 'General' of the Energetics section (**Section 7.2**) below.
Natural England's Comments on Habitats Regulations Assessment – Ornithology Addendum [REP1-026] (REP2-045)		
Natural England Paragraph 2.4	Of these the birds affected the majority of disturbed individuals abandon the roosts in response to vessel passage (e.g. para 6.1.7; 6.1.10; 6.1.14; 6.1.18; 6.1.24) and do not return for the rest of the high tide period. There are therefore two areas of potential AEoI of the site's conservation objectives. Firstly, to individual fitness as a consequence of increased energy expenditure; and secondly to the distribution objective as a consequence of the loss (as a result to disturbance events occurring on 100% of tides) of a significant roost.	In terms of the distribution of birds within the SPA the disturbance from vessels in the baseline situation already causes the redistribution to alternative roosting areas. With an average of two additional vessel movements per tide, it is predicted that the birds will maintain the distributions that occur during the baseline situation.
Natural England Paragraph 2.5	In the current documentation [REP1-026] the risk of AEoI is considered without reference to the objectives (maintain vs restore) of individual species, or their individual energy balances and the loss of the Mouth of the Haven roost area permanently is not considered. **Natural England considers that an AEoI cannot be ruled out beyond all reason scientific doubt for these impacts**. Natural England also notes that while consideration has been given	Additional work on energy budgets is provided below in **Section 7.2**. It is not expected that the MOTH roost would be permanently lost due to the increase over baseline numbers of vessels. It is expected that the birds would continue to use the same alternative roost sites that they currently use when vessels cause disturbance.

Interested Party	Question or comment	AUBP Response
	to impacts on a number of individual species which form features of the site, no assessment is made of the Annex I non-breeding waterfowl assemblage as a feature in its own right of the Wash SPA.	The Annex 1 non-breeding waterfowl assemblage is discussed further in **Section 5** of this document.
Written Representations for the Royal Society for the Protection of Birds (REP1-060)		
RSPB Paragraph 7.102	Whilst the energy budget has been calculated and assessed for lapwing and golden plover this should also be undertaken for other species, notably redshank, black-tailed godwit and dark-bellied brent goose. Where this is not possible, a clear rationale for why this is the case should be provided. We request this be reviewed and a note provided on this issue."	Energy budgets are estimated for these additional species in the sections on redshank, black-tailed godwit and dark-bellied brent goose below in **Section 7.2**.
Final comments on the Ornithology Addendum for the Royal Society for the Protection of Birds (REP4-026)		
RSPB Paragraph 2.53	With respect to the availability of alternative roost site, no work has been undertaken by the Applicant to confirm where alternative roosts are located and their nature. Roost site availability will be dependent on the height of the tides. On a neap tide (the lowest tidal heights), some areas may not be fully inundated and enable waterbirds to roost and forage. On a spring tide (the highest tidal heights), very few, if any, areas will be left exposed and therefore roost sites will be at a premium or not available at all until the tide recedes. The weather can also impact on the inundation of areas, with strong winds creating surge tides. If these coincide with spring tides in particular, all available roost sites around The Haven might be inundated. This has been reported by WeBS counters over the weekend of 6 November 2021, where a surge tide left very few roost sites on The Wash. The surge tide also held the tide from	The Applicant agrees that the availability (to mouth of The Haven roosting birds) of alternative roost sites on The Haven, and along the foreshore of The Wash at Freiston and Frampton, clearly varies between neap and spring tide heights, as observed also by the Applicant's contractor during bird surveys. At neap tide the alternative roosts are within 800 m of the mouth of The Haven and, to at least some species (curlew, redshank, black-tailed godwit, golden plover), are of primary quality/preference and used immediately without prior disturbance (as the tide shifts foraging birds into initial roost sites). However, suitable non-tidal, freshwater roost sites adjacent to The Haven would remain available under all tide magnitudes, in part due to the landscaping and engineering already in place at the RSPB reserves at Frampton Marsh and more distantly Freiston Shore nature reserves. The final programme of winter bird surveys being carried out for the

Interested Party	Question or comment	AUBP Response
	retreating meaning that mudflats took longer to become exposed and for birds to return to forage. In such situations, this places additional stress on birds and means that there is a greater amount of competition for space at the roost sites that are available. This can have serious consequences for the energy budget of waders. Where these natural events already put pressure on waders, additional disturbance from vessels and other activities that generate noise and visual disturbance will exacerbate the stress. This could have serious ecological consequences for the birds fitness and survival.	Applicant Project (Nov 2021 to Mar 2022) includes effort to record precise locations of high tide roosts in the tidal reaches in and around The Haven, with scheduling of visits to capture both spring and neap tides. This data is expected to be available during late March 2022. With regard to surge tides, the Applicant acknowledges the occurrence of such (exceptional) events (around once per year) due to seasonal storms and long-term climate change. With an existing 75% likelihood of vessel transit of The Haven on a given tide under baseline conditions, the Applicant considers that, should the responsibility for mitigating the impacts of such surge tides on birds lie with vessel operators, a system for mitigation must already be in place by arrangement with the Port of Boston and its client operators. If such a system is not currently in place, then the Applicant questions whether placement of responsibility for mitigating surge tide impacts on birds upon the Applicant Project is proportionate.
RSPB Paragraph 2.54	We have also observed a similar situation at the Tabs Head hide. On neap tides, there is an area of mudflat that is left exposed at high tide. This allows birds to not simply roost but also to continue to forage over the hightide period. This can be important for species that have energy budget deficits such as black-tailed godwit and vessel disturbance could be significant when these lower tides would still allow birds to forage and bathe. This has not been explored by the Applicant in detail.	The Applicant confirms that they are aware of the greater availability of mudflat at and around the mouth of The Haven during neap tides. This is an area of information which has recently been confirmed to the Applicant through further discussions with their surveyor 'on the ground' at The Haven who carried out the surveys of waterbird responses to vessel movements; and one which is the subject of the final programme of winter bird surveys concluding in March 2022. On such tides, existing surveys have noted mudflats that remain exposed 800 m from the mouth of The Haven, to which many species fly on first disturbance and are subsequently not

Interested Party	Question or comment	AUBP Response
		disturbed by later vessels (species in which this was observed were redshank, dunlin, knot, golden plover and black-tailed godwit). The Applicant is also aware of the history of black-tailed godwits on The Wash operating in some winter months at a net energetic loss as detailed in Alves *et al.* (2013). Key factors suggested by the authors of this study as to why this population experiences such net loss (relative to the southern Ireland population) included colder prevailing winter weather conditions, but also the poorer availability of coastal grasslands to supplement foraging intake. If a limiting factor to this availability is abundance of grassland of the correct sward and low level of disturbance from recreation or agricultural work (rather than simply winter freezing), then the Applicant's net gain/in principle compensation design (which includes wet grassland creation close to The Haven) stands to increase availability of foraging grasslands. Designs in progress draw upon existing sites such as Caldy, Wirral UK (global co-ordinates 53.36498, -3.15194) where simple pools and open grassland accommodate thousands of black-tailed godwit from the Dee Estuary at certain tides. Creation of such habitat is expected to provide a refuge or actively preferred foraging site for this species and provide additional habitat/compensate not only for project-level disturbance but potentially baseline-level disturbance (i.e. net gains for the species).
RSPB Paragraph 3.36-3.38	At the mouth of The Haven, it is therefore likely that oystercatchers would be predominantly juvenile and female birds. Any increase in disturbance that increases energy	The Applicant confirms that they are aware of the concept of 'carryover' effects on breeding success of individuals originating from impacts/pressures that are applied during non-breeding

Interested Party	Question or comment	AUBP Response
	expenditure and reduces the ability of birds to forage could affect the numbers of pairs that able to breed in future seasons, or the number of young birds surviving to become adults, all of which could cause population declines. We do not consider the evidence presented in the HRA provides sufficient evidence that such an impact could not occur from increased vessel movements on this species.	periods of the annual cycle. However, the disturbance from vessels is considered not to act with sufficient severity (% of SPA population) to exert such an effect. Although Appendix A1 of the HRA Addendum, Table 13, cites potential impact on 20% of the SPA population, this is precautionary and based on observations of only 3% maximum exhibiting disturbance.
RSPB Paragraph 3.52	As a consequence of the selection criteria clearly being met for golden plover and lapwing it is essential that a full assessment of these features is carried out. Table 4 of the addendum appendix (p.87) clear shows the significant proportion of The Wash SPA lapwing and golden plover populations that are being impacted by vessel disturbance (10% and 19% of The Wash SPA populations respectively). The observations of bird disturbance at the mouth of The Haven recorded lapwings and golden plovers being disturbed on multiple occasions, highlighting the importance of the area for the birds and the reluctance to move away. This strongly indicates that there is some factor making this area highly important for these species. In addition, surveys on 19 December 2019, recorded 1,100 lapwings and 2,500 golden plovers being disturbed by vessel movements and they collectively made up 56% of the total 6,480 birds disturbed by that event (the total birds disturbed equated to 1.9% of The Wash SPA waterbird assemblage). A full assessment of these species must be presented, including a fully developed energy budget.	The Applicant provides further coverage of energetics of these species in the sections for lapwing and golden plover in **Section 7.2** below.
RSPB Recommendations Table	We consider the Kvist et al. (2001) and Collop et al. (2016) papers are helpful references for the basis of the energy budget calculations that have been applied to qualifying	Noted by The Applicant. The Applicant directs attention to the submission on construction and operational phase noise levels impacts on redshank (document reference 9.50, REP4-015)

Interested Party	Question or comment	AUBP Response
Ref 1, Para 2.1.1, Page 7	features if The Wash SPA/Ramsar that were observed to take flight and return to their original location following disturbance by vessel. These are established, peer-reviewed methods for calculating energy expenditure. However, reality is different from the answer to an equation. The impacts on birds does not depend only on energy budgets but also on behavioural ecology. The site may be abandoned by the birds or used only by smaller numbers of birds because of the disturbance. There is good evidence that this is what actually happens in reality in response to disturbance at coastal sites. Burton *et al*. 2002 showed that construction work at Cardiff Bay reduced the numbers of redshank and several other wader species and reduced the carrying capacity of the bay. Burton *et al.* 2006 showed that the loss of intertidal habitat in Cardiff Bay caused the redshank mortality rate to increase by 44%. Whittingham *et al*. 2019 showed that undisturbed sites supported higher densities of turnstones than those with human disturbance. Burton, N.H.K., Rehfisch, M.M. & Clark, N.A. 2002. Impacts of disturbance from construction work on the densities and feeding behaviour of waterbirds using the intertidal mudflats of Cardiff Bay, UK. Environmental Management 30. 865-871. Burton, N.H.K., Rehfisch, M.M., Clark, N.A. & Dodd, S.G. 2006. Impacts of sudden winter habitat loss on the body condition and survival of redshank Tringa totanus. Journal of Applied Ecology 43: 464-473.	submitted at Examination Deadline 4. The level of disturbance from baseline activities, and the level of increase in disturbance as a result of the project above baseline, are not considered to be sufficient to cause decreases in the numbers of birds using the resources on The Haven.

Interested Party	Question or comment	AUBP Response
	Whittingham, M.J., McKenzie, A.J., Francksen, R.M., Feige, D., Cadwallender, T., Grainger, M., Fazaa, N., Rhymer, C., Wilkinson, C., Lloyd, P., Smurthwaite, B., Percival, S.M., Morris-Hale, T., Rawcliffe, C., Dewson, C., Woods, S., Stewart, G.B. & Oughton, E. 2019. Offshore refuges support higher densities and show slower population declines of wintering Ruddy Turnstones Arenaria interpres. Bird Study 66: 431-440. **RSPB's Recommendation:** More detailed species accounts that consider site-specific abundance, distribution and behaviour to inform the HRA conclusions.	
RSPB Recommendations Table Ref 22, Para 4.3.6, Page 30	This isn't clear whether it's referring to the wharf site or the Witham Mouth. The assumption about utilising another roost site is not supported by any evidence one is even available. This could have significant consequences for energy budgets. This paragraph assumes an alternative site is available and suitable. 0.36% additional energy requirement (if correct) could be significant for species already in net energy deficit as has previously been identified for at least one species (black-tailed godwit).	The Applicant confirms that the paragraph is referring to the proposed wharf site. References to alternative locations to which birds would move within 400 m when disturbed, refer to other areas of foreshore which remain exposed at high tide, particularly on neap tides. Following observations made of behavioural responses to vessel movement at the proposed wharf site, these sites would act as temporary refugia from which birds would typically quickly return to the main roost after the vessel had become more distant; rather than being used as secondary roost sites. The Applicant directs attention to further accounts of repeat disturbance and energetics of redshank at the Principal Application Site in the redshank sub-section of **Section 7.2** below.
RSPB Recommendations Table	It is not correct that the dark-bellied brent geese observed at the mouth of The Haven were roosting. Where birds are feeding any displacement will have a direct impact on energy intake and energy budgets. This could impact on	The Applicant confirms that the dark-bellied brent geese observed were not roosting. They were bathing and drinking and so also were not feeding, therefore displacement from

Interested Party	Question or comment	AUBP Response
Ref 39, Para 6.1.8, Page 48	the birds overwinter survival and fitness for migration and breeding. We disagree with the conclusions. **RSPB's Recommendations:** Collect abundance and distribution data along the whole length of The Haven and navigation channel out to the anchorage area to assess potential impacts on dark-bellied brent geese.	these activities was not an imposition on time budgeted for foraging. The Applicant confirms that abundance and distribution data on SPA and assemblage waterbirds is being collected along the whole length of The Haven in the current and final programme of winter surveys (December 2021 to March 2022). This data is to be made available during late March 2022.
RSPB Recommendations Table Ref 40, Para 6.1.9, Page 48	Given the potential impact on energy budget for dark-bellied brent geese and the displacement from favoured feeding areas, we disagree that this species will not be adversely affected. It is not clear that the behaviour of dark-bellied brent geese has been accurately applied to this section and therefore we cannot agree with any of the statements that are made regarding impacts arising from the Application on this species. **RSPB's Recommendations:** Collect abundance and distribution data along the whole length of The Haven and navigation channel out to the anchorage area to assess potential impacts on dark-bellied brent geese.	The Applicant confirms that abundance and distribution data on SPA and assemblage waterbirds is being collected along the whole length of The Haven in the current and final programme of winter surveys (December 2021 to March 2022). This data is to be made available during late March 2022
RSPB Recommendations Table Ref 41, Para 6.1.11, Page 49	BW has been identified as in energy deficit, so the conclusion about no impact appears to be unsubstantiated. Black-tailed godwits experience an energy deficit during the winter and additional disturbance could have significant consequences for their overwintering survival and fitness for migration and breeding. The species has also declined likely due to site-specific pressures, as identified in the	The Applicant directs attention to further accounts of disturbance and energetics of black-tailed godwit in the black-tailed godwit sub-section of **Section 7.2** below. The Applicant confirms that abundance and distribution data on SPA and assemblage waterbirds is being collected along the whole length of The Haven in the current and final programme

Interested Party	Question or comment	AUBP Response
	current WeBS Alerts. The fact that such high numbers of black-tailed godwits have been observed at the mouth of The Haven highlights the considerable importance this area of The Wash has for this species. We disagree with a comparison of the energy budget of knot, given the energy deficit that has been identified for this species. We do not agree that this species would not be adversely affected. Any additional pressures will make restoration of this SPA feature more difficult. Any conclusions must be suitably precautionary given the limited evidence that has been gathered to draw conclusions. **RSPB's recommendations:** Collect abundance and distribution data along the whole length of The Haven and navigation channel out to the anchorage area to assess potential impacts on black-tailed godwits.	of winter surveys (December 2021 to March 2022). This data is to be made available during late March 2022
RSPB Recommendations Table Ref 42, Para 6.1.14, Page 49	It is not clear that knot is an appropriate proxy for the energy budget of oystercatcher. We also disagree that birds being forced to move up to 3.3km to an alternative roost can be easily dismissed as not impacting on the conservation objectives of the species. This area of The Wash is clearly important for the species. The species has also declined by 14% in the short term and 22% in the long term based on available WeBS data. It is essential that any additional activity does not exacerbate declines or make restoration of numbers harder. There is no evidence presented to suggest that the current baseline level of disturbance is not affecting overwintering survival or fitness of oystercatcher. We therefore cannot agree that there will	The Applicant confirms they are aware of the WeBS trends for oystercatcher of The Wash SPA and that while the scales of change are 'borderline' they have not triggered a WeBS Alert (Woodward *et al*., 2019) over any timescale. The Applicant confirms that abundance and distribution data on SPA and assemblage waterbirds is being collected along the whole length of The Haven in the current and final programme of winter surveys (December 2021 to March 2022). This data is to be made available during late March 2022

Interested Party	Question or comment	AUBP Response
	not be an adverse effect on this species from increased vessel movements. **RSPB's Recommendation:** Collect abundance and distribution data along the whole length of The Haven and navigation channel out to the anchorage area to assess potential impacts on oystercatchers.	
RSPB Recommendations Table Ref 44, Para 6.1.22, Page 51	It is not clear that knot is an appropriate proxy for the energy budget of redshank. We also disagree that birds being forced to alternative roosts can be easily dismissed as not impacting on the conservation objectives of the species. This area of The Wash is clearly important for the species. It is essential that any additional activity does not exacerbate declines or make maintenance and/or restoration of numbers harder. We therefore cannot agree that there will not be an adverse effect on this species from increased vessel movements. **RSPB's Recommendation:** Collect abundance and distribution data along the whole length of The Haven and navigation channel out to the anchorage area to assess potential impacts on redshanks.	The Applicant directs attention to further accounts of disturbance and energetics of redshank in the redshank sub-section of **Section 7.2** below. The Applicant confirms that abundance and distribution data on SPA and assemblage waterbirds is being collected along the whole length of The Haven in the current and final programme of winter surveys (December 2021 to March 2022). This data is to be made available during late March 2022

7.1.2 Cargo vessels associated with the Facility will transit along The Haven around high water (when draught is sufficient for vessels to move) during both construction and operation phases. The boundaries of The Wash SPA, Ramsar site and SSSI align with one another in this region of The Wash Embayment and align with the mean high water line on the foreshores with The Wash on both sides of the mouth of The Haven and extend up The Haven to the saltmarsh patches (inclusive) on both sides of the channel at the confluence with Hobhole Drain, 3 km downstream of the Principal Application Site. Some of the species for which these sites are designated are also found in upstream areas of non-designated habitat, including adjacent to the Principal Application Site. The connectivity of such sites is discussed in **Section 4** of this document.

7.1.3 Appendix 17.1 – HRA (document reference 6.4.18, APP-111) (paragraphs A17.6.32 to A17.6.64) sets out potential impacts, including baseline surveys of behavioural changes during vessel movement, on all features of The Wash SPA/Ramsar site/SSSI at the mouth of The Haven (which lies within the designated sites). It outlined that feature and assemblage species whose peak counts of birds giving a disturbance response to baseline vessel movements were significant (by virtue of exceeding 1% of their Wash SPA populations), were: redshank, oystercatcher, shelduck, dark-bellied brent goose, turnstone, black-tailed godwit; and waterbird assemblage species northern lapwing (hereafter 'lapwing') and golden plover. Of these, redshank, oystercatcher, turnstone, shelduck, and dark-bellied brent goose were concluded to be subject to initial displacement by the first vessel movement per high tide period, thus moving to a roost site or sites more distant from the vessel route and not subject to subsequent vessel disturbance; while lapwing, golden plover and occasionally black-tailed godwit were concluded likely to be subject to repeated vessel disturbance due to a tendency to make return flights to their original location following disturbance. Completion of observation sessions up to November 2021 (Bentley 2021) show that repeat disturbance of black-tailed godwit is rare and that the species is more likely to be displaced during first vessel passage of the high tide period, as with other species above.

7.1.4 Of bird species concluded to be vulnerable to repeated disturbance with each vessel passage, lapwing and golden plover were further assessed regarding energetics of (vessel) disturbance, following calculations previously used for The Wash shorebirds in Collop *et al.* (2016), and it was concluded that a predicted four additional disturbance flights per day would "result in an increase in daily energy requirements of up to 2%." Predicted impacts of additional energy expenditure was concluded to be "very low".

7.1.5 Vessel disturbance at the Principal Application Site itself was also covered by baseline surveys of waterbird behaviour in response to vessels (Bentley 2020, 2021). Disturbance responses of waterbirds here (predominantly redshank, plus oystercatcher, curlew, shelduck and bar-tailed godwit *Limosa lapponica*) were largely displacement flights to elsewhere on The Haven banks a similar distance from the shipping route, and therefore potentially vulnerable to subsequent repeat disturbance from vessels. Vessels causing disturbance at this site also included small commercial (fishing) vessels (HRA Addendum Table 6-3 (document reference 9.13, REP1-026)) (potentially due to the narrow nature of The Haven at this site) as well as commercial cargo and pilot vessels which were predominant causes of vessel-based disturbance at the wider mouth of The Haven. Data from the Principal Application Site and the mouth of the Haven are collated in HRA Addendum Appendix A3 (document reference 9.13, REP1-026).

7.1.6 This section of the report refers to the worst-case scenario for vessel-based disturbance during the construction and operation phases, and to additional published studies, to provide more detail on the energetics of disturbance to waterbirds on The Haven.

7.2 Further detail on energetics of disturbance to each species

7.2.1 The methodology used in the HRA for lapwing and golden plover energetics was the method used in Collop *et al*. (2016) study of disturbance energetics of experimentally disturbed (by walk-up) waders on The Wash Embayment. Cost per second of flight in this study was estimated using an equation published in Kvist *et al.* (2001) which relates body mass to energetic cost of (level) flight. Daily thermoneutral energy requirement was estimated using an equation published in Nagy *et al.* (1999). In the HRA analysis, a worst-case flight time (typically rounded up from the maximum recorded flight time during surveys), was used to estimate the percentage of daily energy (intake) requirement taken up by a single disturbance flight. Natural England, in their Relevant Representation (document reference RR-021) appendix B13, indicated that the flight times as recorded by the field surveyor appeared short given the distance likely to be flown by birds disturbed and returning to their high tide roost, and recommended a 15 m/s airspeed for waders based on intercepts and averages of airspeed for three species provided by Hedenström & Åkesson (2017). However, the study cited concerns migrating waders likely to be pacing their flight over a vastly longer distance, whereas birds undertaking escape flight will prioritise speed over longevity or stamina in flight. The Applicant assures that the relationship between flight time and flight distance originally indicated in the HRA is accurate.

7.2.2 The number of flights predicted per day due to vessel movements was used to estimate the percent of energy intake requirement taken up in total per day by vessel disturbance. For lapwing and golden plover this was suggested to be four additional disturbance flights per day, due to four large-vessel transits/movements related to the Facility per day in addition to baseline shipping traffic. This is calculated as a worst-case scenario and the average will be less than this with 580 additional vessels per year, averaging 1.6 vessels related to the project per day (3.2 vessel movements) or 0.8 vessels (1.6 movements) per high tide period. The means by which individuals may compensate for the additional use of their energetic intake when disturbed, was not detailed in the original HRA. The additional use was considered to be a very low percentage and as such it was implied that birds could therefore readily compensate. However, how additional energy demand is compensated is an important consideration. Options for individual waders to compensate increased energy use include:

- Feeding as normal, i.e., birds already take in food energy in surplus to their daily thermoneutral requirement and can already accommodate even the projected level of additional disturbance without need for increased foraging effort;
- Feeding additionally by day, i.e., birds forego some other activity, e.g. loafing or roosting, to instead forage and compensate the additional energy use;
- Feeding additionally at night, i.e., birds forego another night-time activity to instead forage (potentially in a habitat or area too disturbed during the day) to compensate the additional energy use; and
- Proceeding to live and survive within The Wash at an energy deficit, or increased deficit, and increasing seasonal intake at another location on the migratory cycle.

7.2.3 Existing research has shown that wader populations range from readily reaching their energetic demands by solely diurnal foraging (Cohen *et al.* 2011, Alves *et al*., 2013) to failing to meet energetic demands at the monthly scale under existing conditions such as black-tailed godwit on The Wash (Alves *et al*., 2013). Nocturnal foraging is also well documented among many wading bird taxa (McNeil & Rodríguez 1996). Site-specific information is variable regarding the strategies available to or used by populations of the respective waterbird species cited as occupying the regularly disturbed high tide roosts in The Wash such as the MOTH.

7.2.4 While flight times are likely to genuinely reflect rapid flight speeds, a general caveat on energy expended on flight as calculated by Collop *et al*. (2016) and the HRA analyses is that the calculation concerns level flight, and so is likely to underestimate expenditure as take-off itself requires an additional input of energy. Nudds and Bryant (2000) indicated that multiple quantitative physiological studies

(using doubly-labelled water) of short flights which include take-off and may be relevant to escape behaviour, had predicted flight costs more than double the costs predicted from 'steady-state' flapping flight data, as is the approach in Kvist *et al*. (2001) and therefore Collop *et al*. (2016). The difference in methodologies and the form of flight behaviour studied mean that quantifying the underestimate is not straightforward.

Redshank

7.2.5 Energetics of disturbance responses in redshank in The Wash have been previously estimated from experimentally disturbing foraging birds (Collop *et al*. 2016). This is the study from which energetics calculations were determined in the original HRA assessment. Using a standard estimated body mass of 143 g and a mean flight time of 17.44 s (standard error 1.67 s, min 4, max 58), this study estimated a daily thermoneutral energy requirement of 308.30 kJ and a cost per flight response of 0.227 kJ, i.e., 0.074% of daily thermoneutral intake requirement. Assuming a flight speed of 18.3 m/s (APEM 2014), the above mean flight time and energy use covers a distance of 319 m. **A displacement of 800 m, the maximum recorded during observations of responses to commercial vessels at the mouth of The Haven, would equate to 0.186% of thermoneutral daily energy requirement**.

7.2.6 Redshank at the mouth of The Haven are considered to be subject to single displacement disturbance per high tide, as the first large vessel passes through the area. Under baseline (BL) vessel traffic where 75% of high tides are utilised by commercial shipping and pilotage, and under worst-case scenario (WCS) project conditions where 100% of tides are utilised, redshank are estimated to be displaced from the mouth of The Haven 1.5 times per day (once on 75% of high tides) and 2 times per day (100% of high tides), respectively. (There is therefore a projected increase in the mean number of daily displacement events of 33%.) Rounding up to one additional displacement flight per day, there is an additional energetic demand equivalent to 0.186% of daily energy requirement. This assumes that displacement does not itself lead to subsequent disturbance from (e.g.) landing in less suitable or more disturbed habitat (by vessels, recreation or predators). This assumption reflects the reality for redshank during neap tides when mudflats 800 m from the mouth of The Haven remain available for roosting (e.g. the foreshore on the Freiston side of the Haven mouth) with no observed subsequent disturbance from vessels and no difference in exposure to predators or recreation (A. Bentley, *personal observation/communication*).

7.2.7 Redshank at the Principal Application Site are considered more likely to be subject to repeat disturbance and furthermore to also be responsive to smaller

commercial vessels (e.g. fishing fleet) in addition to large commercial vessels. Maximum disturbance flight time observed at this location is 60 s (estimated following Collop *et al*. (2016) as above to equate to 0.25% of thermoneutral daily energy requirement). Under baseline conditions, redshank at this location are expected to experience vessel disturbance on 75% of high tides wherein typically one to three (but up to five) large vessel movements take place, undertaking disturbance flights with return to an equally vulnerable location each time. Under condition of three large vessel movements on each of these tides, this gives a daily average of 4.5 disturbance flights per day in response to large vessels plus one or two per day in response to fishing boats assuming a convoy system. Under 60 s flights, 5.5 to 6.5 per day totals 1.38 to 1.65% of daily energy requirement under baseline conditions. Under project conditions assuming an additional 3.2 vessel movements per day (using 100% of high tides) this would cause an equivalent increase of 3.2 additional disturbance flights per day, equivalent to an **additional 0.81%** of daily energy requirement. Assuming 60 s flights, and no change to the fishing fleet location and their use of a convoy system, **redshank under project conditions at the Principal Application Site are predicted to expend 2.19 to 2.46% of daily energy requirement on disturbance response to vessels.**

Black-tailed godwit

7.2.8 Black-tailed godwit at the mouth of The Haven are considered likely to be rarely subject to repeat disturbance due to rarely returning to their roost location following some disturbance events due to vessel traffic. Black-tailed godwit are suggested overall to be subject to single displacement disturbance per high tide, as the first large vessel passes through the area (A Bentley *personal communication*). The maximum disturbance flight time observed was 90 s. Following Collop *et al*. (2016) using this flight time and a standard female (larger than males) body mass of 332 g (Alves *et al*. 2013[3]), cost per maximum flight time is estimated to be 1.60 kJ. Of an estimated daily thermoneutral energy requirement of 547kJ, **a 90 s disturbance flight would therefore equate to 0.29% of daily energy requirement.**

7.2.9 Under baseline (BL) vessel traffic where 75% of high tides are utilised by commercial shipping and pilotage, and under worst-case scenario (WCS) project conditions where 100% of tides are utilised, black-tailed godwit are estimated to be displaced from the mouth of The Haven 1.5 times per day (once on 75% of high tides) and 2 times per day (100% of high tides), respectively. (There is therefore a projected increase in the mean number of daily displacement events of 33%.) Rounding up to one additional displacement flight per day, there is an

[3] *Costs, benefits, and fitness consequences of different migratory strategies (Alves et al., 2013)*

additional energetic demand equivalent to 0.29% of daily energy requirement. This assumes that displacement does not itself lead to subsequent disturbance from (e.g.) landing in less suitable or more disturbed habitat (by vessels, recreation or predators). This assumption reflects the reality for black-tailed godwit during neap tides when mudflats 800 m from the mouth of The Haven remain available for roosting (e.g. the foreshore on the Freiston side of the Haven mouth) with no observed subsequent disturbance from vessels and no difference in exposure to predators or recreation (A. Bentley, *personal observation/communication*).

7.2.10 Black-tailed godwit wintering in The Wash Embayment are understood historically to have **operated at an energetic net loss in at least some months of the winter** – i.e., monthly average thermoregulatory costs exceeded net energy intake for those months regardless of whether both diurnal and nocturnal feeding was undertaken (Alves *et al*. 2013). Factors underlying this were cited to include exposure to low temperatures including easterly wind chills, and more limited access to grasslands to supplement feeding on mudflats, than other wintering populations which do not suffer the same energy deficit during winters (Alves *et al.* 2013). This further adds importance to limiting additional energy demands on individuals due to disturbance. The proposed net gain measures would provide additional habitat that could benefit black-tailed godwit at the site.

Dark-bellied brent goose

7.2.11 Following Collop *et al.* (2016) using a standard body mass of 1365 g (Riddington *et al.* 1996) and using a maximum flight distance of 650 m (the maximum recorded during observations of responses to commercial vessels at the mouth of The Haven) and assumed flight speed of 17.7 m/s (APEM 2014) to produce a maximum flight time of 37 s, cost per maximum flight response distance is estimated to be 1.101 kJ. Of an estimated daily thermoneutral energy requirement of 1433 kJ, **a displacement of 650 m would therefore equate to 0.077%.**

7.2.12 Dark-bellied brent geese at the mouth of The Haven are considered to be subject to single displacement disturbance per high tide, as the first large vessel passes through the area. Under baseline (BL) vessel traffic where 75% of high tides are utilised by commercial shipping and pilotage, and under worst-case scenario (WCS) project conditions where 100% of tides are utilised, dark-bellied brent geese are estimated to be displaced from the mouth of The Haven 1.5 times per day (once on 75% of high tides) and 2 times per day (100% of high tides), respectively. (There is therefore a projected increase in the mean number of daily displacement events of 33%.) Rounding up to one additional displacement flight per day, there is an additional energetic demand equivalent to 0.077% of daily

energy requirement. This assumes that displacement does not itself lead to subsequent disturbance from (e.g.) landing in less suitable or more disturbed habitat (by vessels, recreation or predators).

7.2.13 Riddington *et al*. (1996) previously studied the energetics of the dark-bellied brent goose at North Norfolk sites of potential similar ecology to those on The Wash Embayment. Using energy cost estimates for daily activities and energy intake estimates in various foraging habitats, then constructing daily activity compositions on (i) less disturbed and (ii) higher disturbance days, **this study indicated a 10.9% higher energy expenditure on high-disturbance days.** Under maximum rates of disturbance (4 minutes in flight per hour), the compensation was concluded to require nocturnal foraging, as diurnal foraging time was too constrained by other activities to allow the necessary 29 additional minutes of feeding in pasture (or >50 minutes on saltmarsh) during this time (Riddington *et al*. 1996). The higher relative estimates of energy expenditure in this study compared to the HRA and Collop *et al*. (2016) approach are likely to be a product of (i) the former's coverage of disturbance in relation to all causes, and (ii) the former's attention to energy expenditure as calculated from activities in contrast to the latter's attention to basic thermal energy requirements calculated from body mass. While both studies have methodology considered valid following peer-review and make underlying assumptions to simplify estimation, the contrasting results of Riddington *et al*. (1996) highlights the information value of considering all causes of disturbance.

Lapwing

7.2.14 Lapwing at the mouth of The Haven are considered likely to be subject to repeat disturbance due to returning to their roost location following disturbance events due to vessel traffic. The maximum disturbance flight time observed was 120 s. Following Collop *et al*. (2016) using this flight time and a spring body mass of 222 g (Eichhorn *et al.* 2017), cost per maximum flight response distance is estimated to be 1.84 kJ. Of an estimated daily thermoneutral energy requirement of 416.0 kJ, **a 120 s disturbance flight would therefore equate to 0.442%.**

7.2.15 Under baseline conditions, lapwing at the mouth of The Haven are expected to experience vessel disturbance on 75% of high tides, wherein typically one to three (but up to five) large vessel movements take place, undertaking disturbance flights with return to an equally vulnerable location each time. Under condition of three vessel movements on each of these tides, this gives a daily average of 4.5 disturbance flights per day in response to large vessels. Assuming 120 s flights this totals 1.99% of daily energy requirement. Under project conditions assuming an additional 3.2 vessel movements (worst-case scenario 4 vessel movements

following the original HRA approach) per day (using 100% of high tides) this would cause an equivalent increase of 4 additional disturbance flights per day, equivalent to an **additional 1.77%** of daily energy requirement as previously estimated by the HRA analysis. **Assuming 120 s flights, lapwing under project conditions are predicted to expend 3.76% of daily energy requirement on disturbance response to vessels.**

7.2.16 Following Riddington *et al*. (1996), required additional time spent feeding was estimated under disturbance conditions for lapwing. Here, required additional foraging time was estimated per disturbance flight. Barnard *et al*. (1982) provides estimates of energetic intake of lapwing feeding in pasture in the presence or absence of gulls. In the latter, mean estimated net energy intake was 5.12 cal/s, or 1.285 kJ/min. Under an estimated disturbance flight energetic cost of 1.84 kJ, this indicates that additional feeding time of 1.4 minutes is required for every disturbance flight. The estimated increase in vessel-related disturbance flights above (four) is expected to require 5.6 mins of additional foraging time per day. This time is likely to be an underestimate, as energy cost of flight does not include the (higher) energetic cost of take-off. This estimate for foraging time based on use of pasture assumes access to this habitat (or other short-sward grasslands such as parkland or amenity fields) at any time it is required, but in reality, frozen ground or disturbance is likely to limit access to this habitat. Compensatory foraging in other habitats such as saltmarsh is documented (in brent geese) to carry slower intake of energy (Riddington *et al*., 1996), and mudflat invertebrate food resources are prone to depletion over winter under existing levels of use by birds (Alves et al. 2013). Additional foraging time also requires reduction of time spent on other activities such as roosting, which could be deleterious. In lapwing, and golden plover, nocturnal foraging is possible and well documented including in pasture (Gillings *et al*., 2005). However, this is considered to be a result of insufficient energy intake being possible during daylight hours, and individuals could already be undertaking compensatory feeding for existing disturbance (including at night) under baseline conditions (Gillings *et al*., 2006). Disturbance flights will also be taking place (under both baseline and project conditions) in response to other sources of disturbance such as coastal recreation and predators.

7.2.17 There is a medium term (10 year) and also a long term (up to 25 year) WeBS Alert for population trend of lapwing in The Wash SPA (Woodward et al. 2019), indicating a distinctly more negative population trend for the species at the SPA scale relative to the regional or national trends. While it is not possible to conclude with certainty that the baseline level of disturbance is sustainable among the lapwing population of The Wash SPA, there is equally no data demonstrating a

link between disturbance to lapwing and their survival rates or population trend within The Wash SPA.

Golden plover

7.2.18 Golden plover at the mouth of The Haven are considered likely to be subject to repeat disturbance due to returning to their roost location following disturbance events due to vessel traffic. The maximum disturbance flight time observed was 90 s. Following the HRA analysis a worst-case flight time of 120 s is assumed. Following Collop et al. (2016) using this flight time and a spring body mass of 214 g (Piersma & Jukema 2002), cost per maximum flight response distance is estimated to be 1.81 kJ. Of an estimated daily thermoneutral energy requirement of 405.7 kJ, **a 120 s disturbance flight would therefore equate to 0.446%.**

7.2.19 Under baseline conditions, golden plover at the mouth of The Haven are expected to experience vessel disturbance on 75% of high tides, wherein typically one to three (but up to five) large vessel movements take place, undertaking disturbance flights with return to an equally vulnerable location each time. Under condition of three vessel movements on each of these tides, this gives a daily average of 4.5 disturbance flights per day in response to large vessels. Assuming 120 s flights this totals 2.01% of daily energy requirement. Under project conditions assuming an additional 3.2 vessel movements (worst-case scenario 4 vessel movements following the original HRA approach) per day (using 100% of high tides) this would cause an equivalent increase of 4 additional disturbance flights per day, equivalent to an **additional 1.78%** of daily energy requirement as previously estimated by the HRA analysis. **Assuming 120 s flights, golden plover under project conditions are predicted to expend 3.79% of daily energy requirement on disturbance response to vessels.**

7.2.20 Following Riddington *et al*. (1996), required additional time spent feeding was estimated under disturbance conditions for golden plover. Here, required additional foraging time was estimated per disturbance flight. Barnard *et al*. (1982) provides estimates of energetic intake of golden plover feeding in pasture in the presence or absence of gulls. In the latter, mean estimated net energy intake was 1.53 cal/s, or 0.384 kJ/min. Under an estimated disturbance flight energetic cost of 1.81kJ, this indicates that additional feeding time of 4.7 minutes is required for every disturbance flight. The estimated increase in vessel-related disturbance flights above (four) is expected to require 18.8 mins of additional foraging time per day. This time is likely to be an underestimate, as energy cost of flight does not include the (higher) energetic cost of take-off, and similar other caveats apply as with lapwing above. An effective minimum additional 18.8 minutes of foraging time in grassland due to vessel disturbance is likely to be an imposition on golden

plovers' existing time-energy-activity budget, and while the species is one well established to forage readily at night this will already be part of their daily cycle under baseline conditions (Gillings *et al*. 2006). It is unclear how this additional foraging time would be afforded by individuals. One option by which it may be facilitated as part of Applicant Project net gain/compensation is the provision of expansive, safe foraging grassland with disturbance and predation engineered to be low but foraging in this habitat relies on its uptake by birds, and nocturnal foraging time availability varies with illumination levels from the moon (moon phase, cloud cover) (Gillings *et al*. 2005) and grassland foraging is reduced unavoidably during freezing weather conditions.

7.2.21 There is a medium term (10 year) WeBS Alert for population trend of golden plover in The Wash SPA (Woodward et al. 2019), indicating a distinctly more negative population trend for the species at the SPA scale relative to the regional or national trends. While it is not possible to conclude with certainty that the baseline level of disturbance is sustainable among the golden plover population of The Wash SPA, there is equally no data demonstrating a link between disturbance to golden plover and their survival rates or population trend within The Wash SPA.

7.3 Conclusions

7.3.1 Disturbance to individuals of the bird species above is concluded to place a daily energetic demand equivalent to up to a few per cent of their daily thermoneutral energy requirement, under the baseline scenario, on days and high tides when vessel passages occur. Under Applicant Project worst-case scenario conditions, activities relating to the project are indicated to place energetic demands equivalent to less than an additional 1% of daily energy requirements, but on an additional 25% of tides, on species prone to one-off displacement; and energetic demands equivalent to approximately an additional 1-2% of daily energy requirements on species prone to repeat displacement.

7.3.2 The potential for population level impacts on individuals' energy balances, survival and subsequent breeding success depends additionally on the probability of disturbance impacting significant numbers of individuals. The species prone to accumulating at the MOTH in 'moderate' (1-5%) or 'large' (>5%) numbers by virtue of percentage of their SPA populations (as highlighted in the HRA Ornithology Addendum Appendix A1 Table 2 (document reference 9.13, REP1-026) includes species which are indicated here to face the lowest additional energetic demands at the MOTH: dark bellied brent goose and redshank. Lapwing also occur in moderate to large numbers at more than half of high tides at the MOTH and are prone to repeat disturbance. Golden plover is similarly prone to repeat disturbance. However, both lapwing and golden plover have daily routines

considerably more de-coupled from tidal cycles, readily entering open terrestrial habitats by day and night. Their limited association with intertidal ecology is such that they have historically been excluded from analyses for an estuarine bird predator-prey dynamics study (Atkinson et al. 2010). Additionally, golden plover are typically present at the MOTH in 'negligible' numbers relative to their mean peak SPA populations (HRA Ornithology Addendum Appendix A1 Table 2 (document reference 9.13, REP1-026). Black-tailed godwit are similarly reported to be generally present in 'negligible' numbers relative to their SPA population and are considered to be prone to one-off displacement entailing a very low additional demand on daily energy requirement, especially on neap tides when alternative high quality roosting habitat is present within 800 m of the MOTH. Redshank at the Principal Application Site are considered as a majority to be less likely to form part of The Wash SPA population of this species.

7.3.3 Overall, the energetic demands of disturbance responses to project-related activities are not considered to apply at sufficient severity, or to a sufficient number of individuals, to impact survival or subsequent breeding success of The Wash SPA waterbird populations.

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